On the fundamentals of winning virtuous strategies creation toward leveraged buyout transactions implementation during private equity investment in conditions of resonant absorption of discrete information in diffusion-type financial system with induced nonlinearities

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Abstract – The authors perform an original research on the fundamentals of winning virtuous strategies creation toward the leveraged buyout transactions implementation during the private equity investment in the conditions of the resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities at the influences by the Schumpeterian creative disruption processes in the free market economy. We propose that the money is a financial computing process, which is executed by the operating system, representing an exchange medium, at a computing device. We make a comprehensive academic literature review on the various aspects of modern financial engineering approaches to make the private equity investments and design the leveraged buyout and venture capital firms, funds and transactions in the finances. We highlight a private equity’s important role in the Schumpeterian creative destruction processes in the free market economy, discussing the leverage buyout transactions process and properties. We develop the MicroLBO software: 1) to create the winning virtuous strategies toward the LBO transactions implementation, and 2) to compute the direct/reverse LBO transaction probability number for the selected public/private companies. We formulate the Ledenyov theory on the winning virtuous strategies creation toward the LBO transactions implementation at the resonant absorption of discrete information in the diffusion-type financial economic system with the induced nonlinearities.

JEL Codes: G3, G11, G13, G20, G23, G24, G30, G32, G34, G34, G39, J2, J33, J44, L2.

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

Keywords: winning virtuous strategies creation, corporate governance, private equity financing, leveraged buyout (LBO) firms/funds/transactions, venture capital (VC) firms/funds/transactions, management buyouts, direct/reverse leveraged buyouts (D/RLBOs), bootstrap acquisitions, mergers and acquisitions, “quick flips” business deals, capital structure, leverage risks, post-buyout company business operation efficiency over time, return on equity (ROE), return on investment (ROI), employment/productivity/innovation effects, ownership change, socially responsible investment, probability theory, information absorption theory, econophysics, econometrics, nonlinearities, meaning of money, leveraged finance, microeconomics.
Introduction

The **science of financial engineering** had been thoughtfully used to design and implement the first financial transactions in the financial markets in Joseph Penso de la Vega (1668, 1996). The science of financial engineering had been also applied to evaluate the associated financial risks during the first financial transactions completion in the financial markets, using a number of conceptual mathematical tools and theories, in Bernoulli (1738, 1954), Bagehot (1873, 1897).


In the beginning of XX century, the sophisticated high-level mathematical techniques have been mainly applied to evaluate the financial risks and predict the returns-on-investments in the finances. For instance, Bachelier (1900), French scientist contributed significantly to a scientific progress, developing his original research ideas to estimate the valuable financial papers prices evolution with the help of the probability theory in the mathematics, using the knowledge base in De Laplace (1812), Bunyakovsky (1846), Chebyshev (1846, 1867, 1891), Markov (1890, 1899, 1900).
At the end of XIX century, Hirsch (1896), Australian philosopher formulated the scientific notion of money: “That which is accepted freely, throughout the community, in final discharge of all debts, or in exchange for all commodities, without any intention on the part of the acceptor to consume it, or use it for any other purpose than in his turn to tender it in discharge of debts or in exchange for commodities.” Hirsch (1896) emphasized that the money are used as a medium of exchange and listed the following functions of money:

1. “To enable the exchanges to be made independently of the double coincidence of wants and possessions;
2. To enable the exchange of commodities of different value without any division of these commodities themselves;
3. To serve as a common denominator for the value of existing commodities;
4. To serve as a measure for obligations to be discharged in the future.”

Presently, taking to an account the contemporary research findings in Dodd (2014a, b), the authors think that the initial scientific notion on the meaning of money in Hirsch (1896) can be successfully complemented by the authors’ general theoretical proposition that the money is not an adorable physical object (the metal coin or the paper money) or a virtual object (the bitcoin), but it represents a financial process, taking place in the so called exchange medium, which can be dynamically characterized by the changing values of financial variables in the financial markets over the time, frequency, scale domains. In fact, we can assume that there are numerous financial processes (the money), which are executed in the exchange medium at every given time moment. The authors prefer to make an analogy between the money (the financial processes) and the computing tasks (the computing processes), which can be performed by the operating system (the exchange medium) during the parallel computing at a supercomputer at the same time.

In the course of research on the theory of financial speculations in Bachelier (1900), Slutsky (1922a, b, 1925a, b, 1927a, 1937a, b), it was understood that a possible characterization of complex financial systems within the financial markets can be done much more accurately, considering the existing theoretical models in the science of statistical physics, namely in the condensed matter physics: the model on the Brownian motion of molecules at the heat transfer process in the solids in Bunyakovsky (1825) as well as the Brownian movement of small particles suspended in a stationary liquid demanded by the molecular-kinetic theory of heat in Einstein (1905, 1956), Einstein, Smolukhovsky (1936). Sometime later, the role of the Brownian motion in the random processes has been summarized in Brush (1968, 1977). Moreover, Shiryaev, Grossinho, Oliveira, Esquível (editors) (2006) write: “A.N. Kolmogorov, in his own landmark
work Über die analytischen Methoden in der Wahrscheinlichkeitsrechnung, Math. Annalen 104 (1931), pp.415-458, credits Bachelier with the first systematic study of stochastic processes in continuous time.”

As it has been explained in Ledenyov, Ledenyov (2014d), the ingenious remarkable research ideas on the application of probability theory in finances in Bachelier(1900) have been further developed in the research works in Slutsky (1922a, b, 1925a, b, 1927a, 1937a, b). The groundbreaking propositions on the application of both the theory of probability and the theory of random processes in the finances in Bachelier (1900) have been comprehensively considered during the formulation of the mathematical theory of the Wiener processes in Wiener (1923, 1930, 1949). At later date, aiming to overcome the critical limitations of classical theoretical models like the fractional Brownian motion, the multi-fractals have been introduced in the finances from the mathematical physics in Mandelbrot (1960, 1963a, b, 1965, 1965, 1967a, b, 1969, 1971, 1972, 1975a, b, 1977, 1982, 1997), Mandelbrot, Taylor (1967), Mandelbrot, van Ness (1968), Mandelbrot, Wallis (1969), Ausloos (2000), Kantelhardt, Zschiegner, Koscielny-Bunde, Havlin, Bunde, Stanley (2002), Norouzzadeh, Rahmani (2006), Kim, Yoon (2004), Jiang, Ma, Cai (2007), Jiang, Zhou (2009), Liu, Qian, Lu (2010), Wang, Yu, Suo (2012), Trenca, Plesoianu, Căpusan (2012).

In the early XX century, Schumpeter (1911, 1939, 1947) highlighted a notable fact that, the creative disruptive innovation appears due to the innovation breakthrough processes during the capitalism evolution process in Schumpeter (1911, 1939, 1947). This research outcome has been investigated in details in Christensen (Christensen (June 16, 1977; Fall, 1992a, b; 1997; 1998; December, 1998; April, 1999a, b, c; 1999a, b; Summer, 2001; June, 2002; 2003; March, April, 2003; January, 2006), Bower, Christensen (January, February, 1995; 1997; 1999), Christensen, Armstrong (Spring, 1998), Christensen, Cape (December, 1998), Christensen, Dann (June, 1999), Christensen, Tedlow (January, February, 2000), Christensen, Donovan (March, 2000; May, 2010), Christensen, Overdorf (March, April, 2000), Christensen, Bohmer, Kenagy (September, October, 2000), Christensen, Craig, Hart (March, April, 2001), Christensen, Milunovich (March, 2002), Bass, Christensen (April, 2002), Anthony, Roth, Christensen (April, 2002), Kenagy, Christensen (May, 2002; 2002), Christensen, Johnson, Rigby (Spring, 2002), Hart, Christensen (Fall, 2002), Christensen, Verlinden, Westerman (November, 2002), Shah, Brennan, Christensen (April, 2003), Christensen, Raynor (2003), Burgelman, Christensen, Wheelwright (2003), Christensen, Anthony (January, February, 2004), Christensen, Anthony, Roth (2004), Christensen, Baumann, Ruggles, Sadler (December, 2006), Christensen, Horn, Johnson (2008), Christensen, Grossman, Hwang (2009), Dyer, Gregersen, Christensen...

Firstly, let us explain the meaning of the private equity (PE) in Jegadeesh, Kräussl, Pollet (2009): “Private equity (PE) refers to equity securities in private companies that are not publicly traded. Private equity funds that specialize in PE investments opened up this asset class to institutional investors and other capital market participants. The early successes of some large PE funds led to a rapid growth of this asset class. Capital commitment to private equity in the U.S. has grown rapidly from around $20 billion in 1990 to over $496 billion in 2007.”

The private equity plays an important role in the country’s innovation potential as explained in Bernothy, Colavecchioz, Sass (2010): “Private equity (PE), which was relatively unknown in the early 1980s, has become an important asset class in global financial markets. A number of studies have documented the key role that PE plays in a country's entrepreneurial performance as PE-backed firms create more innovations, employment and growth than their peers.”

Edgerton (January, 2011) notes: “Three components are generally identified as key to the PE funds’ approach to managing firms:

1. highly performance-sensitive managerial compensation,
2. highly levered financing, and
3. active monitoring of firm activities by skilled professionals from the PE fund.

These changes are intended to transform firms into better-managed, more efficient organizations.”

Secondly, let us make a historical overview on the venture capital funds origination in Allen (2012): “Two seminal figures in the development of venture capital were George Doriot, a former general affiliated with Harvard Business School, and MIT President Karl Compton. They effectively launched the venture capital industry in 1946 with the founding of American
Research and Development (ARD), a publicly traded closed-end mutual fund marketed mostly to individuals. Doriot had an ability to identify the most promising entrepreneurs, and he found two in Kenneth Olson and Harlan Anderson, who wanted to start a firm to manufacture small computers. They had no money and no credit when they incorporated Digital Equipment. In 1956 Doriot offered to invest $70,000 in the company in return for a 60 percent stock interest; Olson and Anderson eagerly accepted. The company and the investment proved to be very successful.” Paul A. Gompers, Professor of Business Administration at Harvard Business School writes that the first examples of successful venture capital funded companies are the Digital Equipment Corporation, Memorex, Raychem, and Scientific Data Systems in Fast (1978), Gompers (2002). The authors would like to add that, presently, there is a number of the high-tech clusters with the venture capital funded hi-tech companies, which are situated at the Long Island in New York; Silicon Valley near San Francisco in California; Fort Worth near Dallas in Texas; Research Triangle Park near Durham in North Carolina and at some other places like San – Diego in California, Miami in Florida, and Hawaii in the USA. The biggest financial and law services clusters are located in the New York, Chicago, Atlanta in the USA. The advanced technologies are usually developed in the hi-tech start-up companies, founded by the talented entrepreneurs; financed by the venture capital firms/funds or by the state agencies such as the U.S. National Science Foundation (NSF), Defense Advanced Research Projects Agency (DARPA), Air Force Office of Scientific Research (AFOSR), Office of Naval Research (ONR), Army Research Office (ARO), National Aero Space Agency (NASA), National Security Agency (NSA), Central Intelligence Agency (CIA). The Small Business Innovation Research (SBIR) program represents another example of startup financing initiative by the US government in Link, Ruhm, Siegel (August 2012), Gompers (2002). In many cases, these startup companies are situated at the business incubators within the high-tech clusters near the leading American universities. There are the strong connections between the state agencies and the universities: the Air Force Office of Scientific Research – Massachusetts Institute of Technology; the Army Research Office – Duke University; the National Security Office – Maryland University; the Central Intelligence Agency – Virginia University; the Office of Naval Research – California University Los Angeles; the National Aero Space Agency – Texas University. Also, there are the relatively small high-tech clusters in Canada such as the Kanata high-tech cluster near Ottawa in Ontario; the Calgary high-tech cluster in Calgary in Alberta; the Richmond high-tech cluster near Vancouver in British Columbia; the Mississauga high-tech cluster near Toronto in Ontario; the Waterloo high-tech cluster near Waterloo in Ontario; the Montreal high-tech cluster in Montreal in Quebec. The early stage financing of the Canadian high-tech companies is mainly
performed with the use of the American / Canadian venture capital. For example, Josh Lerner, the Jacob H. Schiff Professor of Investment Banking at Harvard Business School explains in Lerner (2002): “Decisions about whether to finance firms are made not by centralized bodies but rather devolved in many agencies to program managers who are seeking to address very specific technical needs (for example, an Air Force research administrator who is seeking to encourage the development of new composites). As a result, many offbeat technologies that are not of interest to traditional venture investors have been funded through this program.” For example, the Intelligence Advanced Research Projects Activity (IARPA) has decided to develop a superconducting computer at the International Business Machines, Raytheon BBN Technologies and Northrop Grumman. Manheimer, Cryogenic Computer Complexity (C3) program manager at the IARPA states in Reuters (December 3 2014): “Computers based on superconducting logic integrated with new kinds of cryogenic memory will allow expansion of current computing facilities while staying within space and energy budgets, and may enable supercomputer development beyond the exascale.” The authors would like to add that the outsourcing of the R&D and production functions to the Japan, Korea, Taiwan, Malaysia, Singapore, P. R. China on one side, as well as a preservation of the corporate governance, financial engineering and legal support functions in the USA on other side, are commonly spread business practices among the VC financed high-tech companies in the time of globalization. The discussion on the venture capital investing strategies has been conducted in Ledenyov D. O., Ledenyov V. O. (2013i).

Thirdly, let us continue by providing a few leveraged buyout definitions in the contemporary academic literature (see below).

Diamond (editor) (1985): “Leveraged buyouts are all buyout transactions, which increase the leverage (the total debt to total equity ratio) of the purchased company.”

Lichtenberg, Siegel (June, 1989) write: “In an LBO, a group of investors (which sometimes includes incumbent management) takes a company (or a division of a company) private by purchasing all of the outstanding equity of the company, mainly using borrowed funds. The enterprise is much more highly leveraged (it has a higher debt/equity ratio) after the LBO than before. The financing of LBOs often involves the sale of high-yield (or "junk") bonds. The debt incurred to buy out the company is expected to be serviced by a combination of operating income and asset sales.”

Burrough, Heylar (1990, 2005) state: “The basics of LBO are relatively simple: A [consulting investment] firm, working with a company’s management, buys the company, using money raised from banks and the public sale of securities; the debt is paid down with cash from the company’s operations and, often, by selling pieces of the business.”
Piatkowski (June, 2001) write: “Leveraged buyouts (LBOs) represent transactions where a buyer utilizes external financing (bank debt, bonds, third party equity) to finance a purchase of a company. Share of external financing represents the majority part of the total value of the purchase; buyer’s own capital constitutes the minor portion of the total purchase price. Assets of the purchased company along with its cash flow provide collateral and a source of repayment for the incurred debt in the transaction. In the case of a LBO of a public company, quite often the purchased company is delisted from the stock market in what is called as taking it private. Yet, delisting is not necessary.”

Le Nadant, Perdreau (2006) explain: “LBO transactions can be defined as acquisitions of a significant equity stake of a company by private venture capital investors using additional debt financing. They comprise both the case of Management Buy-outs (MBOs) and Management Buy-ins (MBIs). In a MBO, current management with the aid of financial investors takes over the company’s equity from its previous owners, whereas in a MBI, an external management team funded by outside investors takes over the control of a given target company.”

Groh, Baule, Gottschalg (2008) write: “Leveraged Buyouts (LBOs) are transactions in which a financial investor takes over a company via a special purpose vehicle. The funding of the special purpose vehicle is typically composed of several layers of debt and non-traded equity claims. In most of the cases the debt/equity ratios of LBO transactions are above what is considered normal. These two properties - the illiquidity of the private equity market and the leverage ratio make LBOs high-risk investments.”

Kaplan, Strömberg (2008, 2009) denote: “In a leveraged buyout, a company is acquired by a specialized investment firm using a relatively small portion of equity and a relatively large portion of outside debt financing. The leveraged buyout investment firms today refer to themselves (and are generally referred to) as private equity firms. In a typical leveraged buyout transaction, the private equity firm buys majority control of an existing or mature firm. This is distinct from venture capital (VC) firms that typically invest in young or emerging companies, and typically do not obtain majority control.”

Schäfer, Fisher (October 16, 2008) explain: “Private equity investors are primarily active on the market for debt-financed corporate acquisitions (leverage buy-outs). The necessary equity capital for these acquisitions is provided by the buy-out funds and—to a lesser extent—also the future management of the acquired companies. The debt capital generally comes from a syndicate comprised of banks and increasingly also institutional investors. After conclusion of the acquisition, the different risk-bearing loan tranches are passed on to the participating investors and, in some cases, also to the market. The share of debt capital in the total acquisition
price generally fluctuates between 60% and 80%. The aim of the fund is to generate a high return. The investment horizon is usually limited to several years.”

Tåg (2010) defines the LBO as: “Private equity buyouts are acquisitions of established companies undertaken by private equity firms. They are partly financed with debt and partly with equity raised from institutional investors for private equity funds with a predetermined life span. Private equity buyouts are also known as leveraged buyouts or bootstrap acquisitions. When management participates, they are sometimes called management buyouts.”

Allen (2012) explains: “Fenn, Liang and Prowse (1997) point out that before the 1980’s funds for non-venture private equity investments came from venture capital funds and informal investor groups. During the 1980s, limited partnership funds were created specifically to provide non-venture funds. The largest of these specialized in the leveraged buyouts of large public companies. These funds tended to be much larger in size than venture capital funds. This meant they appealed more to pension funds with large amounts of funds to invest.”

In other words, the authors can sum up all the above research statements and formulate a precise definition of leveraged buyout: The Leveraged Buyout (LBO) is a powerful economic and financial mechanism for the corporate transformation by the means of the financial engineering techniques such as a chain of financial transactions implementation with the purpose of corporate ownership change, allowing the management to acquire a company as a result of leveraged buyout deal. In other words, the LBO is the purchase of a company or division of a company using significant debt, whereby the target company’s cash flows are used to support the loan repayments. The Debt can be in the form of the traditional bank financing, bond offerings, seller financing and loans from the specialized funds. The issuance of high yield debt is a key to private equity deals. Fig. 1 shows the value of LBO transactions in the USA in 1986-1997 (in USD billion) in Piatkowski (June, 2001).

Fig. 1. Value of LBO transactions in USA in 1986-1997 (in USD billion) (after Piatkowski (June, 2001)).
Let us illustrate the relative volume of the private equity market in France in 2011 in Crifo, Forget (February, 2012).

Fig. 2 shows the French private equity market (data AFIC 2011 and UN PRI 2011) in amounts of funds raised, funds invested and UN PRI signatories in Crifo, Forget (February, 2012).

![Chart showing the French private equity market in amounts of funds raised, funds invested and UN PRI signatories.](chart)

**Fig. 2.** French private equity market (data AFIC 2011 and UN PRI 2011) in amounts of funds raised, funds invested and UN PRI signatories (after Crifo, Forget (February, 2012)).

Also, let us demonstrate the structure and relative volume of the private equity market in Germany in 2008 in Bannier, Müsch (August, 2008).

Fig. 3 displays the structure of private equity market in Germany in Bannier, Müsch (August, 2008).

Fig. 4 demonstrates the leveraged buyout transactions valuation in Germany in Bannier, Müsch (August, 2008).

In the shown figures, it can be seen that the LBO firms/funds/transactions contribute to both:

1) the optimization of business processes,
2) the increase of effectiveness of business operations,
3) the business innovations introduction in the USA, France, Germany and other countries globally.
Fig. 3. Structure of Private Equity market in Germany (after Bannier, Müsch (August, 2008)).

Fig. 4. Leveraged buyout transactions in Germany (after Bannier, Müsch (August, 2008)).
Fig. 5 shows a number of closed or effective transactions worldwide from 1.1.1970 - 31.12.2009 in the *Capital IQ database* that are marked as LBO or MBO in Strömberg (2008), Tåg (2010)).

**Fig. 5.** Number of closed or effective transactions worldwide from 1.1.1970-31.12.2009 in the *Capital IQ database* that are marked as LBO or MBO. For a careful discussion on the coverage of the *Capital IQ database* (after Strömberg (2008), Tåg (2010)).

Fig. 6 depicts the geographical breakdown of the number of closed or effective transactions worldwide from 1.1.1970-31.12.2009 in the *Capital IQ database* that are marked as LBO or MBO in Strömberg (2008), Tåg (2010)).

**Fig. 6.** Geographical breakdown of the number of closed or effective transactions worldwide from 1.1.1970-31.12.2009 in the *Capital IQ database* that are marked as LBO or MBO (after Strömberg (2008), Tåg (2010)).
Let us note that the *research article discussions* will include, but they certainly will not be limited to, the following *research themes*:

1. Introduction on the *private equity*, including the *venture capital* and *leveraged buyout firms, funds and transactions* in the *economics* and *finances*.

2. The review on some aspects of *modern financial engineering approaches* to design the *leveraged buyout firms, funds and transactions* in the *economics* and *finances*, going from the contemporary research findings in the *academic literature*.

3. The discussion on a *private equity’s important role* in the *Schumpeterian creative destruction processes* in the *free market economy*, considering the *leverage buyout transactions process* and the *accurate characterization of the leverage buyout transactions properties* at the *resonant absorption of discrete information in the diffusion - type financial system* with the *induced nonlinearities*.

4. The discussion on the fundamentals of *winning virtuous strategies creation* toward the *leveraged buyout transactions implementation* during the *private equity investments* in the conditions of the *resonant absorption of discrete information in the diffusion - type financial system* with the *induced nonlinearities* in particular, and at the influences by the *Schumpeterian creative disruption processes* at all.

5. Concluding remarks.

**Modern financial engineering approaches to leveraged buyout firms, funds and transactions during private equity investment in conditions of resonant absorption of discrete information in diffusion - type financial system with induced nonlinearities**

Let us make a comprehensive review on the *leveraged buyout firms, funds and transactions*, explaining the essence of *scientific terms* as in the *academic literature*. We will pay special attention to the modern definitions and interpretations of *scientific terms* in the reviewed research papers.

The *leveraged buyouts* have been researched, because of the reasons outlined in *Opler, Titman (1991)*: “The American corporate sector experienced a dramatic increase in *leveraged buyout activity* in the 1980s. Between 1979 and 1989 there were over 2,000 *leveraged buyouts* (LBOs) valued in excess of $250 billion. A number of possible motivations for these transactions have been advanced, most of which fall into one of the following categories:
1. Incentive realignment, i.e. gains from operating improvements resulting from realigning the interests of stockholders and management,

2. Favorable inside information, i.e. gains from acquiring undervalued assets,

3. Stakeholder wealth transfers, i.e. gains from employee layoffs, union-busting or raising the risk of preexisting debt, and

4. Tax savings, i.e. tax reductions from increasing leverage and stepping up asset basis.”

Let us define the **leveraged buyout (LBO) firm** as in Kaplan, Strömberg (2008; Winter, 2009): “The typical *private equity firm* is organized as a *partnership* or *limited liability corporation*. Blackstone, Carlyle, and KKR are three of the most prominent *private equity firms*. In the late 1980s, Jensen (1989) described these firms as lean, decentralized organizations with relatively few investment professionals and employees. In his survey of seven large *leveraged buyout partnerships*, Jensen found an average of 13 investment professionals, who tended to come from an investment banking background. Today, the large *private equity firms* are substantially larger, although they are still small relative to the firms in which they invest. KKR’s *S-1* (a form filed with the *Securities and Exchange Commission* in preparation for KKR’s *initial public offering*) reported 139 investment professionals in 2007. At least four other large *private equity firms* appear to have more than 100 investment professionals. In addition, *private equity firms* now appear to employ professionals with a wider variety of skills and experience than was true 20 years ago.”

Let us understand a meaning of the **leveraged buyout (LBO) fund** as in Kaplan, Strömberg (2008; Winter, 2009): “A *private equity firm* raises equity capital through a *private equity fund*. Most *private equity funds* are “*closed-end*” vehicles in which *investors* commit to provide a certain *amount of money* to pay for *investments* in companies as well as *management fees* to the *private equity firm*. Legally, *private equity funds* are organized as *limited partnerships* in which the *general partners* manage the fund and the *limited partners* provide most of the capital. The *limited partners* typically include *institutional investors*, such as *corporate and public pension funds, endowments, and insurance companies*, as well as *wealthy individuals*. The *private equity firm* serves as the fund’s *general partner*. It is customary for the *general partner* to provide at least 1 percent of the *total capital*.

The fund typically has a fixed life, usually ten years, but can be extended for up to three additional years. The *private equity firm* normally has up to five years to invest the fund’s *capital* committed into companies, and then has an additional five to eight years to return the *capital* to its investors. After committing their capital, the *limited partners* have little say in how
the general partner deploys the investment funds, as long as the basic covenants of the fund agreement are followed. Common covenants include restrictions on how much fund capital can be invested in one company, on types of securities a fund can invest in, and on debt at the fund level (as opposed to debt at the portfolio company level, which is unrestricted). Sahlman (1990), Gompers and Lerner (1996), and Axelson, Strömberg, and Weisbach (2008) (forthcoming) discuss the economic rationale for these fund structures.

The private equity firm or general partner is compensated in three ways. First, the general partner earns an annual management fee, usually a percentage of capital committed, and then, as investments are realized, a percentage of capital employed. Second, the general partner earns a share of the profits of the fund, referred to as “carried interest,” that almost always equals 20 percent. Finally, some general partners charge deal and monitoring fees to the companies in which they invest. Metrick and Yasuda (2007) describe the structure of fees in detail and provide empirical evidence on those fees.”

Some aspects of the LBO fund business structure and its operational issues have been researched in Shell (2006).

Let us provide the leveraged buyout (LBO) transaction definition as in Kaplan, Strömberg (2008; Winter, 2009): “In a typical private equity transaction, the private equity firm agrees to buy a company. If the company is public, the private equity firm typically pays a premium of 15 to 50 percent over the current stock price Kaplan (1989b); Bargeron, Schlingemann, Stulz, and Zutter (2007). The buyout is typically financed with 60 to 90 percent debt—hence the term, leveraged buyout. The debt almost always includes a loan portion that is senior and secured, and is arranged by a bank or an investment bank. In the 1980s and 1990s, banks were also the primary investors in these loans. More recently, however, institutional investors purchased a large fraction of the senior and secured loans. Those investors include hedge fund investors and “collateralized loan obligation” managers, who combine a number of term loans into a pool and then carve the pool into different pieces (with different seniority) to sell to institutional investors. The debt in leveraged buyouts also often includes a junior, unsecured portion that is financed by either high-yield bonds or “mezzanine debt” (that is, debt that is subordinated to the senior debt). Demiroglu and James (2007) and Standard and Poor’s (2008) provide more detailed descriptions.

The private equity firm invests funds from its investors as equity to cover the remaining 10 to 40 percent of the purchase price. The new management team of the purchased company (which may or may not be identical to the pre-buyout management team) typically also
contributes to the new equity, although the amount is usually a small fraction of the equity dollars contributed.


Fig. 7 shows the U.S. private equity fundraising and transaction values as a percentage of total U.S. stock market value from 1985 to 2007 in *Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009)*.

![Fig. 7. U.S. private equity fundraising and transaction values as a percentage of total U.S. stock market value from 1985 to 2007 (after Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009)).](image)

Fig. 8 depicts the global private equity transaction volume, 1985–2006 in *Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009)*.

![Fig. 8. Global private equity transaction volume, 1985–2006 (after Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009)).](image)
Tab. 1 shows the global leveraged buyout transaction characteristics across time in Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009).

### Table 1: Global Leveraged Buyout Transaction Characteristics Across Time.
The table reports transaction characteristics for 17,171 worldwide leveraged buyout transactions that include every transaction with a financial sponsor in the CapitalIQ database announced between 1/1/1970 and 6/30/2007. Enterprise value is the sum of the sum of equity and net debt used to pay for the transaction in 2007 U.S. dollars. For the transactions where enterprise value was not recorded, these have been imputed using the methodology in Strömberg (2008).

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<tbody>
<tr>
<td>Combined Enterprise Value</td>
<td>$257,214</td>
<td>$148,614</td>
<td>$553,852</td>
<td>$1,055,070</td>
<td>$1,365,250</td>
<td>$3,610,787</td>
<td></td>
</tr>
<tr>
<td>Number of transactions</td>
<td>642</td>
<td>1,123</td>
<td>4,348</td>
<td>5,673</td>
<td>5,188</td>
<td>17,171</td>
<td></td>
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</tbody>
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**LBOs by type:**

<table>
<thead>
<tr>
<th>Type</th>
<th>% of Combined Enterprise Value</th>
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<tbody>
<tr>
<td>Public to private</td>
<td>49%</td>
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<tr>
<td>Independent private</td>
<td>31%</td>
</tr>
<tr>
<td>Divisional</td>
<td>17%</td>
</tr>
<tr>
<td>Secondary</td>
<td>2%</td>
</tr>
<tr>
<td>Distressed</td>
<td>0%</td>
</tr>
</tbody>
</table>

**LBOs by target location:**

<table>
<thead>
<tr>
<th>Region</th>
<th>% of Combined Enterprise Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States and Canada</td>
<td>87%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7%</td>
</tr>
<tr>
<td>Western Europe (except UK)</td>
<td>3%</td>
</tr>
<tr>
<td>Asia and Australia</td>
<td>3%</td>
</tr>
<tr>
<td>Rest of World</td>
<td>0%</td>
</tr>
</tbody>
</table>

Tab. 2 displays the exit characteristics of leveraged buyouts across time in Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009).

### Table 2: Exit Characteristics of Leveraged Buyouts Across Time.
The table reports exit information for 17,171 worldwide leveraged buyout transactions that include every transaction with a financial sponsor in the CapitalIQ database announced between 1/1/1970 and 6/30/2007. The numbers are expressed as percentage of transactions, on an equally-weighted basis. Exit status is determined using various databases, including CapitalIQ, SDC, Worldscope, Amadeus, Cao and Lerner (2007), as well as company and LBO firm web sites. See Strömberg (2008) for a more detailed description of the methodology.

|--------------------------|-----------|-----------|-----------|-----------|-----------|-----------|--------------|

**Type of exit:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankruptcy</td>
<td>7%</td>
<td>6%</td>
<td>5%</td>
<td>8%</td>
<td>6%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>IPO</td>
<td>28%</td>
<td>25%</td>
<td>23%</td>
<td>11%</td>
<td>9%</td>
<td>11%</td>
<td>1%</td>
</tr>
<tr>
<td>Sold to strategic buyer</td>
<td>31%</td>
<td>35%</td>
<td>38%</td>
<td>40%</td>
<td>37%</td>
<td>40%</td>
<td>35%</td>
</tr>
<tr>
<td>Sold to financial buyer</td>
<td>5%</td>
<td>13%</td>
<td>17%</td>
<td>23%</td>
<td>31%</td>
<td>31%</td>
<td>17%</td>
</tr>
<tr>
<td>Sold to LBO-backed firm</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
<td>5%</td>
<td>6%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Sold to management</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Other / unknown</td>
<td>20%</td>
<td>18%</td>
<td>12%</td>
<td>11%</td>
<td>10%</td>
<td>7%</td>
<td>24%</td>
</tr>
<tr>
<td>No exit by Nov. 2007</td>
<td>3%</td>
<td>5%</td>
<td>9%</td>
<td>2%</td>
<td>43%</td>
<td>43%</td>
<td>88%</td>
</tr>
</tbody>
</table>

**% of deals exited within:**

<table>
<thead>
<tr>
<th>Period</th>
<th>24 months</th>
<th>60 months</th>
<th>72 months</th>
<th>84 months</th>
<th>120 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-1974</td>
<td>14%</td>
<td>47%</td>
<td>53%</td>
<td>48%</td>
<td>70%</td>
</tr>
<tr>
<td>1985-1989</td>
<td>12%</td>
<td>40%</td>
<td>53%</td>
<td>48%</td>
<td>75%</td>
</tr>
<tr>
<td>1990-1994</td>
<td>14%</td>
<td>41%</td>
<td>43%</td>
<td>49%</td>
<td>82%</td>
</tr>
<tr>
<td>1995-1999</td>
<td>13%</td>
<td>40%</td>
<td>45%</td>
<td>49%</td>
<td>82%</td>
</tr>
<tr>
<td>2000-2004</td>
<td>9%</td>
<td>13%</td>
<td>43%</td>
<td>55%</td>
<td>82%</td>
</tr>
<tr>
<td>2005-2007</td>
<td>13%</td>
<td>13%</td>
<td>43%</td>
<td>55%</td>
<td>82%</td>
</tr>
<tr>
<td>Whole period</td>
<td>12%</td>
<td>42%</td>
<td>51%</td>
<td>58%</td>
<td>76%</td>
</tr>
</tbody>
</table>

Tab. 2. Exit characteristics of leveraged buyouts across time (after Strömberg (2008), Kaplan, Strömberg (2008; Winter, 2009)).
The most innovative research contributions to the modern theory of venture capital transactions, firms, funds and closely linked scientific subjects have been done by a number of truly distinguished researchers as shown in a chronological order in Berle, Means (1932a, b), Solow (August, 1957), Modigliani, Miller (June, 1958), Penrose (1959), Marris (May, 1963),
Design of leverage buyout process and accurate characterization of leverage buyout transactions properties during private equity investment in conditions of resonant absorption of discrete information in diffusion-type financial system with induced nonlinearities

Let us discuss the financial engineering techniques to design the LBO process during the private equity investment in the conditions of resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities.

According to Piatkowski (June, 2001), the strategic investors and sellers in the LBO process can be defined as (see below) and the financing for the leverage transactions can be described as (see below):

1. **Strategic investors** are represented by:
   
   (1) incumbent management (the so-called management buyout - MBO),
   
   (2) employees (mostly through Employee Share Ownership Programs - ESOP),
   
   (3) external management (management buy-in - MBI), and
   
   (4) other corporations.

2. **Sellers** are comprised of three main groups:
   
   (1) private, family-owned companies willing to share business with new investors or quit entirely, because of retirement, desire for liquidity or problems with management succession;
   
   (2) corporations, which spin-off their non-core, non-strategic assets, which do not fit the business strategy or do not meet criteria on return on equity or market potential;
   
   (3) and finally shareholders in public companies, which want to sell their stakes in return for some premium over the prevailing market stock price.

3. **Financing for the leverage transactions** is provided by various financial institutions:
   
   (1) commercial banks,
   
   (2) insurance companies,
   
   (3) pension funds, which usually assume the role of secured debt lenders, and
   
   (4) venture capital and private equity firms along with investment banks, which primarily position themselves as providers of subordinated debt or equity.”
Piatkowski (June, 2001) writes: “There are two main structures of the leveraged buyout depending on what is bought:

1. assets of the company or
2. its shares.

In both cases, the economic result is the same: the investor assumes control over the company. Yet, financial, tax, accounting and legal implications may largely differ depending on the chosen transaction structure.”

Piatkowski (June, 2001) explains:

“Asset purchase: The leveraged buyout of the company based on the purchase of its assets offers some benefits versus the purchase of the company’s shares. In short, the purchase of assets considerably limits the legal risk associated with the buyout. The buyer assumes the liabilities, which are directly related to the assets being bought. Almost none of the remaining liabilities of a target company are conveyed. Hence, the buyer is not liable for any of the selling corporation’s undisclosed or unknown liabilities (.skeletons in the cupboard.). Thanks to clear identification of the assets being purchased, lenders can secure themselves on identifiable pieces of assets rather than the total company’s property including both assets and liabilities. Consequently, the purchase of assets allows easier access to secured debt financing.

Share purchase: The purchase of shares rather than assets can be accomplished much faster. In addition, the purchase of shares allows automatic and complete takeover of all assets of the company, including those, which due to their nature are not transferable and can not be sold (contracts, administrative permits, licenses etc.). Those advantages are mitigated by the higher risk of buying a company with potential unreported liabilities (.skeletons.), and the higher cost of debt financing due to less clearly identifiable debt collateral (for more on legal aspects see the “Legal, tax, and accounting aspects” section of the paper).”

Piatkowski (June, 2001) proposes the following LBO business plan: “The LBO business plan would normally comprise the following elements:

a) Executive summary of the transaction,
b) Information memorandum on the target company,
c) Valuation of the target company,
d) Financing of the purchase,
e) Exit strategies (ways of selling back the purchased company),
f) Calculations of investor’s ROI for different scenarios,
g) Analysis of tax, legal and accounting aspects.”
Piatkowski (June, 2001) notes: “Leveraged buyouts improve performance of companies owing to three effects:

1. **Higher operating efficiency** due to:
   a) *reduction in agency costs* (conflicts of interests between management and shareholders) due to closer control of shareholders over the management,
   b) *higher commitment of management due to salary incentive programs focused on the performance of a company rather than its size* (share options etc.),
   c) *disciplinary impact of the debt burden*, which prompts the management to conserve cash and pursue investment projects with undoubted positive returns (NPV).

2. **More efficient financial structure** with higher debt leverage, which, while decreasing the overall cost of a company’s capital, increases a company’s ROE. **Tax deduction of debt interests** (tax shield) decreases tax payments and consequently results in larger free cash flow, which is another source of value for shareholders.

3. **Better allocation of assets** achieved through the sale of non-core or redundant assets and rigorous assessment of all investment projects aimed at selection of the investment projects with high net present values.”

Fig. 9 shows the LBO market players in Michel, Schaked (1988), Piatkowski (June, 2001). Tab. 3 depicts the investment in largest LBO funds in 1997 (in USD billion) in Piatkowski (June, 2001)). Tab. 4 demonstrates the LBO financing sources and its structure in American market in Gaughan (1996), Piatkowski (June, 2001). Fig. 10 presents some information on the cost of LBO financing in Piatkowski (June, 2001).

![Diagram of LBO market players](image-url)
### Tab. 3. Investment in largest LBO funds in 1997 (in USD billion)
(after Piatkowski (June, 2001)).

<table>
<thead>
<tr>
<th>LBO Fund</th>
<th>Investment received</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kohlberg, Kravis, Roberts &amp; Co. (KKR)</td>
<td>5.8</td>
</tr>
<tr>
<td>Blackstone Group</td>
<td>3.8</td>
</tr>
<tr>
<td>Forstmann Little</td>
<td>3.2</td>
</tr>
<tr>
<td>Thomas H. Lee Company</td>
<td>3.5</td>
</tr>
<tr>
<td>Hicks, Muse, Tate and Furst</td>
<td>3.5</td>
</tr>
<tr>
<td>Texas Pacific Group</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22.3</strong></td>
</tr>
</tbody>
</table>

### Tab. 4. LBO financing sources and its structure in American market
(after Gaughan (1996), Piatkowski (June, 2001)).

<table>
<thead>
<tr>
<th>Type of financing</th>
<th>Per cent in total financing</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secured debt</td>
<td>5-20%</td>
<td>Commercial banks</td>
</tr>
<tr>
<td>Subordinated debt (long-term debt, junk bonds, convertible bonds)</td>
<td>40-80%</td>
<td>Commercial banks, insurance companies, pension funds, investment banks</td>
</tr>
<tr>
<td>Third-party equity</td>
<td>10-20%</td>
<td>insurance companies, investment banks, venture capital funds, LBO funds</td>
</tr>
<tr>
<td>Own equity</td>
<td>1-20%</td>
<td>LBO investors</td>
</tr>
</tbody>
</table>

### Fig. 10. Cost of LBO financing (after Piatkowski (June, 2001)).

- **Low cost**
- **High cost**
- **Low risk**
- **High risk**
Let us emphasize that the main strategic purpose of an LBO transaction is to increase the company value through the following financial engineering processes:

1. **Buying low and selling high** (value arbitrage or multiple expansion).

2. **Structuring an improved combination of equity and debt** (restructuring the balance sheet or re-capitalizing to add value).

3. **Improving operations to increase cash flow** (restructuring the income statement).

Let us highlight the interesting facts about the LBO transactions, namely that the following business goals may be achieved due to the leveraged buyout transaction implementation:


2. The **significant business operation improvements** in Lichtenberg, Siegel (1990), Lichtenberg, Siegel (1990), Davis, Haltiwanger, Jarmin, Lerner, Miranda (2009), Amess (2002), Amess (2003), Harris, Siegel, Wright (2005), Tåg (2010).


The **LBO** has the following positive characteristics:


2. **A buyout introduces the uncertainty** in the creation and implementation of the business strategies, business operation objectives, managerial incentives and executive compensation plans, contracts with the well established suppliers, contracts with the existing business...

3. **A buyout makes the temporary ownership possible** as a result the strategic business objectives by the temporary owners and the strategic business objectives by permanent owners may differ significantly, for instance, the decisions on the short or long time investments, the decisions on the business operation, the supply chain decision, etc in Hellmann (2007), Norbäck, Persson, Tåg (2010), Tåg (2010).

4. **A buyout brings in the capital and knowledge**, leading to the new investments, financial stability and greatly improved knowledge base creation by the involved private equity firms in Bloom, Sadun, van Reenen (2009).

Guo, Hotchkiss, Song (2008) write: “A substantial body of empirical work based on leveraged buyout transactions from the 1980s supports the notion that leveraged transactions create value; specifically, those studies have documented either

1. gains in value from pre-buyout to a later change in ownership or restructuring,
2. gains in operating performance post-buyout, or
3. the relationship between buyouts premiums and proxies for sources of the value gain.

The theories proposed to explain these gains include benefits of tax shields, disciplining effects of leverage, and better governance (monitoring by the financial sponsor, concentrated ownership, etc.).”

Guo, Hotchkiss, Song (2008) write on the cash flow gains:

1. **Increased tax shields.** A large increase in debt used to finance the buyout generates increased interest tax shields, particularly if the debt remains at high levels following the transaction. Kaplan (1989b) shows that tax benefits are an important source of wealth gains for a sample of 76 management buyouts (MBOs) between 1980 and 1986, and that these gains are reflected in the premiums paid to pre-buyout shareholders.

2. **Disciplining effect of debt.** Increasing required debt payments can also reduce free cash flow available to management to potentially dissipate on value reducing investments (Jensen (1986)). In the context of buyouts, the heavier debt burden forces management to efficiently run the firm to avoid default, and also will force a restructuring of the firm before substantial value can be lost (Jensen (1989b), Wruck (1990), Andrade and Kaplan (1998)).

3. **Increased monitoring reduces agency costs.** Senior lenders (banks) may be effective monitors, leading managers to focus on performance and value, and reducing wasteful uses of corporate resources. Financial sponsors of the buyout (private equity firms) may be important to firm governance, either through their presence on the board or through their selection of new
management. Recent deals involving some private equity firms have been criticized, however, either because the private equity firm allegedly channeled gains from the transaction to their own investors through dividends or other payments, or because lower prices are paid when companies are acquired by more than one private equity firm (club deals).

4. Better management incentives. Management ownership may become more concentrated with the buyout if management provides some portion of the equity financing (as in an MBO). The alignment of incentives of management and shareholders can reduce agency conflicts (Jensen and Meckling (1976)). However, high levels of management ownership can lead to management entrenchment.

5. Other pre-buyout characteristics. Gains in operating efficiency due to post-buyout actions of management, as well as monitoring by lenders or buyout specialists, may be particularly useful for firms with poorer pre-buyout performance.”

Let us discuss the capital structure of a typical LBO, which consists of the four types of capital:

1. Bank Debt, which usually accounts for about 50 per cent. Bank debt consists of a revolving credit facility that can be paid back and drawn down as needed by the company, as well as several tranches or categories of term loans differing in seniority, maturity and cost.

2. High-Yield Debt at about 10 per cent. High-yield debt is used to increase leverage beyond levels that banks are willing to provide. Companies will make offerings to either the public bond market or the private institutional market (for example, insurance companies and pension plans) of debt with a relatively high interest rate (or large discount to par) reflecting the risks involved in being in a subordinate position to bank debt.

3. Mezzanine Debt at about 10 per cent. Mezzanine debt is in an even lower position, so buyout funds, hedge funds and other lenders will provide this capital with a high interest rate and require warrants (options to purchase stock) as additional compensation.

4. Private Equity, which represents the remaining 30 per cent. Private equity is the riskiest form of capital. If a company goes bankrupt, debt holders control the bankruptcy process and, in the case of liquidation, have priority in receiving the proceeds from the sale of any assets such as real estate and equipment. Equity investors, being last in line, lose control of the company and usually lose their entire investment. The nature of taking a public company private may impose a higher cost of capital to the capital market. You have huge costs involved, because of the management private equity fees, less transparency, less liquidity in the market.

5. Other forms of debt may also be utilized, such as asset-based loans and securitizations, second-lien loans, equipment leases and seller financing, but these are less common.
Burrough and Helyar (1990) mention: “Of the money raised for any LBO, about 60 percent, the secured debt, comes in the form of loans from commercial banks. Only about 10 percent comes from the buyer itself. For years the remaining 30 percent - the meat in the sandwich – came from a handful of major insurance companies, whose commitments sometimes took months to obtain. Then, in the mid-eighties, Drexel Burnham began using high-risk “Junk” bonds to replace the insurance company funds. The firm’s bond czar, Michael Milken, had proven his ability to raise enormous amounts of these securities on a moment’s notice for hostile takeovers. Pumped into buyouts, Milken’s junk bonds became a high-octane fuel that transformed the LBO industry from a Volkswagen Beetle into a monstrous drag racer belching smoke and fire. Thanks to junk bonds, LBO buyers, once thought too slow to compete in a takeover battle, were able to mount split-second tender offers of their own for the first time. Suddenly LBOs became a viable alternative in every takeover situation; because they held out the promise of operating autonomy and vast riches…”

The topic on junk bonds is further discussed in Ridpath (1995): “Junk bonds, or “high yield bonds” as they are sometimes more politely called, can be very profitable. They can also be very dangerous. The name “high-yield” comes from the high –interest coupon that these bonds pay. The name “junk” comes from the high risk that they represent. They are usually issued by companies, burdened with high levels of debt. If everything goes well, then everyone is happy; the investors get theirs high coupon, and the owners of the company make a fortune out of an often small initial investment. If everything does not go well, then the company is unable to earn enough cash to meet its interest bills and goes bankrupt, leaving its junk-bondholders and its owners with paper fit only for the dustbin. The secret is to pick those companies that will survive…”

The following topics of interest toward the leveraged buyout transactions management must be considered in details in Lexpert (2006):

1. What are financial implications of transaction?
2. Is it dilutive or accretive for earnings?
3. How will pooling vs. purchase accounting affect the company's financial ratios?
4. What are the short term and long term implications for the stock price?
5. What are the risks involved?
6. Are they best managed with cash or equity swaps?
7. How will Security and Exchange Commission react to the bid?
8. How does a company get around a target's shareholder right plan?
9. Are there competition concerns that might force a restructuring of the offer?
The LBOs are sometimes criticized and perceived negatively, because of the following reasons:

1. The reducing R&D and capital expenditures,
2. The extending accounts payable,
3. The lowering accounts receivable, selling real estate and other assets,
4. The modifying compensation to reduce base salaries and increase performance bonuses,
5. The restructuring health and retirement benefits.

Let us demonstrate the buyout transactions statistics in Europe, considering the Germany and the UK buyout markets as possible examples in Schäfer, Fisher (2008): “Buy-outs by financial investors have become the most important segment of the private equity sector in Germany in recent years. Two drivers are assumed for these trends, with respect to supply and demand: On the one hand, efficiency advantages result from the restructuring of affected companies, on the other hand, demand for innovative financial instruments can be assumed. Both aspects have a positive effect on the “coming together” of company buyers and sellers. These statements are compatible with the majority of the findings of relevant empirical economic research. Without bank loans and liquid bond markets, buy-outs are not conceivable. The current liquidity crisis in the banking sector and the quasi collapse of the market for credit sales therefore also leave traces in the private equity sector and tend to have a restrictive effect. Clear legal regulations that do not impair the market are all the more important.”

Tab. 5 provides some information on the buy-outs / buy-ins in Germany, according to origin, in Schäfer, Fisher (2008).

<table>
<thead>
<tr>
<th>Table 5. Buy-outs / buy-ins in Germany, according to origin (after Schäfer, Fisher (2008)).</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buy-Outs/Buy-Ins in Germany, according to origin</strong></td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
<td>2006</td>
</tr>
<tr>
<td><strong>Sale by</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family-owned or private company</td>
<td>19</td>
<td>9</td>
<td>14</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>Foreign parent company</td>
<td>18</td>
<td>16</td>
<td>17</td>
<td>24</td>
<td>17</td>
</tr>
<tr>
<td>Domestic parent company</td>
<td>47</td>
<td>42</td>
<td>40</td>
<td>48</td>
<td>53</td>
</tr>
<tr>
<td>Privatization</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Reorganization/insolvency</td>
<td>15</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Buy-out fund</td>
<td>2</td>
<td>14</td>
<td>18</td>
<td>12</td>
<td>31</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>6</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>108</td>
<td>105</td>
<td>111</td>
<td>124</td>
<td>155</td>
</tr>
<tr>
<td><strong>Shares in percent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family-owned or private companies</td>
<td>17.6</td>
<td>8.6</td>
<td>12.6</td>
<td>21.8</td>
<td>24.5</td>
</tr>
<tr>
<td>Foreign parent company</td>
<td>16.7</td>
<td>15.2</td>
<td>15.3</td>
<td>19.4</td>
<td>11.0</td>
</tr>
<tr>
<td>Domestic parent company</td>
<td>43.5</td>
<td>40.0</td>
<td>44.1</td>
<td>38.7</td>
<td>34.2</td>
</tr>
<tr>
<td>Privatization</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Reorganization/insolvency</td>
<td>13.9</td>
<td>11.4</td>
<td>4.5</td>
<td>4.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Buy-out fund</td>
<td>1.9</td>
<td>13.3</td>
<td>16.2</td>
<td>9.7</td>
<td>20.3</td>
</tr>
<tr>
<td>Others</td>
<td>8.9</td>
<td>2.9</td>
<td>0.9</td>
<td>2.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Unknown</td>
<td>5.6</td>
<td>8.6</td>
<td>6.3</td>
<td>4.0</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Quellen: CBOR/Barclays Private Equity/Debitel. DIW Berlin 2008
Fig. 11 shows the average equity capital ratio of mainly debt-capital-financed corporate acquisitions in Axelson, Jenkinson, Strömberg, Weisbach (2007, 2008), Schäfer, Fisher (2008). Fig. 12 illustrates the market capitalization in selected countries in Schäfer, Fisher (2008). Fig. 13 displays the funds raised for buy-out funds in Germany and in Great Britain in Schäfer, Fisher (2008). Fig. 14 depicts the invested funds from buy-out funds in Germany and Great Britain in Schäfer, Fisher (2008).
Fig. 15 presents the number and total value of companies acquired in Germany by buy-out funds in Schäfer, Fisher (2008).

![Graph of number and total value of companies acquired in Germany by buy-out funds](image)

**Fig. 15. Number and total value of companies acquired in Germany by buy-out funds (after Schäfer, Fisher (2008)).**

Allen (2012) states: “The evidence presented suggests that venture capital and LBOs do contribute to economic efficiency in a number of ways. Venture capital has helped many prominent firms do well and there is evidence that it increases innovation. Similarly, LBOs seem to also improve economic efficiency in a number of dimensions.” Allen (2012) write: “The conclusion is that venture capital and LBOs have contributed significantly to economic progress. These are therefore important innovations and have allowed higher growth and improved welfare.”
In the business administration science, a considerable attention is paid to develop the methodologies for an accurate characterization of various risks, which are associated with the private equity investments, including the VC and LBO investments, because as it is described in Groh, Baule, Gottschalg (2008): “LBOs play an increasingly important role as a financing alternative in corporate lifecycles and as an asset class for institutional investors.” A considerable number of other researchers worked to solve the risk management problem for the LBO investments in Peng (2001), Piatkowski (June, 2001), Quigley and Woodward (2003), Ljungqvist and Richardson (2003), Cochrane (2005), Groh and Gottschalg (2007, 2008), and Groh, Baule, Gottschalg (2008).

Piatkowski (June, 2001) write: “Higher risk of bankruptcy of the leveraged companies is nonetheless a real concern. According to Jensen (September, October, 1989b), leveraged companies are more likely to experience financial difficulties than non-leveraged companies. However, only a few leveraged companies finally go bust. Thanks to concentrated ownership, companies in financial distress are quickly and successfully restructured; the improvement in financial health and prevention of bankruptcy is achieved at much lower cost than with non-leveraged companies Jensen (September, October, 1989b). Nonetheless, higher risk of financial distress is real. There is no free lunch - higher benefits of LBO come with higher financial risk.”

Groh, Baule, Gottschalg (2008) write: “… Cochrane (2005) reports a mean volatility of 86% p.a. for a sample of 16,638 private equity transactions – calculated via maximum likelihood estimates and sample bias correction for unobservable returns but does not differentiate between VC and LBOs; more importantly, he does not take account of the degrees of leverage deployed in the LBOs. Kaplan and Schoar (2005) analyze the performance of private equity investments and create a sub sample of LBOs. They do not consider idiosyncratic risk, but systematic risk - which they assume to be both equal for every transaction, and equal to the systematic risk of the S&P 500 Index. Their approach also implies, therefore, that leverage in public and private markets is identical on average. Quigley and Woodward (2003) create a VC index similar to that of Peng (2001), and report a mean annual standard deviation of returns of 14.6%, while Peng (2001) reports annual standard deviations of returns between 9.5% and 70.3% for the period from 1987 to 1999. Both papers focus on correcting missing values and selection bias and fail to either create a LBO sub-sample or to consider individual LBO capital structures in their approach. Ljungqvist and Richardson (2003) distinguish between VC and LBO market segments and analyze LBO performance while controlling for systematic risk. However, because they do not have access to exact data for individual deals, they assume industry averages for the debt/equity ratios in their calculations of LBO beta factors. These authors report an average beta factor of
1.08 for their LBO sample. Groh and Gottschalg (2008) investigate LBO performance and focus on systematic risk for transactions using detailed information on debt/equity ratios. For several scenarios based on differentiated assumptions about the risk of debt and of debt tax shields, they calculate average equity beta factors (for each scenario) ranging from 0.78 to 2.57 at transaction closing. However, it is not clear which of their scenarios is the “right” one. Furthermore, their focus on systematic risk does not enable to calculate rewards for variability.”

Lang, Cremers, Hentze (February, 2010) researched the risk factors, associated with the leveraged buyout (LBO) transactions and demonstrated a new rating method based on a logistic regression to predict the defaulting and non-defaulting LBO transactions.

Therefore, the main scientific problem, faced by the investors, can be described as: What are the winning virtuous strategies for the LBOs implementation during the private equity investment in the conditions of the resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities?

**MicroLBO software program to create winning virtuous strategies toward leveraged buyout transactions implementation and to compute direct/reverse leverage buyout transaction completion probability number for selected public/private companies during private equity investment in conditions of resonant absorption of discrete information in diffusion-type financial system with induced nonlinearities**

Let us discuss the **MicroLBO software program**, which can be used with the aims:

1) **to create winning virtuous strategies toward leveraged buyout transactions implementation**, and

2) **to compute direct/reverse leverage buyout transaction completion probability number for selected public/private companies in the LBO process**, during the private equity investment in the conditions of resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities.

**Firstly**, let us explore the winning virtuous strategies creation toward leveraged buyout transactions implementation during the private equity investment in the conditions of resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities. The authors developed the embedded optimized near real time artificial intelligence algorithm, which assumes that the LBO transaction occurs in the case, if the
intended private equity investment value into the company is bigger than the market value of company in agreement with the research findings in Haddad, Loualiche, Plosser (March, 2013)

\[ PEIV - MV > 0 \]

where \( PI \) – the private equity investment value into the company;

\( MV \) – the market value of company.

The embedded optimized near real time artificial intelligence algorithm makes it possible to numerically solve a challenging research problem on the creation, selection and execution of the winning virtuous strategies toward the leveraged buyout transactions implementation during the private equity investment in the conditions of the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities. The embedded optimized near real time artificial intelligence algorithm is based on the Ledenyov theorem, which is discussed in the next section of our research article in details. It makes sense to comment that a main distinctive technical feature of the developed embedded optimized near-real-time artificial intelligence algorithm consists in an application of the inductive, deductive and abductive logics in Martin (1998-1999, 2005-2006) in the frames of the strategic choice structuring process, that is the winning through the distinctive choices process in Martin (1998-1999a, 2005-2006a, 2004, 2009), Moldoveanu, Martin (2001), Lafley, Martin (2013), during the numerical solution finding for the decision making problem on the winning virtuous strategy, taking to the consideration the LBO successful completion / failure probability number. The developed embedded optimized near-real-time artificial intelligence algorithm belongs to a group of complex artificial intelligence algorithms, which have been initially developed to solve the decision making problem on a number of pre-programmed tasks during the process of tracking of a slow moving object by a formation of high-speed flying objects with the near-real-time data fusion from the various onboard sensors in the space science.

Secondly, let us discuss the financial engineering techniques to compute direct/reverse leverage buyout transaction successful completion probability number for selected public/private companies during the private equity investment in the conditions of resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities.

A first generation of software programs to assist with the LBO transactions management have been developed by German researchers at Frankfurt School of Finance & Management in Lang, Cremers, Hentze (February, 2010) and by some other research groups.

Fig. 16 demonstrates a forecast of the probability of default for the selected LBO transaction over the different time horizons in Lang, Cremers, Hentze (February, 2010).
**Fig. 16.** Forecast of default probability for selected LBO transaction over different time horizons (after Lang, Cremers, Hentze (February, 2010)).

Fig. 17 shows the **Leverage effect**: a change of Return-on-Investment (ROI) at the different use of debt capital.

**Fig. 17.** Leverage effect – Change of Return on Investment (ROI) at different use of debt capital (after Lang, Cremers, Hentze (February, 2010)).
The **MicroLBO software program** represents a second generation software program, which takes into account the following technical parameters:

1. **The characteristics of target company:** (Earnings Before Interests, Taxes, Depreciation and Amortization (EBITDA));
2. **The structure of private equity investments**;
3. **The management team qualifications**;

with the purpose to compute the following **financial variables**:

1. **Total Leverage Ratio**;
2. **Total Debt Cover Ratio**;
3. **Total Interest Cover Ratio**;
4. **Return on Investment**;
5. **Probability of LBO transactions successful completion over the short / long time periods.**

The **probability of LBO transactions successful completion over the time** is computed, using the formula, derived with the application of the **probability theory** in De Laplace (1812), Bunyakovsky (1846), Chebyshev (1846, 1867, 1891), Markov (1890, 1899, 1900, 1906, 1907, 1908, 1910, 1911, 1912, 1913), Kolmogorov (1938, 1985, 1986), Wiener (1949), Brush (1968, 1977), Shiryaev (1995). The derived formula computes the probability of LBO transactions successful completion over the time as a sum of probabilities of separate events.

In the next section, the **authors** will discuss the **resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities** and its influence on the **investor’s ability to create the winning virtuous strategies toward the leveraged buyout transactions implementation during the private equity investment process.**

**Resonant absorption of discrete information in diffusion-type financial system with induced nonlinearities and its influence on investor’s ability to create winning virtuous strategies toward leveraged buyout transactions implementation during private equity investment process**

Let us continue our research by presenting the important research results on the selected scientific subjects in the following order:

1. **The technologies overview for the information transmission in the information communication technologies (ICT) science.**
2. **The discussion on the definition of the phenomena of resonance in the science of physics.**
3. The discussion on the research results on the resonant absorption of electromagnetic signals in the science of condensed matter physics.

4. The discussion on the research findings on the resonant absorption of radioactive chemical elements and their isotopes in the science of nuclear physics.

5. The discussion on the obtained research results by other authors on the information absorption in the econophysics and in the finances.

6. The discussion on the existing risk factors during the private equity investments in conditions of the resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities.

7. The formulation of the Ledenyov theory on the winning virtuous strategy creation toward the leveraged buyout transactions implementation during the private equity investments in conditions of the resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities.

8. The discussion on the understanding of the existing differences between the influences on the investors by the symmetric/asymmetric information transmission phenomena from one side, and the impacts on the investors by the changing levels of the information absorption capacity from other side.

In the science of information communication technologies, it is a well known fact that the information can be transmitted in the information communication channels over the certain frequency bands, using the different modulation, coding, error correction, access, multiplexing techniques in Ledenyov D O, Ledenyov V O (2014):

1. The information modulation techniques, for example: The low order modulation techniques such as the Pulse Code modulation in the Ultra Wide Band (UWB) communications or the high order modulation techniques such as the 256 Quadrature Phase Shift Keying modulation in the Narrow Band (NB) communications.

2. The information coding techniques, for example: The Walsh coding in the spread spectrum communications.

3. The information error correction techniques, for example: The forward error correction techniques in the spread spectrum communications.

4. The information access techniques (the transmission bandwidth allocation and utilization techniques), for example: The Wide band Code Division Multiple Access (WCDMA) technique; or the Frequency Hoping technique (GSM); or Orthogonal Frequency Division Multiplexing (OFDM) in the wireless communications and the optical communications (all optical WCDMA network).
5. The information multiplexing techniques (over the selected optical bandwidth), for example: The Synchronous Optical Network (SONET) or the Asynchronous Transfer Mode (ATM) in the optical communications, where the information multiplexing or de-multiplexing can be done with the application of the in-fiber Bragg gratings and other optical devices.

In the information communication theory in Ledenyov D O, Ledenyov V O (2014), it was shown that the physical or virtual information communication channels can be symmetric or asymmetric. For example, the asymmetric physical information communication channels can have different bandwidths in the frequency (wavelength) domain, hence the different data streams over the same time period can be transmitted with the application of same modulation techniques. The asymmetric virtual information communication channels can have the same bandwidths in the frequency domain or other physical domains, however the different data streams over the same time period can be transmitted, because of various modulation techniques application. The use of the different bandwidths or the modulation techniques at the uplink and downlink in the satellite wireless communications or the wireline communications (Asymmetric Digital Subscriber Line (ADSL)) results in an appearance of the asymmetric information communication channels with the asymmetric data streams.

In the science of physics the phenomena of resonance is defined as in Morris (1913, 1982, 1985), Ledenyov D O, Ledenyov V O (2014):

a) The enhancement of the response of an electric or mechanical system to a periodic driving force, when the driving frequency is equal to the natural undamped frequency of the system.

b) The condition of a system of subatomic particles in which the probability of a particular reaction, as for nuclear capture of a neutron, is a maximum.

c) The event corresponding to such a maximum, esp. the formation of a particle state, having only a few possible modes of decay and characterized by a lifetime considerably longer than neighbouring states.

In the science of condensed matter physics, the research on the accurate characterization of the condensed matter by the measurements of the absorbed electromagnetic signals in the sub-surface layers in the condensed matter (the high temperature superconducting ceramics and dielectrics) at the resonance in the range of the ultra high frequencies has been conducted in Ledenyov D O, Mazierska, Allen, Jacob (2012), Leong, Mazierska, Jacob, Ledenyov D O, Batt (2012), Mazierska, Ledenyov D O, Jacob, Krupka (2012), Jacob, Mazierska, Ledenyov D O, Krupka (2012), Mazierska, Krupka, Jacob, Ledenyov D O (2012), Jacob, Mazierska, Leong, Ledenyov D O, Krupka (2012), Jacob, Mazierska, Krupka, Ledenyov D O, Takeuchi (2012),

In addition, the absorption phenomena in the condensed matter and soft condensed matter physics and chemistry has been researched by the authors in the following publications:

1. The absorption of the different radioactive chemical elements and their isotopes in the soft condensed matter (the coal granules of different geometric shapes, the coal dust particles of micro- and nano- sizes) at the sound frequencies have been researched in the nuclear physics in Ledenyov O P, Neklyudov (2013), Neklyudov, Dovbnya, Dikiy, Ledenyov O P, Lyashko (2013), Neklyudov, Ledenyov O P, Fedorova, Poltinin (2013a, b), Neklyudov, Fedorova, Poltinin, Ledenyov O P (2013), Ledenyov O P, Neklyudov, Poltinin, Fedorova (2012a, b), Neklyudov, Ledenyov O P, Fedorova, Poltinin (2012), etc.
2. The absorption of the electromagnetic signals in the condensed matter (the high pure metals and superconductors) at the ultrasonic frequencies has been investigated in the solid state physics at the in Ledenyov O P (2012a, b, c), Ledenyov V O, Ledenyov D O, Ledenyov O P, Tikhonovsky (2012), Ledenyov O P, Fursa V P (2012), Shepelev, Ledenyov O P, Filimonov (2012a, b, c, d, e), etc.


In the sciences of economics and finances, it is a well known fact that an access to the information by the market agents can be symmetric or asymmetric, depending on the information volumes or the information quality. The possible presence of the asymmetric information phenomena and its influence on the various processes in the economics (the automobiles market) has been explained for the first time in Akerlof (1970, 2014). The early research on the informational asymmetries, financial structure and financial intermediation has been also conducted in Leland, Pyle (1977). Researching the corporate financing problems, it was confirmed that there is an information asymmetry between the firm’s management and the capital investors in Myers (1984), Myers, Majluf (1984). Considering the structure of corporate ownership, Demsetz and Lehn (1985) proposed that the asymmetric information results in a change of corporate ownership structure toward the concentration of the corporate ownership in the hands of better informed managers. Long, Ravenscraft (1993) explain that there is a problem of asymmetric information in the firms: “Myers (1984) focuses on the asymmetric information between the firm's management and external funding agencies. Insiders have superior information about R&D projects that is difficult to reveal to the capital markets. For example, revealing this confidential information can provide an important signal to competitors (Bhattacharya and Ritter, 1983). Even announcing that an R&D project is being undertaken may provide the competition with valuable information. This asymmetric information creates a pecking order where internal funds are preferred to external sources of capital.” In the case of leveraged buyouts, there are various information asymmetries, which have been researched by
scientists. Opler, Titman (1991) write: “Another influence on leveraged buyout activity may be the extent of informational asymmetry between managers and shareholders. There are two reasons why informational asymmetry may induce a firm to go private:

(i) informational asymmetry increases the chances that a firm is undervalued, creating opportunities for individuals with superior information (such as management) to gain from going private;

(ii) informational asymmetry gives managers more latitude to implement their own agendas without sanction from public shareholders and thus increases gains from high ownership concentration.

The second reason is related to work by Demsetz and Lehn (1985) who argue that share ownership is likely to be more concentrated when there is more asymmetric information because of larger gains from monitoring. They argue that unsystematic risk is related to the uncertainty of the firm's operating environment and thus proxies for the degree of asymmetric information.”

Most recently, Schäfer, Fisher (October 16, 2008) stated: “Asymmetric information between entrepreneurs and capital investors and behavior risks limit the financing opportunities for companies. This can result in rationing by lenders—or as regards listing in an illiquid stock market segment—by the capital market. Companies that are owned privately and by families are regarded as being particularly in-transparent for a potential lender or shareholder and therefore tend to be limited in terms of financing. Buy-out funds can alleviate this. Off-market equity capital is suitable for strengthening the companies’ assets.”

The LBO transactions completion problem in the conditions of asymmetric information has been investigated in Opler, Titman (1991), Kaplan, Strömberg (2008; Winter, 2009), Schäfer, Fisher (October 16, 2008), Yousfi (2012).

In the science of econophysics, the authors studied a role of the absorptive capacity in the learning and innovation processes in Cohen, Levinthal (1990), Farina (2008), Hussinger (2010, 2012). Farina (2008) write on the knowledge and information absorptive capacity by the firm: “According to Cohen and Levinthal’s (1990) “absorptive capacity” concept, firms’ ability to get knowledge and information from their external environment is a function of the firms’ specialization choices and experiences. In particular, firms operating in many market segments are likely to possess more internal capabilities than firms operating in few market segments since, as the volume and complexity of information in the environment increase, the organization needs to have correspondingly high levels of information processing capacity (Miller and Chen (1994); Hambrick, (1982); Khandwalla (1973)).” Farina (2008) continues to explain: “In fact firms’ ability to use network ties for accessing information about opportunities and choices
otherwise not available is depending on internal resource endowments and in particular on “absorptive capacity”.


In other words, the absorbed information by the investors, who experience the phenomenon of resonant absorption of information, creates a knowledge base, which is necessary for the successful creation and execution of the winning virtuous strategies toward the leveraged buyout transactions implementation during the private equity investments at the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities. It follows from the Ledenyov theory that the level of information absorption by the investor (the deal maker) in the free market economy is predefined by the information absorption capacity, which may depend on the investor’s education degree, professional skills and competence, professional experience, access to the consulting advices, access to the computing power, presence of simulation software and some other factors.

In general, the authors think that the information modulation techniques, information coding techniques, information error correction techniques, information access techniques, information multiplexing techniques can lead to the information asymmetries appearance and have multiple possible impacts on the various economic variables in the economics and finances, which have to be researched in details. However, let us distinguish the impacts by both:

1. The asymmetric information (the asymmetric information communication channels, asymmetric information data streams) by the market agents, and
2. The influences by the asymmetric information absorption (the different levels of information absorption) by the market agents.

For instance, in accordance with the Ledenyov theory on the information absorption in the economics and finances, we can assume that the different investment strategies (the successful or failed investment strategies) can be created to implement the LBO transactions in the case, when there are the symmetric information communication channels for all the investors (the market agents), because there may be the different levels of information absorption (the different information absorptive capacity) by the investors. This result is not trivial and it is in a contradiction with the existing understanding that the asymmetric information is mainly responsible for the creation of the different investment strategies (the successful or failed investment strategies) by the investors (the market agents) to implement the LBO transactions.
In the case of the LBO transactions, going from the existing understanding, all the investors have to create the same investment strategies to implement the LBO transactions in the ideal case of the symmetric information communication channels; however, as it is shown in the Ledenyov theory on the information absorption in the economics and finances, there may be the phenomena of asymmetric information absorption by the investors, which results in the various investment strategies creation by the investors in the real life conditions.

The authors think that the next avenue for our prospective research will be a finding of possible understanding of the following scientific problems:

1) How can the different levels of information absorption by an investor impact the winning virtuous strategy creation ability during the PE investment process?

2) What is an optimal level of information absorption by an investor, which can allow the winning virtuous strategy creation during the PE investment process?

3) Can an excessive level of information absorption by an investor result in the bifurcations and chaos appearances in the frames of a decision making process on the winning virtuous strategy creation during the PE investment process?

Conclusion

The authors performed an original research on the fundamentals of winning virtuous strategies creation toward the leveraged buyout transactions implementation during the private equity investment in the conditions of the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities in particular, and at the influences by the Schumpeterian creative disruption processes in the free market economy in general.

We propose that the money is a financial computing process, which is executed by the operating system, representing an exchange medium, at a computing device.

Going from the academic literature, we made a comprehensive review on the various aspects of modern financial engineering approaches to make the private equity investments and to design the leveraged buyout and venture capital firms, funds and transactions in the finances. We highlighted a private equity’s important role in the Schumpeterian creative destruction processes in the free market economy, discussing the leverage buyout transactions process and the accurate characterization of the leverage buyout transactions properties at the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities.
We developed and tested the MicroLBO software program with the aims:

1) to facilitate the creation of the winning virtuous strategies toward the leveraged buyout transactions implementation, and

2) to compute the direct/reverse leverage buyout transaction probability number for the selected public/private companies during the private equity investment in the conditions of the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities.

We formulated the Ledenyov theory on the winning virtuous strategies creation toward the leveraged buyout transactions implementation during the private equity investment in conditions of the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities.

We applied the accumulated knowledge bases in the nuclear physics, condensed matter, space physics, econophysics and software engineering to achieve the innovative research goals in the financial engineering, namely to facilitate the winning virtuous strategies creation toward the leveraged buyout transactions implementation during the private equity investment in conditions of the resonant absorption of discrete information in the diffusion - type financial system with the induced nonlinearities.

Acknowledgement

The science of econophysics, which considers the physics of the finance and economics, is becoming very popular among the financiers in Weatherall (2013). In this introductory condensed research article, the authors attempted to apply the theoretical econometrical and econophysical principles from the academic literature to research and better understand the complex private equity issues with a particular attention to the venture capital funds and leveraged buyout funds. In our opinion, the presented research findings may be of some use for the young scientists, professors in the finances and economics, subject experts, financial analytics, experienced financiers, and business leaders, who have a desire to learn more on the fundamentals of leveraged buyout transactions in conditions of the continuous and discrete information absorption processes in the diffusion – type financial systems with the induced nonlinearities. It makes sense to say that the research article is written on the basis of lecture notes, which have been prepared for and presented at the courses of our invited lectures on the fundamentals of leveraged buyout transactions under the influences by the continuous and discrete information absorption processes in the diffusion – type financial systems with the
induced nonlinearities at the leading universities around the World over the recent decades. We also decided to include some our thoughts, expressed during the subsequent Q&A sessions after the presented lectures and kindly recorded by our students. Following a hugely successful release of the early developed MicroFX software platform, we developed the MicroLBO software program to create the winning virtuous strategies toward the leveraged buyout transactions implementation and to compute the direct/reverse leverage buyout transaction completion probability number for the selected public/private companies during the private equity investment in conditions of the resonant absorption of discrete information in the diffusion-type financial system with the induced nonlinearities.

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

There would be appropriate to say that, in an information age, the first author’s special efforts have been primarily directed towards the scientific information gathering, systematization and detailed analysis in the frames of this research project on the fundamentals of leveraged buyout transactions at an influence by the continuous and discrete information absorption processes in the diffusion-type financial systems with the induced nonlinearities; hence, the first author would like to thank the professional stuff at the central library at James Cook University in Townsville, Queensland, Australia for providing the first author with all the necessary technical support in relation to the literature search on the subjects of his multidisciplinary research interest in the electronic research databases at Australian universities, replying to the numerous chaotic research requests timely, and making everything possible to
assist with the completion of the highly innovative advanced research on the fundamentals of leveraged buyout transactions at presence of the continuous and discrete information absorption processes in the diffusion – type financial systems with the induced nonlinearities at the James Cook University in Townsville, Queensland in Australia in 2000 – 2014.

The first author would like to comment that the informative scientific discussions on the accurate characterization of the fundamentals of leveraged buyout transactions at an impact by the continuous and discrete information absorption processes in the diffusion – type financial systems with the induced nonlinearities, which have been conducted by the first author with the M.Sc. students, Ph.D. candidates, professors, visiting scientists and other faculty members during the numerous scientific seminars and brain storm research meetings at James Cook University in Townsville in Queensland in Australia, are generously appreciated, because these valuable scientific opinions exchanges encouraged the first author to generate the new original scientific ideas and make the creative imperative integrative intelligent conceptual co-lateral adaptive logarithmic thinking with the application of the inductive, deductive and abductive logics analysis as far as the fundamentals of leveraged buyout transactions is concerned.

A certain part of an introductory condensed research article has been written during the first author’s yachting with the Australian friends in Melbourne, Victoria, Australia and in Brisbane, Queensland, Australia, when a number of the creative research ideas and important research findings on the private equity, including the venture capital and leveraged buyout firms, funds, transactions, came to his mind. Most of the ideas have been discussed with the Australian friends, when on the yachts. Sometimes, the thoughtful discussions have been further conducted during the “numerous meetings without the ties” with the great Australian philosophers, professors, scientists, businessmen, lawyers, governmental officials and political leaders in the relaxing trusted mutual-respect atmosphere, characterized by the pluralism of research opinions on the topics of interest, during the Yarra valley and Mornington-Peninsula limo tours (www.yarravalleylimowinetours.com.au). All these exchanges of opinions fascinated the first author’s mind, stimulated the abstract thinking on the presented assumptions, and inspired to work consistently to complete the writing of this highly innovative condensed research article on the fundamentals of the leveraged buyout transactions in the case, when the resonant discrete information absorption processes are present in the diffusion – type financial systems with the various types of induced nonlinearities, at James Cook University in Townsville, Brisbane, and Gold Coast in Queensland in Australia in 2014.

The first author would like to thank cordially all the European universities rectors, universities deans, distinguished professors, world renowned financiers and well respected
businessmen for many tens of highly creative and productive business meetings during the first author’s global intellectual journey over the European capitals, including: Warsaw, Poland; Berlin, Germany; Amsterdam, The Netherlands; Brussels, Belgium; Luxemburg, Luxemburg; Paris, France; Barcelona, Madrid, Spain; and Coimbra, Lisbon, Porto, Portugal in October, 2014. It was nice to meet and discuss all the problems of mutual research interest with the old European Friends, coming from Brisbane, Australia.

The second author would like to kindly acknowledge the numerous private communications with the participants of the V. Ya. Bunyakovsky international conference with the special focus on the V. Ya. Bunyakovsky’s research contributions to the mathematical theory of probability and its modern applications in the econophysics and econometrics, which had place during a tour to the Town of Bar, Vinnytsya Region, State of Ukraine in the time of the conference, organized by the Institute of Mathematics of National Academy of Sciences of Ukraine (NASU), Kyiv, Ukraine on August 20 – 21, 2004. Absorbing the brilliant research ideas during a fruitful exchange by the scientific opinions among the conference attendees, the second author came up with a remarkable conclusion that the foundations of the mathematical theory of probability by V. Ya. Bunyakovsky enable us to perform a more accurate scientific analysis and characterization of the complex research problems on the fundamentals of the leveraged buyout transactions in the circumstances, when the resonant discrete information absorption processes are present in the diffusion – type financial systems with the various types of induced nonlinearities. The first author’s has been worked on the research article, discussing the points of mutual research interest with the second author, during his regular visits to the Town of Bar, Vinnytsya Region, State of Ukraine over the recent years.

It is a real tremendous pleasure to comment that some fundamental issues on the strategy creation and execution toward the leveraged buyout transactions implementation have been researched by the second author during his intensive research assignments at the Rotman School of Management, University of Toronto, Canada in 1998 – 1999 and 2005 – 2006. The second author met with many hundreds of North American Corporations Presidents, Board of Directors Chairmen, Chief Executive Officers (CEOs), Chief Information Officers (CIOs), Chief Operating Officers (COOs) and visited the Research Triangle Park high-tech cluster near Durham in North Caroline in the USA as well as the Kanata high-tech cluster near Ottawa in Ontario; the Calgary high-tech cluster in Calgary in Alberta; the Richmond high-tech cluster near Vancouver in British Columbia in the North America in 1998 – 2006, making his innovative research on the private equity investment, including the leverage buyouts and venture capital investments. The obtained information has been researched and analyzed by the second author at the Rotman
School of Management, University of Toronto, Canada, which was a global hub of innovative scientific thinking in the economics and finances mainly due to the high level organizational and personal efforts by Prof. Roger L. Martin, former Dean, Rotman School of Management, University of Toronto, Canada, who strongly supported and facilitated the initiation of innovative research and the creation of intensive business education courses in Canada on that time. It is important to underline the fact that the Rotman School of Management, University of Toronto, Canada was a global financial center of gravity on that time, where the highly innovative research work has been conducted by the second author from the early morning hours until the deep night, being occasionally interrupted by the thoughtful long hours scientific discussions on a variety of research problems in the finances with Profs. John C. Hull and Roger L. Martin, Rotman School of Management, University of Toronto, Canada in 1998 – 1999 and in 2005 - 2006. It makes sense to note that, in some cases, the intensive research discussions and consultations have been continued during our frequent meetings at the Economic Club of Toronto, Empire Club of Canada and Canadian Club in Toronto, Canada outside the U of T in 2005 – 2006. Using every free minute in our busy research schedules, we discussed all the scientific problems of mutual research interest, aiming to find the possible solutions of challenging research problems in time of globalization.

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Of course, the important groundbreaking research results on the creative disruption and evolutionary economics, obtained by Prof. Joseph Alois Schumpeter at the University of Vienna in Austria in 1905 – 1908, University of Czernowitz in Ukraine in 1909 – 1911, University of Graz in Austria in 1912 – 1914, University of Bonn in Germany in 1925 – 1932, Harvard University in the USA in 1932 – 1950, had a considerable influence on the presented research opinions by the authors. As we all know, the ideas on the creative destruction have been further researched by Prof. Clayton M. Christensen, Kim B. Clark University Professor of Business Administration, Harvard Business School, Harvard University and other notable scientists, hence
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References:

Economics Science, Finance Science and Economic History Science:

3. Bagehot W 1873, 1897 Lombard Street: A description of the money market Charles Scribner's Sons New York USA.
7. Schumpeter J A 1906 Über die mathematische methode der theoretischen ökonomie ZfVSV Austria.
13. Slutsky E E 1915 Sulla teoria sel bilancio del consumatore Giornale degli economisti e rivista di statistica 51 no 1 pp 1 – 26 Italy.
18. Ellis H, Metzler L (editors) 1949 Readings in the theory of international trade Blakiston Philadelphia USA.
19. Friedman M (editor) 1953 Essays in positive economics Chicago University Press Chicago USA.

**Private Equity: Venture Capital Firms, Funds and Transactions:**

34. Fogel R 1964 Railroads and American economic growth: Essays in econometric history *Johns Hopkins Press* Baltimore USA.
37. Stigler G 1968 The organization of industry *Richard Irwin Inc* Homewood USA.


60. Wilson J W 1983 The new ventures – inside the high stakes world of venture capital *Addison Wesley Publishing Company* Boston MA USA.


68. Nevermann H, Falk D 1986 Venture capital - Ein betriebswirtschaftlicher und steuerlicher vergleich zwischen den USA und der Bundesrepublik Deutschland *NOMOS Verlagsgesellschaft* Baden-Baden Germany.


81. Stedler H 1987 Venture capital und geregelter freiverkehr: Eine empirische studie *Frankfurt am Main* Germany.
83. Clark R 1988 Venture capital in Britain, America, and Japan *Croom Helm* London UK.
84. Eisinger P 1988 The rise of the entrepreneurial state: State and local economic development policy in the United States *University of Wisconsin Press* Madison USA.
85. Eisinger P 1993 State venture capitalism, state politics, and world of high risk investment *Economic Development Quarterly* 7 (2) pp 131 – 140.
86. Florida R L, Kenney M 1988 Venture capital-financed innovation and technological change in the USA *Research Policy* 17 (3) pp 119 – 137.
93. Tirole J 1988 The theory of industrial organization Cambridge *MIT Press* Cambridge Massachusetts USA.


151. Gompers P, Lerner J 1999d The venture capital cycle *MIT Press* Cambridge Massachusetts USA.


179. Lerner J, Moore D, Shepherd S 2005 A study of New Zealand's venture capital market and implications for public policy *A report to the Ministry of Research, Science and Technology* New Zealand


181. Lerner J 2008, 2009 Boulevard of broken dreams: Why public efforts to boost entrepreneurship and venture capital have failed *Princeton University Press* Princeton USA.


192. Hart O 1995 Firms, contracts, and financial structure Oxford University Press UK.


220. Link A N, Ruhm Ch J 2009 Bringing science to market: Commercializing from NIH SBIR awards Economics of Innovation and New Technology 18 pp 381 – 402.


223. Link A N, Scott J T 2012a Employment growth from public support of innovation in small firms WE Upjohn Institute for Employment Research Kalamazoo MI USA.


Engel D 2001a Höheres beschäftigungswachstum durch venture capital? *ZEW Discussion Paper no 01-34* Mannheim Germany.

Engel D 2001b Die identifizierung VC-finanziert er unternehmen in den ZEW Gründungspanels Unveröffentlichtes Manuskript Mannheim Germany.


Keuschnigg Ch 2003 Optimal public policy for venture capital backed innovation *CEPR DP 3850*.


340. Shachmurove Y 2007b Geography and industry meets venture capital Departments of Economics The City College of the City University of New York University of Pennsylvania USA pp 1 – 34


349. Bottazzi L, Da Rin M 2002b Europe’s “New” stock markets *CEPR Discussion Paper no 3521*.


   http://hdl.handle.net/10419/25395 ,
   www.ifk-cfs.de ,
   www.econstor.eu.

384. Gawlik R, Teczke J 2003 Spin of enterprises as a financing solution for the innovative clients of science and technology parks MPRA Paper no 45224 Munich University Munich Germany pp 1 – 7
   http://mpra.ub.uni-muenchen.de/45224/ .


386. Hirukawa M, Ueda M 2003 Venture capital and productivity University of Wisconsin-Madison USA.


   http://hdl.handle.net/10419/23962 ,
   ftp://ftp.zew.de/pub/zew-docs/dp/dp0282.pdf ,
   www.econstor.eu.


458. Zook M A 2005 The geography of the Internet industry: Venture capital, dotcoms, and local knowledge *Blackwell Publishing* Malden MA USA.

459. Antonelli C, Teubal M 2006 Venture capitalism as a mechanism for knowledge governance *Working paper series no 4* Department of Economics Università di Torino Italy.


http://mpra.ub.uni-muenchen.de/4762/.


http://mpra.ub.uni-muenchen.de/3659/.


528. Aberman J 2009 The decline of the United States venture capital industry: What the federal government should do about it *Amplifier Ventures Washington DC USA*.


http://mpra.ub.uni-muenchen.de/39551/ .


http://mpra.ub.uni-muenchen.de/42890/ .


541. Lingelbach D, Murray G, Gilbert E 2009 The rise and fall of South African venture capital: A co-production perspective


560. Inci E, Barlo M 2010 Banks versus venture capital when the venture capitalist values private benefits of control *MPRA Paper no 25566* Munich University Munich Germany pp 1 - 43 http://mpra.ub.uni-muenchen.de/25566/.


569. Stuetzer M, Obschonka M, Schmitt-Rodermund E 2013 Balanced skills among nascent entrepreneurs MPRA Paper no 48641 Munich University Munich Germany pp 1 – 39 http://mpra.ub.uni-muenchen.de/48641/; http://www.springerlink.com/content/e73m7t6j82733411/.


590. Lazarevski D, Mrsik J, Smokvarski E 2012 Evolution of the venture capital financing for growing small and medium enterprises in Central and Eastern Europe countries: The case of Macedonia *MPRA Paper No. 41997* Munich University Munich Germany pp 1 – 12
http://mpra.ub.uni-muenchen.de/41997/.


593. Pommet S 2012 The survival of venture capital backed companies: An analysis of the
French case GREDEG Working Paper no2012-14 University of Nice-Sophia Antipolis and
594. Yitshaki R 2012 Relational norms and entrepreneurs’ confidence in venture capitalists'
cooperation: The mediating role of venture capitalists' strategic and managerial involvement
595. Alqatawni T 2013 The relationship conflict between venture capital and entrepreneur
MPRA Paper no 48006 Munich University Munich Germany pp 1 – 12
http://mpra.ub.uni-muenchen.de/48006/.
596. Brettel M, Mauer R, Appelhoff D 2013 The entrepreneur's perception in the
entrepreneur–VCF relationship: the impact of conflict types on investor value Venture
597. Pennacchio L 2013 The causal effect of venture capital backing on the underpricing of
Italian IPOs MPRA Paper no 48695 Munich University Munich Germany pp 1 – 44
http://mpra.ub.uni-muenchen.de/48695/.
598. Thomson Reuters 2014 VentureXpert Thomson Reuters
http://www.venturexpert.com/.
599. Reuters December 3 2014 U S intelligence agency to develop superconducting computer
Reuters Washington DC USA.

Private Equity: Leveraged Buyout Firms, Funds and Transactions:
600. Berle A, Means G 1932a The modern corporation and private property The Commerce
Clearing House New York USA.
602. Solow R M August 1957 Technical changes and the aggregate production function
603. Penrose E T 1959 The theory of the growth of the firm Oxford University Press Oxford
UK.
605. Marris R May 1963 A model of the managerial enterprise Quarterly Journal of
Economics 77 pp 185 – 209.
606. Telser L 1963 Cutthroat competition and the long purse Journal of Law and Economics 9
pp 259 – 277.
607. Williamson O E 1964 The economics of discretionary behavior: Managerial objectives in a theory of the firm Prentice-Hall Englewood Cliffs NJ USA.


613. Stigler G 1968 The organization of industry Richard Irwin Inc Homewood USA.


622. Jensen M C 1989a Active investors, LBOs, and the privatization of bankruptcy Journal of Applied Corporate Finance 2 (1) pp 35 – 44.

635. Myers St C, Majluf N S 1984 Corporate financing and investment decisions: When firms have information that investors do not have Journal of Financial Economics 13 (2) pp 187 – 221.
100

649. Shepherd W 1979 The economics of industrial organization Prentice-Hall Inc Englewood Cliffs USA.


667. Diamond S C (editor) 1985 Leveraged buyouts Dow Jones Irwin USA.


684. Lichtenberg F R January 1989a Using linked census R&D-LRD data to analyze the effect of R&D investment on total factor productivity growth Discussion Paper CES 89-2 Center for Economic Studies Bureau of the Census USA.


733. Tirole J 1988 The theory of industrial organization MIT Press USA.


752. Sick G 1989 Capital budgeting with real options *New York USA*.


755. Stein B 1989 Dear Mr. Ruder: Your view of management LBOs is simply dead wrong *Barrons* 69 (4) pp 44 – 45.

756. Stein B 1990 No rest for the wicked-Or, will the ’nineties make ’eighties look good? *Barrons* 70 (1) pp 16, 23 – 24.


758. US National Science Foundation February 1, 1989 An assessment of the impact of recent leveraged buyouts and other restructurings on industrial research and development expenditures *US National Science Foundation USA*.

759. Weiss I W (editor) 1989 Concentration and price *MIT Press* Cambridge MA USA.


769. Opler T 1990 Financial innovation in leveraged buyouts *Manuscript* Anderson Graduate School of Management University of California Los Angeles USA.


777. Weston F J 1990 Takeovers, restructuring, and corporate governance *Prentice-Hall Inc* Upper Sadle River NJ USA.


787. Long W F, Revenscraft D J 1991 The aftermath of LBOs Manuscript University of North Carolina NC USA.


797. Davis S J, Haltiwanger J 1996 Job creation and destruction *The MIT Press* Cambridge MA USA.


818. Sudarsanam s, Wright M, Huang J 2011 Target bankruptcy risk and its impact on going private buyout performance and exit Corporate Governance: An International Review.


822. Weir Ch, Jones P, Wright M 2013 Public to private transactions, private equity and financial health in the UK: An empirical analysis of the impact of going private *Journal of Management & Governance*.


867. Hooke J C 1997 M&A practical guide to doing the deal *John Wiley & Sons Inc* New York USA.


879. Sparkes R 2008 Socially responsible investment *The handbook of finance* *John Wiley & Sons Inc* New York USA.


897. Rickertsen R 2001 Buyout: The insider's guide to buying your own company Amacom NY USA.


900. Amess K, Wright M 2006 The wage and employment effects of leveraged buyouts in the UK Working Paper Nottingham University Nottingham UK.


910. Gottschalg O 2002 Why financial buyers do it better? Agency theory meets the knowledge-based view of the firm Academy of Management Conference Denver USA.

   http://hal.archives-ouvertes.fr/hal-00672034, version 1 - 20 Feb 2012.
932. Zarutskie R 2003 Does bank competition affect how much firms can borrow? New evidence from the U.S. in Corporate governance: Implications for financial services firms 39th Annual Conference on Bank Structure and Competition Chicago IL USA.
938. Beuselinck Ch, Deloof M, Manigart S 2005 Private equity investments and disclosure policy Working Paper 2005/287 D/2005/7012/05 Department of Accounting and Corporate Finance Ghent University Kuiperskaai 55E 9000 Ghent Belgium, Department of Accounting and Finance Economics and Business Administration University of Antwerp Belgium,
Economics and Business Administration and Vlerick Leuven Ghent Management School
Ghent University Ghent Belgium.


942. Ethical Investment Association (EIA) 2005 Sustainable responsible investment in Australia EIA Sydney Australia.


946. Kotler P, Lee N 2005 Corporate social responsibility: Doing the most good for your company and your cause John Wiley and Sons Inc New York USA.


954. BVCA 2006 The economic impact of private equity in the UK *British Venture Capital Association* London UK.


122


968. Achleitner A-K et al (Hrsg) 2007 Private equity, rendite, risiko und markteinflussfaktoren *Uhlenbruch Verlag* Bad Soden/Ts Germany.


976. Caballero R 2007 Specificity and the macroeconomics of restructuring *The MIT Press* Cambridge MA USA.


979. Cressy R C, Munari F, Malipiero A 2007 Creative destruction? UK evidence that buyouts cut jobs to raise returns *SSRN*


987. European Central bank 2007 Large banks and private equity-sponsored leveraged buyouts in the EU *ECB* Germany.


993. ITUC 2007 Where the house always wins: Private equity, hedge funds and the new casino capitalism International Trade Union Confederation Brussels Belgium.


995. Kearney A T 2007 Creating new jobs and value with private equity Chicago IL USA.


1001. Service Employees International Union (SEIU) 2007 Behind the buyouts: Inside the World of private equity SEIU Washington USA.


1014. Cole R A, Mehran H 2008 What do we know about executive compensation at privately held firms? Federal Reserve Bank of New York Staff Reports no 314 NY USA.


1025. Schalast Ch, Stralkowski I 2008 10 Jahre Deutsche buyouts Working Paper no 89 Frankfurt School of Finance & Management Frankfurt Germany.


1027. Schalast Ch 2008 Private equity und der Deutsche mittelstand in Die zukunft der finanzdienstleistungsindustrie in Deutschland Müller, Steffens (Hrsg) pp 245 – 262.

1028. Shapiro R J, Pham N D 2008 American jobs and the impact of private equity transactions Private Equity Council Washington USA.

1029. Standard and Poor’s 2008 Leveraged lending review 1Q08 Standard and Poor NY USA.


1034. Bundesverband Deutscher kapitalbeteiligungsgesellschaften – German private equity and venture capital association e.V. (BVK) 2009 Private equity-unternehmensdatenbank der fachgruppe large buy-out im BVK


1040. Leslie P, Oyer P 2009 Managerial incentives and value creation: Evidence from private equity SSRN eLibrary USA.


1056. KPMG 2010 In case the wheels come off: Why it is imperative for general partners to manage environmental, social and governance (ESG) opportunity and risk KPMG International.


1063. Senequier D 10 May 2010 Why sharing value makes good investment sense Financial News Private Equity NE.


1092. Knauer Th, May M, Sommer F 2013 Corporate governance und unternehmenswerteffekte bei leveraged buyouts – state of the art der empirischen forschung *Journal für Betriebswirtschaft*.


1096. Bernoulli J 1713 Ars conjectandi (The art of guessing).


1098. De Moivre 1730 Miscellanea analytica supplementum (The analytic method).


1102. Bunyakovsky V Ya 1825 Rotary motion in a resistant medium of a set of plates of constant thickness and defined contour around an axis inclined with respect to the horizon Ph D Thesis no 1 under Prof. Augustin - Louis Cauchy supervision École Polytechnique Paris France.


1106. Connor J J, Robertson E F (July) 2000 Viktor Yakovlevich Bunyakovsky (December 16, 1804 - December 12, 1889) School of Mathematics and Statistics University of St Andrews Scotland UK

http://www-history.mcs.st-andrews.ac.uk/Biographies/Bunyakovsky.html .

1108. Chebyshev P L 1846 An experience in the elementary analysis of the probability theory Crelle’s Journal fur die Reine und Angewandte Mathematik.


1115. Markov A A 1906 Extension of law of big numbers on variables, depending from each other Izvestiya Fiziko-Matematicheskogo Obschestva pri Kazanskom Universitete 2nd series vol 15 (94) pp 135 – 156 Russian Federation.


1117. Markov A A 1908, 1912, 1971 Extension of limit theorems of calculation of probabilities to sum of variables, connected in chain Zapiski Akademii Nauk po Fiziko-Matematicheskomu Otdeleniyu 8th series vol 25 (3); Ausdehnung der Satze uber die Grenzwerte in der Wahrscheinlichkeitsrechnung auf eine Summe verketteter Grossen Liebmann H (translator) in Wahrscheinlichkeitsrechnung Markov A A (author) pp 272 – 298 Teubner B G Leipzig Germany; Extension of the limit theorems of probability theory to a sum of variables
connected in a chain Petelin S (translator) in Dynamic probabilities systems Howard R A (editor) vol 1 pp 552 – 576 John Wiley and Sons Inc New York USA.


1130. Slutsky E E 1915 Sulla teoria sel bilancio del consumatore Giornale degli economisti e rivista di statistica 51 no 1 pp 1 – 26 Italy.

1132. Slutsky E E 1922b To the question of logical foundations of probability calculation

1133. Slutsky E E 1923a On the some patterns of correlation connection and the systematic
error of correlation coefficient Statistics Bulletin 1 – 3 pp 31 – 50.

1134. Slutsky E E 1923b On a new coefficient of mean density of population Statistics Bulletin
4 – 6 pp 5 – 19.

1135. Slutsky E E 1923c On calculation of state revenue from emission of paper money Local


1137. Slutsky E E 1925b Ueber stochastische Asymptoten und Grenzwerte Metron Padova Italy
vol 5 no 3 pp 3 – 89.

1138. Slutzhi E E 1926 Ein Beitrag zur Formal-praxeologischen Grundlegung der Oekonomik
Ann de la classe des sci soc-econ Akad Oukrainienne des Sciences Kiev Ukraine vol 4
pp 3 – 12.

1139. Slutsky E E 1927a The summation of random causes as sources of cyclic processes
Problems of Conjuncture (Voprosy Kon'yunktury) vol 3 issue 1 pp 34 – 64 Moscow Russian
Federation.

1140. Slutzhi E E 1927b Zur Kritik des Bohm-Bawerkschen Wertbegriffs und seiner Lehre von
der Messbarkeit des Wertes Schmollers Jb 51 (4) pp 37 – 52.

1141. Slutsky E E 1929 Sur l’erreur quadratique mogenne du coefficient de correlation dans le
cas des suites des epreuves non independantes Comptes rendus 189 pp 612 – 614.

1142. Slutsky E E 1935 To the extrapolation problem in connection with forecast problem

1143. Slutsky E E 1937a Quelche propositione relative alla teoria delle funzioni aleatorie
Giornale dell Istituto Italiano degli Attuari 8 no 2 pp 3 – 19.

1144. Slutsky E E 1937b The summation of random causes as the source of cyclical processes
Econometrica 5 pp 105 – 146.

pp 18 – 21.

1146. Slutsky E E 1960 Selected research works (Izbrannye trudy) Academy of Sciences of
USSR Moscow Russian Federation.

UK.


1150. Kolmogorov A N 1947 The contribution of Russian science to the development of probability theory Uchenye Zapiski Moskovskogo Universiteta no 91.


1164. Mandelbrot B B 1963a The stable Paretoian income distribution when the apparent exponent is near two International Economic Review no 4.


1177. Mandelbrot B B 1977 Fractals: Form, chance and dimension W H Freeman San Francisco USA.

1178. Mandelbrot B B 1982 The fractal geometry of nature W H Freeman San Francisco USA.


1180. Gnedenko B V, Khinchin A Ya 1961 An elementary introduction to the theory of probability Freeman San Francisco USA.


of the Workshop of April 10–14 2007 Lisbon Portugal Sarychev A et al (editors) Springer
Berlin Germany pp 377 – 386.

1210. Eberlein E, Papapantoleon A, Shiryaev A N 2008 On the duality principle in option
pricing: Semimartingale setting Finance Stoch 12 pp 265 – 292

1211. Shiryaev A N, Novikov A A 2009 On a stochastic version of the trading rule "Buy and

1212. Eberlein E, Papapantoleon A, Shiryaev A N 2009 Esscher transform and the duality
principle for multidimensional semimartingales The Annals of Applied Probability vol 19 no

1213. Shiryaev A N, Zryumov P Y 2009 On the linear and nonlinear generalized Bayesian
disorder problem (discrete time case) optimality and risk – modern trends in mathematical
finance The Kabanov Festschrift Delbaen F et al (editors) Springer Berlin Germany
pp 227 – 235.

1214. Gapeev P V, Shiryaev A N 2010 Bayesian quickest detection problems for some

1215. Karatzas I, Shiryaev A N, Shkolnikov M 2011 The one-sided Tanaka equation with drift

1216. Shiryaev A N, Zhitlukhin M V 2012 Optimal stopping problems for a Brownian motion
with a disorder on a finite interval Cornell University NY USA pp 1 – 10

1217. Zhitlukhin M V, Shiryaev A N 2012 Bayesian disorder detection problems on filtered

1218. Feinberg E A, Mandava M, Shiryaev A N 2013 On solutions of Kolmogorov’s equations
for nonhomogeneous jump Markov processes Cornell University NY USA pp 1 – 15

1219. Abramowitz M, Stegun I A (editors) 1964 Handbook of mathematical functions National
Bureau of Standards Applied Mathematics Series vol 55 USA.

Society Providence USA.

1221. Akhiezer N I, Glazman I M 1966 Theory of linear operators in Hilbert space Nauka
Moscow Russian Federation.

1222. Lamperti J 1966 Probability Benjamin New York USA.
1228. Breiman L 1968 Probability Addison-Wesley Reading MA USA.
1235. Box G E P, Jenkins G M 1970 Time series analysis: Forecasting and control Holden Day San Francisco California USA.


1247. Maddala G S 1983 Limited-dependent and qualitative variables in econometrics *Cambridge University Press* Cambridge UK.


1256. Taylor S 1986 Modeling financial time series *John Willey and Sons Inc* New York USA.

1257. Tong H 1986 Nonlinear time series *Oxford University Press* Oxford UK.


1260. Newey W, West K 1987 A simple positive semi-definite, heteroskedasticity and

autoregressive models \textit{Biometrika} 75 pp 491 – 499.

practice of econometrics 2\textsuperscript{nd} edition \textit{John Wiley and Sons Inc} New York USA.

Cambridge University Press} Cambridge UK.

1264. Lancaster T 1990 The econometric analysis of transition data \textit{Cambridge University
Press} Cambridge UK.

Oxford UK}.

1266. Johansen S 1992 Cointegration in partial systems and the efficiency of single equation

1267. Pesaran M H, Potter S M (editors) 1993 Nonlinear dynamics, chaos and econometrics
\textit{John Willey and Sons Inc} New York USA.

1268. Banerjee A, Dolado J J, Galbraith J W, Hendry D F 1993 Cointegration, error correction,
and the econometric analysis of nonstationary data \textit{Oxford University Press} Oxford UK.


1270. Peters E E 1994 Fractal market analysis: Applying chaos theory to investment and
economics \textit{John Wiley and Sons Inc} New York USA.

USA.

models \textit{Oxford University Press} Oxford UK.

New York USA}.

Symposium Optical Microlithography Conference VIII} 2440 2.

1275. Moore G E 2003 No exponential is forever – but we can delay forever \textit{ISSCC}.

\textit{Princeton University Press} Princeton USA.

1277. Mosekilde E 1996 Topics in nonlinear dynamics: Applications to physics, biology and
economic systems \textit{World Scientific Publishing Pte Ltd} Singapore.


1281. Hasem P M, Pesaran B 1997 Working with Microfit 4.0: Interactive econometric analysis *Oxford University Press* Oxford UK.


1284. Hubbard B B 1998 The world according to wavelets *A K Peters* Wellesley MA USA.

1285. Mallat S A 1998 Wavelet tour of signal processing *Academic Press* San Diego CA USA.

1286. Teolis A 1998 Computational signal processing with wavelets *Birkhauser* Switzerland.


1292. Hayashi F 2000 Econometrics *Princeton University Press* Princeton NJ USA.


Business Administration Science, Management Science, Strategy Science:


Porter M E 1982a Cases in competitive strategy *Free Press* New York USA.


Porter M E 1983 Analyzing competitors: Predicting competitor behavior and formulating offensive and defensive strategy in *Policy, strategy, and implementation* Leontiades M (editor) *Random House USA*.

Porter M E 1985 Defensive strategy *Strategy* 7 (1).


1339. Porter M E 2001b The technological dimension of competitive strategy in Research on technological innovation, management and policy vol 7 Burgelman R A, Chesbrough H (editors) *JAI Press* Greenwich CT USA.


and sustaining competitive advantage *Harvard Business School Class Lecture* Harvard University USA pp 705 – 509.


1344. Porter M E January 2008 The five competitive forces that shape strategy *Special Issue on HBS Centennial Harvard Business Review* 86 (1)

http://hbr.org/2008/01/the-five-competitive-forces-that-shape-strategy/ar/1.

1345. Porter M December 2013 Fundamental purpose *Value Investor Insight* pp 8 – 20


1348. Yelle L E 1979 The learning curve: Historical review and comprehensive survey *Decision Sciences* 10 (2) pp 302 – 328.


1363. McKiernan P 1997 Strategy past, strategy futures Long range planning vol 30 no 5 p 792.


1367. Moldoveanu M, Martin R L 2001 Agency theory and the design of efficient governance mechanisms Joint Committee on Corporate Governance Meeting Rotman School of Management University of Toronto Ontario Canada pp 1 – 57.


1370. Martin R L 2007 Designing the thinker Rotman Magazine Rotman School of Management University of Toronto Ontario Canada pp 4 – 8.


1375. Laffont J-J, Tirole J 1999 Competition in telecommunications *MIT Press* USA.


1378. Drejer A 2002 Strategic management and core competencies 1st edition *Quorum Books* Westport Connecticut USA.

1379. Sadler P 2003 Strategic management 1st edition *Kogan Page* Sterling VA USA.


1387. Chamberlain G P 2010 Understanding strategy *Create Space* Charleston SC USA.

*Disruptive Innovation in Technology, Economics and Finances:*
1388. Schumpeter J A 1911; 1939, 1961 Theorie der wirtschaftlichen entwicklung; The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle Redvers Opie (translator) OUP New York USA.


1407. Christensen C M 1999a Innovation and the general manager Irwin McGraw-Hill Homewood IL USA.

1408. Christensen C M 1999b Impact of disruptive technologies in telecommunications in Bringing PC economies to the telecommunications industry PulsePoint Communications.


1413. Christensen C M, Craig Th, Hart S March April 2001 The great disruption Foreign Affairs 80 no 2.


1425. Shah Ch D, Brennan T A, Christensen C M April 2003 Interventional radiology: Disrupting invasive medicine.

1426. Christensen C M March April 2003 Beyond the innovator's dilemma Strategy & Innovation 1 no 1.


Information Asymmetry Theory and Information Absorption Theory in Economics, Finances, and Business Administration Sciences:


1447. Farina V 2008 Network embeddedness, specialization choices and performance in investment banking industry University of Rome Tor Vergata Italy MPRA Paper no 11701 Munich University Munich Germany pp 1 – 26 http://mpra.ub.uni-muenchen.de/11701/ .


1457. Ledenyov D O, Ledenyov V O 2013f Some thoughts on accurate characterization of stock market indexes trends in conditions of nonlinear capital flows during electronic trading
at stock exchanges in global capital markets MPRA Paper no 49964 Munich University Munich Germany pp 1 – 52
http://mpra.ub.uni-muenchen.de/49964/ .

http://mpra.ub.uni-muenchen.de/50235/ .

1459. Ledenyov D O, Ledenyov V O 2013h Tracking and replication of hedge fund optimal investment portfolio strategies in global capital markets in presence of nonlinearities MPRA Paper no 51176 Munich University Munich Germany pp 1 – 92
http://mpra.ub.uni-muenchen.de/51176/ .

1460. Ledenyov D O, Ledenyov V O 2013i Venture capital optimal investment portfolio strategies selection in diffusion - type financial systems in global capital markets with nonlinearities MPRA Paper no 51903 Munich University Munich Germany pp 1 – 81
http://mpra.ub.uni-muenchen.de/51903/ .

1461. Ledenyov D O, Ledenyov V O 2014a Mergers and acquisitions transactions strategies in diffusion - type financial systems in highly volatile global capital markets with nonlinearities MPRA Paper no 53906 Munich University Munich Germany pp 1 – 142
http://mpra.ub.uni-muenchen.de/53906/ .

1462. Ledenyov D O, Ledenyov V O 2014b Strategies on initial public offering of company equity at stock exchanges in imperfect highly volatile global capital markets with induced nonlinearities MPRA Paper no 53780 Munich University Munich Germany pp 1 – 139
http://mpra.ub.uni-muenchen.de/53780/ .


1464. Ledenyov D O, Ledenyov V O 2014d MicroLBO software program with the embedded optimized near-real-time artificial intelligence algorithm to create winning virtuous strategies toward leveraged buyout transactions implementation and to compute direct/reverse leverage
buyout transaction default probability number for selected public/private companies during private equity investment in conditions of resonant absorption of discrete information in diffusion - type financial system with induced nonlinearities ECE James Cook University Townsville Australia, Kharkov Ukraine.


Absorption Phenomena Theory and Experiment in Physics; Chemistry; Electrical, Electronics and Computer Engineering Sciences:


