Investment in capital markets

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Townsville, Australia
Kharkiv, Ukraine
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To our lovely parents Oleg P. Ledenyov and Tamara V. Ledenyova.
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Disruptive technological and social innovations in economics and finances

Metal coins, paper money, electronic money, network money, electronic cash, digital cash, bit coin, electronic payments, debit cards, credit cards, stored value cards, smart cards (electronic purses) in finances

Central banks, federal reserve bank, federal reserve system in finances
Stock exchange history, stock exchange operation principles, company valuation, company stock emission, company stock valuation by market, company stock valuation by rating agencies in finances

Investment capital, investment portfolio, investment portfolio risk management in finances

Land investment, land valuation, land ownership, land exchange, financial capital investment product, financial capital investment medium in finances

Commodity investment, commodity valuation, commodity derivatives, commodity futures, commodities exchange, financial capital investment product, financial capital investment medium in finances

Precious metal investment, precious metal valuation, precious metals exchange, financial capital investment product, financial capital investment medium in finances

Real estate investment, real estate valuation, real estate exchange financial capital investment product, financial capital investment medium in finances

Private and public firms theories in economics and finances

Public company investment, public company initial public offering valuation by rating agency/open market, stock exchange, financial capital investment product, financial capital investment medium in finances

Private company investment, private company valuation, venture capital investment, venture capital fund, angel capital investment, financial capital investment product, financial capital investment medium in finances

Firm’s stock option investment, traded stock options, employee/executive stock options, equity options in finances

Bond investment, bond valuation, financial securities investment, financial securities exchange, financial capital investment product, financial capital investment medium in finances
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**Introduction**

A financial capital investment in the global capital markets creates a solid foundation for the active dynamic prosperous life by the private and institutional investors in the modern society. In this book, the authors clearly and persuasively explain the modern investment theories and practices, solving a problem on the optimal investment of the financial capital in the capital markets with the aim to get an increased return premium in the short and long time periods. We easily create an investment mindset among the interested readers by discussing the advanced research findings on the modern investment techniques application in the capital markets in the finances. Chapter 1 discusses the capital markets history from the ancient time to the present time, using the academic literature. Chapter 2 formulates the main problem on the financial capital investment in the capital markets with the aim to get an increased return premium in short and long time periods. Chapter 3 provides a possible solution to the problem on the financial capital investment in the capital markets with an aim to get the increased return premium in the short and long time periods, using the different investment products, investment vehicles and investment mediums. Chapter 4 focuses on the land, real estate, bonds, stocks, stock options, financial securities, foreign currencies, commodities as the investment products for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. Chapter 5 considers the investment banks, investment funds, hedge funds, pension funds, venture capital funds, investment boutiques firms, private investment offices as the investment vehicles for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. Chapter 6 researches the land exchange, real estate exchange, companies stocks exchange, foreign currencies exchange, financial securities exchange, commodities exchange, precious metals exchange, intellectual properties exchange as the investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. Chapter 7 discusses the investment portfolio, the financial assets valuation, and the financial risk evaluation and mitigation during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. Chapter 8 confers the quantum winning virtuous investment strategies creation and execution, using the inductive, deductive, abductive, quantum logics during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. Conclusion summarizes all the important research findings and discusses their theoretical and practical implications, using the general-audience language.
Chapter 1

Financial capital markets from ancient time to present time

The capital comprises all the forms of stock-wealth, which can be used by the human to create the new wealth with application of human labour, aiming to satisfy the man’s basic and extended needs, education requirements, professional interests, cultural necessities toward the high social status achievement in a prosperous harmonious society in Marx (1867, 1893, 1894), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896).

The first capital markets were established with the goal: to make it possible to conduct the basic financial value exchanges between the economic agents in the economies of the scales and the scopes since around 7th C.B.C. In these capital markets in the economies of the scales and the scopes, the new wealth synthesis process have been realized, using the three main objects: the Matter/Land, Labour and Capital in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Ricardo (1817, 1821), Bentham (1839), Mill (1862), Hirsch (1896)).

Fig. 1 shows the new wealth creation by means of the synthesis process, using the three objects: Matter, Labour and Capital (the Land, Labour and Capital in the Political Economy).

Fig. 1. New wealth creation synthesis process with three objects: Matter, Labour and Capital.
The value of the capital can be measured with an application of the money in frames of the proposed capital pricing theories in the finances/economics sciences. The money represents a legally-established measure of wealth’s value, a freely-exchangeable unit of wealth’s value equivalent storing, a mean of wealth’s value equivalent payment and a media of wealth’s value equivalent exchange, enabling to perform the wealth exchange operations during its free circulation process among the economic agents in the economies of the scales and the scopes. The money is one of the central subjects of research in the capital theory in the political economy science in Smith (1776, 2008), Marx (1867; July, 1893; October, 1894), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), von Mises (1912), Keynes (1936), Piketty (August 2013, August 15 2014), Dodd (2014), Stiglitz (2015, 2016).

Fig. 2 pictures the money definition as the unit of payment and the medium of exchange.

![Money definition diagram]

**Fig. 2.** Money definition.

Over the centuries, the money in the form of the paper money, paper notes and metal coins served mainly as the means of payments exchange in the capital markets in Del Mar (1894), Cook (1958), Carson (1962), Crawford (1970), Balmuth (1971), Thompson, Kraay, Morkholm (editors) (1973), Kagan (1982), Price (1983), Wallace (1987, 1989), Howgego (1990), Karwiese (1991), Thiveaud, Sylvain (1995), Davies (2002), Moroz V S, Moroz V S (September 2014), Yeoman (2014). The multiple historical findings confirm the fact that the financial transactions with the paper money, paper notes, and metal coins began to be introduced in mainland China since the time of the Song and Yuan dynasties. Presently, they are being used
in all the economies of the scales and the scopes, facilitating the domestic/international trade by
the goods and services in various countries in Del Mar (1894), Cook (1958), Carson (1962),

In the course of practical money use, the money’s design has been improved due to the
multiple inventions of the writing, arithmetic, chemistry, physics, astronomy and philosophy
during the historical evolution of mankind in the organized societies over the centuries in Landes
(1998), Thiveaud, Sylvain (1995). The contemporary money design, meaning and impact on the
value payments cycles in the classic economies of the scales and the scopes were researched in
Smith (1776, 1991), Ricardo (1816, 1951), Fisher (1933), Keynes (1936), Redlich (1951),
Baumol (1952), Butlin (1953), Tobin (1956), Tobin (1963), Friedman, Jacobson, Schwartz
(1963), Hayek (1974, 1976a, b, 1978), Checkland (1975), Galbraith (1976), McKinnon (1979),
(August 27 1999, November 1999), Berk (September 2002), Williams, Anderson (March 2007).

A measurement accuracy of the financial capital value depends on a number of
(un)objective factors: the payment unit, the monetary system, the financial system, the financial
arithmetic, the mathematics principles in the capital market in the economy of the scale and the
scope. In fact, a measurement accuracy of the financial capital value may slightly differ in
various financial systems in the economies of the scales and the scopes.

The central banks played a pivotal regulatory role in the financial capital evaluation,
accumulation and distribution processes in the debt and equity capital markets in the economies
of the scopes and the scales, including the Bank of Amsterdam (1609) in The Netherlands,
Sveriges Riksbank (1664) in Sweden, Bank of England (1694) in England, since XVI century
until present time in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Bagehot (1873,
fundamentals on the financial capital evaluation, accumulation and distribution processes in the
debt and equity capital markets in the economies of the scopes and the scales were researched by
the eminent scientists over the recent centuries in Smith (1776, 2008), Marx (1867; July, 1893;
October, 1894), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896),
von Mises (1912), Keynes (1936), Piketty (August 2013, August 15 2014), Dodd (2014), Stiglitz
(2015, 2016). The modern financial systems at the national/global levels have been strongly
influenced by the Austrian school of the financial/economic thinking, namely by the Austrian
economists from the Chicago school of financial/economic thinking in Chicago, USA in von
Böhm-Bawerk (1884, 1889, 1921). Regulating a capital market through the monetary and financial policies in the modern financial systems, the central bank focuses on the two main functional tasks in Owen (1919), Willis (1923), Meltzer (2003, 2009a, b), Fox, Alvarez, Braunstein, Emerson, Johnson, Johnson, Malphrus, Reinhart, Roseman, Spillenkothen, Stockton (2005), Bernanke (2013), Ledenyov D O, Ledenyov V O (December 11-12 2015), Ledenyov D O, Ledenyov V O (2016s):

1. The financial liquidity provision;
2. The financial liquidity regulation.

The central bank fulfills its principal mission by regulating the three main sorts of the money in the capital market in the economy of the scale and the scope in Selgin, White (1994):

1. The natural money based on a single commodity;
2. The multiple commodity money;
3. The no base money.

The central bank issues/distributes/regulates a wide range of the value payments means in the capital market in the economy of the scale and the scope in Goodhart (1989, 2000):

1. The metal coins, made of precious metals;
2. The paper currencies, made of multiple layers of paper/cotton;
3. The paper checks, made of multiple layers of paper/cotton;
4. The wired payment orders, existing in the form of electronic signals;
5. The electronic money, appearing in the form of electronic signals;
6. The network money, existing in the form of electronic signals;
7. The Bitcoin/Ethereum blockchains, existing in the form of electronic signals.

The Bitcoin/Ethereum are classified as the digital crypto currencies/the money exchanges with the blockchain secure encryption/decryption/arbitration technologies in a form of the executable software code in the distributed decentralized data network such as the Internet of Things. The digital currencies introduction results in a pervasive lowering of transaction cost. The following digital currencies system definitions are accepted in Antonopoulos (2014, 2016):

1. The Bitcoin/Ethereum are the digital currencies;
2. The blockchain is a distributed relational database with the blocks of code;
3. The smart contract is a small software program to represent the financial products;
4. The proof of work is a security concept for the digital currencies;
5. The proof of stake is a security concept for the digital currencies;
6. The miner is a group of users with the biggest computer power;
7. The blockchain scaling is a methodology to scale the blockchain.
Fig. 3 provides the information on various sorts of the existing money in connection with the money bases in the modern financial systems in the economies of the scales and scopes.

Fig. 3. Money types in financial system.

Fig. 4 shows the possible means of value payment in the modern financial systems in the economies of the scales and scopes.

Fig. 4. Means of value payment in financial system.
In addition to central bank’s goal to facilitate a sustainable development of the economy of the scale and the scope, it constantly changes the interest rates on the money loans to the commercial/investment banks, as well as, it adjusts the foreign currencies exchange rates between the national currency and the major foreign currencies in the frames of the following central bank’s policies in Ledenyov D O, Ledenyov V O (2016s):

1. The monetary stability policy;
2. The financial stability policy.

As we know, the quantum physics has had the three major development stages, including the light quantum theory creation in Planck (1900c, d, 1901, 1914); the atom quantum theory development in Bohr (1922); and the wave equation derivation in Schrödinger (1926 a, b). Discussing the nature of money together with its econophysical properties, we would like to use this opportunity to propose the Ledenyov quantum theory on the dual nature of the money in the financial system in the economy of the scale and the scope. It makes sense to explain that the Ledenyov quantum theory on the dual nature of the money in the quantum econophysics is formulated in an analogy with the Planck quantum theory on the light in the quantum physics in Planck (1900c, d, 1901, 1914).

The Ledenyov quantum theory on the dual nature of the money postulates that the money has the dual econophysical nature in the financial system in the capital market in the economy of the scale and the scope:

1. The money can be treated as a particle in frames of the particle theory of the money. The money particles could only be emitted in the quantized forms (the certain money nominal) by the treasure. The treasure on the central bank request could add/subtract these money particles to/from the financial system in the economy of the scale and the scope. The money particles of different values in the financial system in the economy of the scale and the scope could be filtered with an application of the particle filters and statistically analyzed with an application of the statistical distributions in the mathematic science;

2. The money can be considered as a wave in the frames of the wave theory of the money. These money waves with the certain wavelengths (the certain money nominal) could only be emitted in the quantized forms (the certain money nominal) by the treasure. These united waves could create the money flows in the financial system in the economy of the scale and the scope. The central bank could adjust the level of the liquidity in the financial system by adding/subtracting the money flows to/from the financial system during the corresponding regulatory policies introduction in the case of the quantitative easing/restricting policies implementations. The real mechanisms of the central bank’s regulatory policies introduction
towards the quantitative easing/restricting policies implementations could be realized through: 1) the low-interest-rates money loans provision to the commercial banks by the treasury as ordered by the central bank, aiming to add the liquidity to the real/speculative sectors of the economy of the scale and the scope; or 2) the treasure bills selling to the commercial banks by the treasury as ordered by the central bank, aiming to subtract the liquidity and decrease the inflationary expectations from/at the real/speculative sectors of the economy of the scale and the scope.

Presently, the necessary infrastructure for the electronic financial transactions realization at the financial data processing centers includes the computer servers, the remote terminals and the data communication networks. Thus, the interconnected remote terminals, including the ATM terminals, desktop computers, laptops, mobile phones and mobile bracelets complete the financial transactions by connecting to the computer servers via the software programs with the implemented communication protocol stacks, using the optical/wireline/wireless data networks with the high speed data rates transfer capabilities. More specifically, we can highlight the following hardware/software technological advancements in the information communication technologies (ICT) to implement the electronic financial transactions in the banking industry in Gabor (1946), Shannon (1948), Oppenheim, Schafer (1989), Simon, Hinedi, Lindsey (1995), Proakis, Manolakis (1996), Prisch (1998), Wanhammar (1999), Sklar (2001), Rice (2008), Ledenyov D O, Ledenyov V O (2015a):

1. Hetero-Junction Bipolar Transistors (HBT), High Electron Mobility Transistors (HEMT), Field Effect Transistors (FET), Metal Semiconductor Field Effect Transistors (MESFET), Metal Oxide Semiconductor Transistors (MOSFET), which are made of the Silicone Carbide (SiC), Gallium Arsenide (GaAs), Germanium Nitride (GeN) wide energy band semiconductor junctions, operating from the low frequencies to the ultra high frequencies range;

2. Very Large Scale Integrated (VLSI) circuits with the high density of the transistors, which operate at the ultra high frequencies range (GHz range);

3. The Digital Signal Processors (DSP), which can be designed in the forms of the standard DSP chipsets as well as the Field Programmable Gate Arrays (FPGA) chipsets;

4. The real-time operational systems like the VxWorks, QNX, Android, iOS, which execute the compiled real-time software programs at the microprocessors/microcontrollers in the radio-transceivers and remote wireless/wireline terminals;

5. The near real-time software programs made in the Assembly and C languages, which can be compiled to encode/decode the headers and the data payload envelops in the protocol stacks at the information transmission process in the wireline/wireless/optical data links as well as to make functional automatisation of electronic devices in the electronics;
6. The high stable operation systems like the Windows, Linux, Unix, which execute the compiled software programs at the big computer servers / the desktop computers fast enough;

7. The object oriented software programs in the C++, Java++, which can be compiled to operate with the distributed relational databases at the operation systems at the big computer servers and the desktop computers reliably;

8. The high speed optical communication networks, which can function at the synchronous transfer mode (SONET) and the asynchronous transfer mode (ATM), transferring the encoded data at the long distances at the high data rates over the short time;

9. The in-fiber optical devices and components: the optical amplifiers, optical couplers, optical circulators, optical splitters, optical phase shifters, optical phasars, optical dense wave division (de)multiplexers (WDM), made of the in fiber Brag gratings, the LiNbO crystals, the Si ultrasonic transducers and the single/multiple filaments optical fibers;

10. The wireless communication networks such as the Latest Technology Evolution (LTE)/Universal Mobile Telecommunication System (UMTS)/Wideband Code Division Multiple Access (WCDMA), which may transfer the encoded data over the wireless channel at the short/long distances at the high data rates over the short time;

11. The quantum cryptography for the quantum data communication protocols for the quantum optical/space/wireless/wireline/ communication networks, based on the quantum encryption techniques in the quantum mechanics, allowing the secure quantum data communications over the long distances in the space domain over the certain time periods;

12. The quantum random number generators in the quantum processors, which can allow to perform the very accurate supercomputer modeling, the very accurate quantum computer modeling and the quantum secure data communications over the long distances in the space domain at the selected time periods.

Continuing our formidable voluminous research, let us say that the modern progress in the information communication technologies made it possible to formulate and implement a concept on the electronic money in the modern financial systems in the economies of the scales and the scopes in 1986. The electronic money (e-money) is financially defined as the electronic store of monetary value on a technical device to make payments without necessarily involving bank accounts in the transaction, but acting as a prepaid bearer instrument in European Central Bank (August 1998). More clearly, the electronic money is based on a complex system of the electronic payments instruments (the digital cash, digital purse, stored-value/debit/credit cards), the financial processes (the debit, credit calculation), the information processing (the mathematical numbers computing and the storing of information at the data centers) and the

In the quantum physics, the authors invented the magnetic flux qubit; and then, designed a chipset of the quantum random number generator on the magnetic flux qubits (1024 QRNG_MFQ) for the first time Kharkiv, Ukraine in 1991, working to improve the 1024 QRNG_MFQ chipset design at Technical University of Denmark in Lyngby, Denmark in 1996-1997. We frequently discussed the 1024 QRNG_MFQ chipset at the international conferences, including the seminars at Leiden University in The Netherlands in 1998, and the University of Toronto in Canada in 1998. At later date, we discovered that the magnetic knot of vortex is in an extreme quantum limit in the quantum physics for the first time in Kharkiv, Ukraine in 1998. We designed a chipset of the quantum memory on the magnetic vortices knots in Kharkiv, Ukraine in 1999, making a report on a chipset of the quantum memory on the magnetic vortices knots at a Marconi seminar at Birmingham University in the United Kingdom in 2000, contributing to a new era of the intensive research and development (R&D) programs in the field of the quantum computing in the quantum physics in Ledenyov D O, Ledenyov V O (2015a).

In the finances, we expressed a general idea on a possible creation of the quantum money in 2000. At later date, we decided to formulate a detailed concept on the quantum money, introducing the quantum money (q-money) as a newest value storing/not storing unit, a mean of payment and an exchange medium for the first time in Ledenyov D O, Ledenyov V O (2015m). Of course, the quantum money (q-money) can be considered as a more convenient, financially innovative, technologically attractive and user/issuer friendly value storing/not storing unit, mean of value payment, and exchange medium in the advanced financial systems within the quantum economies of the scales and the scopes in Ledenyov D O, Ledenyov V O (2015m). The main financial idea behind the quantum money (q-money) is to establish a value storing/not storing q-money, which is most innovative, technologically advanced, financially efficient, economically sustainable, socially equitable, politically democratic in the financial systems within the economies of scales and scopes, aiming to achieve the millennium development goals in Ledenyov V O, Ledenyov D O (2015m, 2016s).

The introduction of the electronic money and the quantum money in the capital markets in the finances creates a strong necessity for the national governments, central banks and the international regulatory bodies to introduce a new regulatory international policies framework
with the aim to govern the processes of the emission, distribution, storing, and evaluation of the new money by the treasures in the financial systems in the economies of scales and scopes in Ledenyov V O, Ledenyov D O (2016s).

Fig. 5 depicts the money design evolution in financial system over the time.

Fig. 5. Money design evolution in financial system in time.

Once again, the money emission, distribution, storing, and evaluation is normally conducted by the national treasures and governed by the central banks, which create and implement the monetary stability policy, financial stability policy, and other regulatory policies. Indeed, the central bank can implement its policies by adjusting the interest rates on the money lending as well as by adding/subtracting the money flow (the liquidity) to/from the financial system in the selected economy of the scale and the scope, going from the macroeconomic indicators. The commercial and investment banks can lend the money on the interbank market, depending on the corresponding macroeconomic and microeconomics indicators. The macroeconomics indicators are uniquely defined by the economic output fluctuations in the time. There are several business cycles, which are distinguished by the financiers/economists:

1. The Juglar economic cycle in Juglar (1862);
2. The Kondratiev economic cycle in Kondratieff (1922, 1925, 1926, 1928, 1935);
3. The Kitchin economic cycle in Kitchin (1923);
4. The Kuznets economic cycle in Kuznets (1973a, b);
5. The Ledenyov economic cycle in Ledenyov DO, Ledenyov VO (2015e, f, 2016s). Most importantly, aiming to complete the monetary and financial regulatory missions, all the central banks use an accumulated knowledge base in the social sciences and natural sciences:


The innovative research in the modern finance science by the central banks continues intensively, aiming to understand the nature of complex processes in the economics and finances with the theories, experiments and computer modeling in the field of econophysics. The research groups at the leading universities/institutions/banks make numerous attempts to re-define the research boundaries in the finances, applying the econophysics principles to solve the complex financial problems. The most recent scientific contributions by the econo-physicists have been summarized in Mantegna, Stanley (1999), Ilinski (2001), Bouchaud, Potters (2003), Sornette (2003), Yakovenko, Rosser (2009), Sinha, Chatterje, Chakraborti, Chakrabarti (2010), Chakrabarti B K, Chakrabarti A (2010), Aoyama, Fujiwara, Iyetomi, Sato (2012).

Finalizing all the above introductory philosophical discussions on the capital markets history, let us focus precisely on the problem of the capital investment in the capital markets in the finances. We will prefer to continue our breathtaking learning journey in the finances by formulating the central problem on the financial resources investment in the capital markets with the aim to get an increased return premium in the short and long time periods in Chapter 2.
Chapter 2

Formulation of problem on financial capital investment in capital markets

In the finances, the investment means an act of allocation of the financial capital in order to gain a certain profit in the form of the increased investment return premium, advantage or interest. A problem on the investment of the financial capital in the capital markets was formulated in the early research books in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Bagehot (1873, 1897). However, on that time, the prevailing scientific opinion was that a highly volatile nature of capital markets makes it quite difficult to accurately analyze, predict and calculate the investment return premium, advantage or interest.

A set of practical questions was raised by the investors on that time: What is the meaningful definition of the financial capital in the finances? What are the financial/economic variables suitable for the accurate characterization of the financial capital changes dynamics in the capital markets in the scale-frequency-time domains? What are the most appropriate measurement units to measure the financial/economic variables suitable for the accurate characterization of the financial capital changes dynamics in the capital markets in the scale-frequency-time domains? How can the process on the investment of the financial capital in the capital markets in the scale-frequency-time domains be optimized? How can the optimal investment decisions on the financial capital allocation in the capital markets be taken from the financial, economic and legal points of view? How can the investment return premium on the invested financial capital in the capital markets be calculated? What is the accuracy of calculation of the investment return premium on the invested financial capital in the capital markets? How successful is the investment of the financial capital in the capital markets? There were no the straightforward clear answers on the above challenging financial questions on the financial capital investment in the capital markets on that time. A general way of thinking on the investment of the financial capital in the capital markets was not based on the scientific grounds, but rather on the investors’ intuition and basic mathematical skills. One of the main reasons of existed state of matters was a lack of understanding of an important fact that the problem on the investment of the financial capital in the capital markets can only be solved, using the advanced theoretical models with the differential equations in the econophysics.
Let us write a list of the financial/economic variables for the accurate characterization of the financial capital changes dynamics in the capital markets in the scale-frequency-time domains:

1. Finances science (the financial capital value; the return premium value; the profit-to-earnings value; the total risk value; the EBITDA value);

2. Economics science (the amplitude, frequency, period, phase of the business cycle; the number of the economic events; the probability of the occurring economic events; the distributions of the occurring economic events in the scale, frequency, time domains);

3. Mathematics science (the number of the occurring events; the probability of the occurring events; the distributions of the occurring events in the scale, frequency, time domains; direction of vector in the multidimensional space, vector absolute magnitude, coordinate space);

4. Econometrics science (the number of the economic events; the probability of the occurring economic events; the distributions of the occurring economic events in the scale, frequency, time domains; the direction of the capital flow vector in the multidimensional coordinate space; financial liquidity level; interest rates; total risk level);

5. Physics science (the amplitude, frequency, period, phase of the continuous- and discrete-time signals; the central frequency of the or the continuous- and discrete-time signals; the dynamic range of the continuous- and discrete-time signals);

6. Econophysics science (the amplitude, frequency, period, phase of the continuous- and discrete-time economic signals; the central frequency and the dynamic range of the particular continuous- and discrete-time economic signals);

7. Psychology science (the deductive, inductive, abductive logics values; intellect level; decision making level; logical analysis level);

8. Computer science (the computer model input and output values; simulation time; simulation accuracy; simulation quality; random number sequence quality; random number sequence length; operating system stability).

9. Biology science: (the structure of the digital DNA of the economy of the scale and the scope).

10. Telecommunications science: (the information generation, coding, transmission and storing between the economic agents in the economy of the scale and the scope; the asymmetric information flows between the economic agents in the economy of the scale and the scope; the bit error rate during the information transmission between the economic agents in the economy of the scale and the scope).
Fig. 6 shows the financial variables to characterize an investment of financial capital in the capital markets in the short and long time periods.

Let us focus on the two most important developments, which have greatly contributed to the clarification of the problem on the investment of the financial capital in the capital markets:

1. The creation of the econometrics, including the statistical distributions theories and the probability theory, which have been developed in the research works in De Laplace (1812), Bunyakovsky (1846), Chebyshev (1846, 1867, 1891), Markov (1890, 1899, 1900, 1906, 1907, 1908, 1910, 1911, 1912, 1913), Bachelier (1900, 1914, 1937, 19 May 1941) Slutsky (1922a, b, 1925a, b, 1927a, 1937a, b), Courtauld, Kabanov, Bru, Crépel, Lebon, Le Marchand (2000), Bachelier, Samuelson, Davis, Etheridge (2006).

2. The creation of the econophysics, including the heat transfer theory (the thermal conductivity theory), the Brownian motion theory, and the probability theory in Bunyakovsky (1825), Bachelier (1900, 1914, 1937, 19 May 1941), Einstein (1905, 1956), Einstein, Smolukhovsky (1936), Brush (1968, 1977).
Fig. 7 shows the illustration of the Gauss normal distribution of the probability of events.

![Gauss normal distribution of probability of occurring events.](image)

**Fig. 7.** Gauss normal distribution of probability of occurring events.

Fig. 8 provides an illustration of the valuable financial papers prices evolution estimation with the probability theory in the finances in Bachelier (1900, 1914, 1937, 19 May 1941).

![Illustration of the valuable financial papers prices evolution estimation with the probability theory in the finances in Bachelier (1900, 1914, 1937, 19 May 1941).](image)

**Fig. 8.** Illustration of the valuable financial papers prices evolution estimation with the probability theory in the finances in Bachelier (1900, 1914, 1937, 19 May 1941). The three Gauss normal distributions of the probabilities of the valuable financial papers prices at various time periods of 1, 5, 10 years are depicted.

In the econophysics, we can pretend to precisely characterize the money in the capital markets by comparing the money in the finances to the small particles in the physics:
1. The money in the finances can be compared to the small particles in the physics;
2. The money can spread randomly in the financial system over the time in analogy to the case, when the small particles can spread randomly in the gas/liquid/condensed matter over the time;
3. The money movement in the financial system over the time can be characterized as the fractional Brownian movement similarly to the case, when the small particles displacement in the gas/liquid/condensed matter under the potentials difference over the time can be characterized as the fractional Brownian movement;
4. The money movement in the financial system over the time can be ballistic or diffusive or captivated. In the diffusion case, the money can diffuse in the financial system over the time in analogy to the case, when the small particles can diffuse in the gas/liquid/condensed matter over the time in agreement with the classic diffusion principles in the chemistry/physics;
5. The money can be characterized by the discrete-time signals with the discretely changing money’s parameters in the diffusion-type financial systems over the time similarly to the case, when the small particles can be characterized by the discrete-time signals in the diffusion-type gas/liquid/condensed matter systems with the discretely changing chemical/physical parameters over the time;
6. The money can exhibit the discrete-time multi-fractal properties in the diffusion-type financial system in the scale-time domains over the time in analogy to the case, when the small particles can demonstrate the fractal properties in the diffusion-type gas/liquid/soft-condensed matter systems in the scale-time domains over the time.

Let us take a minute and explain that, in the physics, all the existing electromagnetic signals in our nature can be conditionally classified in the two broad categories:

1. The continuous-time signals, which can be studied with the continuous-time signals filtering theory and the continuous-time signals processing theory in the electrodynamics science; the physics science; the electrical, electronics, computer engineering science in Maxwell (1890), Ledenyov D O, Ledenyov V O (2015a);
Let us clarify that, in the finances, the continuous- and discrete- time signals can be generated by the oscillating economic/financial variables over the time:

1. The continuous-time signals have been researched with the continuous-time signals filtering theory and the continuous-time signals processing theory in application to the business cycles of GDP(t), GNP(t), GIP(t), PPP(t) in the economics science in Juglar (1862), George (1881, 2009), Kondratieff (1922, 1925, 1926, 1928, 1935, 1984, 2002), Kitchin (1923), Schumpeter (1939), Burns, Mitchell (1946), Dupriez (1947), Samuelson (1947), Hicks (1950), Inada, Uzawa (1972), Kuznets (1973a, b), Ledenyov D O, Ledenyov V O (2013c, 2015d);

2. The discrete-time signals have been researched with the discrete-time signals processing theory in application to the business cycles in the economics science and the foreign currencies exchange rates in the finances science in Ledenyov V O, Ledenyov D O (2016s).

Fig. 9 shows the two signals groups by the oscillating financial variables in the finances.
Continuing our research discussion, we would like to demonstrate the continuous- and discrete-time signals waveforms in the time domain, $S_1(t)$ and $S_2(t)$.

Fig. 10 shows the continuous-time signal in the finances in Maxwell (1890), Ledenyov D O, Ledenyov V O (2015a). Fig. 11 demonstrates the discrete-time signal in the finances in Wanhammar (1999), Ledenyov D O, Ledenyov V O (2015a).

![Fig. 10. Continuous-time signal by oscillating financial variables in finances.](image1)

![Fig. 11. Discrete-time signal by oscillating financial variables in finances.](image2)

The continuous time signals can be filtered out by the continuous-time filters; and the discrete-time digital signals can be filtered by the discrete-time digital filters.

Fig. 12 shows an illustration of the function of the continuous-time signal filter in Ledenyov D O, Ledenyov V O (2015a). Fig. 13 demonstrates an illustration of the function of the discrete-time signal filter in the finances in Wanhammar (1999), Ledenyov D O, Ledenyov V O (2015a).

![Fig. 12. Continuous-time signal filter in finances.](image3)

![Fig. 13. Discrete-time digital signal filter in finances.](image4)
In the frames of the discrete-time signal processing theory, the discrete-time events can also be analyzed from their scaling properties point of view. More clearly, it was found that a mathematical set of valuable financial papers prices may exhibit a repeating pattern that displays at various scales over the time, then it was defined as a fractal in Mandelbrot (1975a, 1977). Therefore, it was assumed that the fractal theoretical model can be used to predict an evolution of the valuable financial papers prices in the scale-time domains in Mandelbrot (1997), Mandelbrot, Hudson (March 7 2006). Indeed, the scaling properties by the discrete-time events in finances, physics, electronics have been studied with an application of the chaos science by a number of famous scientists over recent decades in Mosekilde (1996-1997), Demenok (2011).


Speaking about the precise characterization of the money during the financial capital investment in the capital markets, we think that it can certainly be done in terms of the fractal and multi-fractal theories by observing, registering and analyzing the scaling properties of the discrete-time events (the money properties), characterized by the discretely changing parameters in the time-scale domains. For example, the prices of various investment assets in the capital markets can exhibit the repeating patterns that appear at various scales over the different time periods. It happens, because the prices of various investment assets depend on a big number of the discretely changing financial/economic variables in the economies of the scales and scopes. Therefore, the multi-fractals theory in the chaos science can help the private/institutional investors to make their accurate assumptions on the dynamics of changes of the prices of various investment assets in the capital markets in the finances in Mandelbrot (1960, 1963a, b, 1965, 1965, 1967a, b, 1969, 1971, 1972, 1975a, b, 1977, 1982, 1997, May 7 2006), Mandelbrot, Taylor H M (1967), Mandelbrot, van Ness (1968), Mandelbrot, Wallis (1969).
Fig. 14 shows an illustration of the fractal in form of Cantor set.

Fig. 15 shows an illustration of the fractal in form of Koch snowflake.

Let us discuss, at this point, our new research proposal on the quantum diffusion of the money in the capital markets in the finances. As we know, the classic diffusion of the money occurs discretely as a result of the Brownian motion of the money in the capital markets in the economies of the scales and the scopes at the gradient of the financial/economic potentials application in Shiryaev (1998a, b). It is similar to the small particles classic diffusion in the gas/liquid/(soft)condensed matter at the gradient of the electro-chemical potentials application in accordance with the classic diffusion principles in the physics in Bunyakovsky (1825), Brown (1828, 1829), Einstein (1905, 1956), Einstein, Smolukhovsky (1936), Brush (1968, 1977), Ledenyov V O, Ledenyov D O, Ledenyov O P (2006, 2012).
We formulate the Ledenyov theory on the quantum diffusion of the money in the capital markets in the economies of the scales and the scopes at the gradient of the financial/economic potentials application. It means that the money can experience the quantum diffusion in the capital markets. It is similar to the small particles quantum diffusion through the potential barriers in the gas/liquid/(soft)condensed matter or the multilayered junctions at the gradient of the electro-chemical potentials application in accordance with the quantum diffusion principles in the quantum physics in Andreev (February 1976).

The Ledenyov theory on the quantum diffusion of the money in the capital markets can be expressed in terms of the modified Schrödinger wave function in Schrödinger (1926a, b)

\[ \psi = \psi_0 \exp \left[ \frac{i (p r - e t)}{l_{QD}} \right], \]

where \( p \) is the impulse; \( r \) is the distance; \( t \) is the time; \( l_{QD} = \frac{\hbar}{2\pi} \) — the Ledenyov constant with the quantum diffusion index (QD).

The Ledenyov theory on the quantum diffusion of the money in the capital markets can also be described in terms of the modified Schrödinger wave function, using the Feynman paths representation in Feynman, Hibbs (1965), Kleinert (2004)

\[ \psi_i = \psi_0 \exp \left[ \frac{i \left( \int p_i dr_i - \int \varepsilon_i dt \right)}{l_{QD}} \right], \]

where \( S_i = \int p_i dr_i - \int \varepsilon_i dt \) is the action on the money (the quantum particle) during its transposition along the trajectory \( i \); \( p_i \) is the propagator of the money (the quantum particle); \( P = \sum p_i \) is the full propagator of the money (the quantum particle), \( l_{QD} = \frac{\hbar}{2\pi} \) — the Ledenyov constant with the quantum diffusion index (QD) in analogy with the Plank constant \( \hbar = \frac{\hbar}{2\pi} \) in the physics.

Feynman proposed to order all the basic events in the form of the Feynman paths in the quantum system, using the Feynman paths representation in Feynman, Hibbs (1965)

\[ \sum_i^\infty \left\{ \prod_k^\infty \psi_k(i) \right\}_{p,x}, \]

We suggest to order all the basic events in the form of the cross-sections of Feynman paths in the quantum system, using the Feynman paths representation in Feynman, Hibbs (1965)

\[ \prod_k^\infty \left\{ \sum_i^\infty \psi_i(k) \right\}_{m,D}. \]
Then, we can derive the following equation, going from the commutation principle

\[ \sum_{i} \left\{ \prod_{k} \psi_{k}^{*}(i) \right\}_{p,x} = \prod_{k} \left\{ \sum_{i} \psi_{i}(k) \right\}_{m,D}. \]

We can also write a set of the uncertainty principle expressions as

\[ \Delta p \Delta x \geq \frac{\hbar}{2}, \quad \Delta x \Delta t \geq \frac{\hbar}{2}, \quad \Delta m \Delta D \geq \frac{\hbar}{2}, \]

where \( \Delta p \) is the uncertainty of the money momentum; \( \Delta x \) is the uncertainty of the money location; \( \Delta \varepsilon \) is the uncertainty of the money energy; \( \Delta t \) is the uncertainty of the time; \( \Delta m \) is the uncertainty of the money mass; \( \Delta D \) is the uncertainty of the money diffusion.

The probability of the money (the quantum particle) presence in the given point of the capital markets space at the certain time moment in the econophysical state with the corresponding econophysical impulse is equal to

\[ W = |\psi^{*} \psi|, \]

where * is the mathematical operation of complex conjugation.

Fig. 16 depicts the quantum diffusion of money at the cross-sections (CS) of the Feynman paths in the capital markets in the finances.

![Fig. 16. Quantum diffusion of money at cross-sections of Feynman paths in capital markets.](image)

In Chapter 3, we will search for an optimal solution to the problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, using various investment products, vehicles and mediums.
Chapter 3

Solution of problem on financial capital investment in capital markets, using various investment products, vehicles and mediums

A research on the optimal investment of the financial capital in the capital markets began in the early research books in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Bagehot (1873, 1897). Despite the numerous proposed ideas, the optimal solution was not found on that time, because the problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods is a quite challenging task to think about from all the points of view. One of the reasons to believe so is hidden in the fact that there is a big number of the changing financial/economic variables to characterize the financial capital investment in the capital markets. Paradoxically, the small short-term changes as well as the big long-term changes of the financial/economic variables may have the multiple unpredictable impacts on the performance of the financial capital in the capital markets.

Making a philosophical observation on our modern life, we can say that the humans live in the modern information societies in the environment, consisting of the multiple layers such as the atmosphere, ionosphere, stratosphere and cyber-sphere. These modern information societies can be precisely identified by the unique digital DNA(s) in Ledenyov V O, Ledenyov D O (2016p, s) in an analogy with the biological objects identification in the medicine by the DNA(s) in Miescher (1871), Kol'tsov (December 12 1927), Watson, Crick (1953), Watson (2002, 2004), Gamow (1954a, b), Library of Congress (2015), DeVinne (1985), Dahm (2008), Wikipedia (2015i). In the modern information societies, the humans like to interact with the quantum/electronic/photonic devices, designed with the application of the hardware/software components in the complex quantum/electronic/photonic systems. The hardware includes all the mechanical, electronic, photonic, quantum devices, which are made of the multilayered thin films of the metals, superconductors, semiconductors, insulators and (non)organic compounds, for the automatisation/communication purposes mainly. The software includes the multilayered protocol stacks such as the TCP/IP protocol stack for the text/audio/video communications over the Internet. Therefore, it is quite natural for the engineers to design the complex quantum/electronic/photonic systems made of the multiple layers in the electrical, electronics and computers engineering, physics, chemistry, and mathematics in Oppenheim, Schafer (1989),
In the finances, we think that the financial capital investment in the capital markets with an aim to get the increased return premium in the short and long time periods can be characterized much more accurately, researching the multiple layers in the financial capital investment process with an application of the advanced theories with the differential equations with many oscillating financial/economic variables:

1. Finances science (the general finances, accounting theories);
2. Economics science (the macro-, micro-, and nano- economics theories);
3. Business administration science (the business administration theory);
4. Management science (the governance theory);
5. Mathematics science (the statistic, probability, differential equations theories);
6. Econometrics science (the financial/economic risks, signals filtering theories);
7. Physics science (the continuous- and discrete-time signals theories);
8. Econophysics science (the quantum macro-, micro-, nano- economics theories);
9. Philosophy science (the philosophical thinking with scientific reasoning theory));
10. Psychology science (the logics, logical analysis, decision making theories);
11. Computer science (the computer modeling theory);
12. Engineering science (the financial engineering theory);
13. Biology science (the DNA theory);
14. Sociology science (the investor behaviour, the customer behaviour theories).

However, the multiple financial/economic variables can change nonlinearly in the nonlinear diffusion-type financial system in the time domain, making it difficult to predict their magnitudes precisely in Ledenyov V O, Ledenyov D O (2016s). In addition, the multiple financial/economic variables can change discretely in the nonlinear diffusion-type financial system in the time domain, making it challenging to forecast their values accurately in Ledenyov V O, Ledenyov D O (2016s). Therefore, the theoretical knowledge bases in many sciences must be beneficial for the creation of the optimal investing models, aiming to get the increased return premium at the financial capital investment in the capital markets in the short and long time periods in Ledenyov V O, Ledenyov D O (2016s). Summarizing all the above statements, we think that the multidisciplinary approach in tackling of the problem on the financial capital investment in the capital markets with the aim to get the increased return premium in the short and long time periods can be regarded as a most fruitful and optimal one from the scientific point of view.
Fig. 17 shows the sciences with the theories, which can be used to solve the problem on the investment of the financial capital in the capital markets.

Of course, an overall successful development of the investment economy of the scale and the scope critically depends on a created/implemented set of the regulatory policies by the state governments, aiming to encourage the financial capital investment into the real sector of the economy of the scale and the scope rather than into the speculative sector of the economy of the scale and the scope. The set of refined regulatory policies may represents a legislative base, which has to be introduced before the moment, when:

1. The additional emission of the money in the frames of the financial liquidity adding policies to finance the state budget will be introduced;

2. The additional financial resources from the international capital markets to finance the new business development programs will be attracted;

3. The additional financial resources from the national capital markets to finance the new business programs will be collected.
The solution of problem on the investment of the financial capital in the capital markets can be derived as a result of completion of the following research stages:

1. The investment problem formulation;
2. The financial capital modeling;
3. The investment process modeling;
4. The financial system modeling;
5. The investment problem solution.

Fig. 18 shows the block scheme on the optimal solution search for the problem on the investment of the financial capital in the capital markets.

![Block Scheme](image)

**Fig. 18.** Multilayered theoretical modeling to find solution of problem on investment of financial capital in capital markets.

Considering the investment process modeling, we would like to explain that the investment process can be viewed as a process of the financial capital investment in the capital markets with the goal to get an increased return premium in the short and long time periods. The investment process generally includes the following nine phases, which can be complemented by the additional phases, depending on the considered case of the research interest:
Fig. 19 shows the block scheme of the investment process with the main stages explained.

Fig. 19. Block scheme of investment process with main stages.
At this point, we can clearly see that there are the three main activities at the core of any investment process in the capital markets in the finances:

1. The selection of the investment products;
2. The selection of the investment vehicles;
3. The selection of the investment mediums.

Let us conditionally draw the investment star planetary system in our abstract philosophical imagination with the purpose to make it easy to memorize all the three important components of the financial capital investment process in the capital markets in the finances.

Fig. 20 shows the investment star planetary system in the finances galaxy.

![Investment Star Planetary System](image)

Fig. 20. Investment star planetary system in finances galaxy.

In general, the problem on the investment of the financial capital in the capital markets can be approximately solved, using the theoretical modeling with the mathematical differential equations with a number of the interdependent financial/economic variables at the specified boundary conditions in the econometrics and econophysics sciences. The final result can only be obtained with a certain accuracy, which is a sum of the following accuracies: the accuracy of the financial capital modeling, the accuracy of the investment process modeling; and the accuracy of the nonlinear dynamical financial system modeling.
Let us focus our attention on the **investment products/asset classes/instruments**, which are being sold to the prospective investors by the financial firms/institutions in the capital markets at present time. We would like to give an example on the investment products by listing a certain number of the possible investment products such as the land, real estate, government bonds, companies stock, companies options, financial securities, foreign currencies, commodities, and antique/modern arts. We can continue this short list with many more entries, because a number of the innovative financial products increases every day exponentially.

All the investment products/asset classes/instruments can be classified into the two broad categories:

1. The real investment products/asset classes/instruments, which include the real financial products like the land, real estate, commodities;
2. The imaginary investment products/asset classes/instruments, which include the synthesized financial securities and other derivatives.

Fig. 21 depicts the investment products/instruments in the capital markets.
Let us concentrate on the **investment vehicles/intermediary**, which can be used by the prospective private/institutions investors in the capital markets in the finances. We would like to give an instance of the investment vehicles, presenting a certain number of the investment vehicles such as the investment banks, investment funds, hedge funds, pension funds, investment boutiques, investment firms, investment corporations, investment groups, investment angels.

All the investment vehicles can be classified into the two broad categories:

1. The real investment vehicles, which include the real financial institutions like the banks, funds, firms;

2. The virtual investment vehicles, which include the virtual financial institutions like the structured investment vehicle (SIV).

The investment vehicles can be rated by the rating agencies, depending on the financial performance indicators demonstrated by the investment vehicles in the capital markets.

Fig. 22 shows the investment vehicles in the capital markets.

![investment vehicles diagram](image)

**Fig. 22.** Investment vehicles in capital markets.
Let us focus on the investment mediums, which are present in the capital markets. We prefer to define the investment medium as the medium of the investment products exchange in the capital markets. We would like to give an example on the investment mediums, providing a certain number of the investment mediums such as the land exchange, real estate exchange, stock exchange, foreign currencies exchange, financial securities exchange, commodities exchange, precious metals exchange, patents exchange, antique arts exchange.

Fig. 23 provides information on the investment mediums in the capital markets.

![Investment Mediums Diagram](image)

**Fig. 23.** Investment mediums in capital markets.

In Chapter 3, we decided to divide the investment process on the multiple layers and shortly discussed a possible practical application of the investment products, the investment vehicles, the investment mediums in the investment process at the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. In the forthcoming research chapters, we will comprehensively discuss an application of the investment products (Chapter 4), the investment vehicles (Chapter 5), the investment mediums (Chapter 6) in the investment process at the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.
Chapter 4

Investment products for financial capital investment in capital markets

The investment product (the investment asset class / investment instrument) is something, which is synthesized by the natural process or developed by the human efforts process with the purpose of the value estimation, the value storing and the value incrementing by the way of financial capital investment with the aim to get an increased return premium in the capital markets in the short and long time periods. There are many different types of investment products with the natural or artificial properties, created by the financial organizations in the capital markets in the finances.

Fig. 24 shows the investment products in the capital markets in the finances.
Illustrating the investment product conception in Fig. 22, we decided to draw a marvelously simple picture of the star with the multiple beams of the radiating light. In our imagination, we can conditionally associate this image in the astrophysics with the researched topics in the finances by thinking abstractly and cognitively about the two things:

1. The star, consisting of the numerous investment products in the capital markets galaxy; and
2. The radiating beams of the light with the different wavelengths, corresponding to the specific investment product in the capital markets galaxy.

### 4.1 Land as investment product.

Now, let us consider the numerous investment products in the capital markets in the finances in details, conducting our research discussion in order of investment attractiveness of the investment products. We would like to begin with the consideration on the land, which is a scarce natural resource of limited availability on our planet. In the finances, the land can be classified as an investment product (an investment asset class and an investment instrument) for the financial capital investment with the aim to get an increased return premium in the short and long time periods, because the land can be freely traded at the land markets in the economies of the scales and the scopes.

The straightforward investment idea by the investor is to forecast the land prices changes dynamics; then to invest the financial capital into the selected land at a certain time moment; after that moment to wait for some time period, and finally to sell the land at the certain time, obtaining an increased return premium at the land market in the short/long time periods.

There may be many classifications of the land types in the economics, including the agricultural, urban, industrial lands, which can be evaluated, sold and purchased on the land markets. The land pieces can be situated at the various locations, for instance, in the central districts in the city or in the suburban areas far away from the downtown. Therefore, the land valuation depends on a number of the land properties, which uniquely characterize the selected land site in the land market.

The land is freely traded at the certain prices at the land exchanges in the land markets worldwide, however the big landlords with a lot of the privately owned land can keep the land sites for the re-selling purposes only for the long time, restricting the development projects realization in the big cities and elsewhere. In agreement with the reputable economists’ opinions, the land trade / exchanges can be further stimulated by the adaptation of the progressive single
tax in the frames of the land value taxation theory in George (1879, 1881, 2009), Hirsch (1896), Morris, Heathcote (2007).


4.2 Real estate as investment product.

The real estate can also be considered as one of the investment products (a fixed tangible investment asset class and an investment instrument) for the financial capital investment with the goal to get an increased return premium in the short and long time periods, because the real estate is freely traded at the real estate markets on a global scale.

In fact, the real estate can be considered as a largest category of the residential, commercial, and industrial properties assets to make the investments in (see Johnson (2006)). There are the two most frequently used ways to invest in the real estate:
1. The direct investment in the real estate by buying the real property;

2. The indirect investment in the real estate, using the private equity investment in the real estate asset class in the financial investment portfolio in Friedman (March 1971).

In the case of the seasoned private/institutional investors, the main investment idea is to predict the real estate prices dynamics; then to invest (in)directly the financial capital into the selected real estate at a certain time moment; after that to wait for some time period, and finally to sell the real estate at the certain time moment, obtaining an increased return premium at the real estate market in the short or long time periods.

4.3 Commodity as investment product.

We have already discussed the land and the real estate as the investment products. The land and the real estate are also frequently regarded as the commodities. In the academic literature, the commodity can be described as an investment product (an investment asset class and an investment instrument) for the financial capital investment with the aim to get an increased return premium in the short and long time periods, because the fact that the commodities are freely traded at the global commodities markets.

In general, the commodity investment products (the commodity investment asset classes) may include, but not limited to: the extracted natural resources, the processed row materials and some other transportable products, which are freely exchanges and traded at the global commodities markets. For example, the following things can be classified as the commodities in Gilbert (March 2010):

1. The precious metals (the gold, silver, platinum, palladium);
2. The industrial metals (the copper, aluminum, steel);
3. The extracted minerals (the potassium, calcium, iron ore);
4. The extracted energy sources (the crude oil, heating oil, gasoline, natural gas);
5. The generated energy (the nuclear, solar, wind energies);
6. The harvested agricultural products (the wheat, corn, cocoa, coffee, cotton, sugar);
7. The produced livestock (the feeder cattle, live cattle).

The investment into the commodities has been considered as a sensible thing to do among the professional seasoned investors during the time of high volatility in the capital markets. The prime investment idea is to forecast the commodities indexes values changes dynamics; then to invest the financial capital into the selected commodities at a certain time moment; after that, to wait for the investment expectation realization for some time period; and finally, to sell the commodity investment products at the commodities market, obtaining the increased return-on-investment (ROI) in the capital markets in the short or long time periods.

The commodities indices are regularly published and updated by the investment rating agencies and the investment firms in Yamori (September 7 2009):

1. The Tokyo Commodity Exchange’s Nikkei-TOCOM Commodity Index;
2. The Goldman Sachs Commodity Index (GSCI);
3. The Dow Jones AIG Commodity Index;
4. The (DJ-AIGCI) Deutsche Bank Liquid Commodity Index;
5. The Rogers International Commodity Index;
6. The Standard & Poor’s Commodity Index;
7. The Reuters Commodity Research Bureau Index
8. The Deutsche Bank Liquid Commodities Index.

There are the three most applicable ways to invest the financial capital into the commodities in Demidova-Menzel; Heidorn (August 2007):

1. The direct investment into the physical commodities indices, which are freely traded at the commodities exchanges in the commodities markets;
2. The direct investment into the commodity futures, which are freely traded at the commodity futures markets. The futures are defined as the valid business contracts to buy a definite quantity of the selected commodity at a certain price at a future delivery date. The backwardation situation occurs in the case, when the futures prices of commodities are below the spot prices of commodities. The contango situation has place in the case, when the futures prices of commodities are above the spot prices of commodities;
3. The direct/indirect investment into the commodity producing companies stocks, which are freely traded at the stock exchanges in the capital markets.
It may be interesting to note that the prices changes dynamics of the global commodity derivatives such as the oil, copper and some other commodity futures derivatives may have the fractal nature in Mykhailovska (2014). Presumably, the prices changes dynamics of both the physical commodities indices and the commodity futures derivatives in the capital markets can be more accurately characterized in the frames of the chaos science in Baumol, Benhabib (1989), Blank (1991), DeCoster, Labys, Mitchell (1992), Yang, Brorsen (1993), Chatrath, Adrangi, Dhanda (2002).

In this context, we would like to express our research opinion that the prices changes dynamics of both the physical commodities indices and the commodity futures derivatives in the capital markets may be much better characterized, using the recently proposed theories in the quantum chaos science, the quantum microeconomics science and the quantum macroeconomics science in Ledenyov D O, Ledenyov V O (2015h, i, j).

4.4 Bond as investment product.

The bond can also be related to the investment products (an investment asset class and an investment instrument) for the financial capital investment with the aim to get an increased return premium in the capital market in the short and long time periods, because the various types of bonds are constantly and freely exchanged at the global bonds markets.

Actually, there are many possible types of the inflation linked/protected callable/(non)callable bonds, which are issued by different market agents in the financial systems in the economies of the scales and scopes:

1. The sovereign bonds;
2. The treasury bonds;
3. The municipal bonds;
4. The corporate bonds;
5. The bank bonds.

The basic investment idea behind the investment deal with the bonds is to predict the bonds prices fluctuation dynamics; then to invest the financial capital into the selected bonds at a certain time moment; after that to wait for some time period, and finally to sell the bonds at the increased prices at the certain time moment, obtaining the increased return premiums at the bonds markets in the short or long time periods.

4.5 Company stock and stock option as investment products.

The firm’s preferred/common stock (the company’s shares) can be regarded as an investment product (an investment asset class and an investment instrument) for the financial capital investment with the aim to get an increased return premium in the short and long time periods, because the company’s stock is freely exchanged at the stock exchange in the capital market.

The simple investment idea is to foresee the firm’s stock prices changes dynamics; then to invest the financial capital into the selected company’s stock at a certain time moment; after that to wait for some time period, and finally to sell the company’s stock at the certain time moment, obtaining an increased return premium at the stock market in the short or long time periods.

Discussing the company’s stock, let us explain that the theory of the firm (the company) in the classic microeconomics science investigates the firm’s organizational structure, the firm’s functional performance, the firm’s economic variables change forecast, and the firm’s operation financing schemes. A big number of the research articles, reports, chapters and books on the theory of the firm in the classic microeconomics science have been written by the academicians and the practitioners in Babbage (1832), Ueda (1904, 1937), Marshall (1923), Berle, Means...

In recent years, the quantum theory of the firm in the quantum microeconomics science has been proposed in Ledenyov D O, Ledenyov V O (2015k). The quantum theory of the firm in the quantum microeconomics theory in the quantum econophysics science takes to an account the premises that there may be the quantum economic processes in the nonlinear dynamic economic system over the certain time period, which have to be discovered, described and considered in details. In this context, the quantum theory of the firm postulates that the discrete-time transitions from one level of the firm’s economic performance to another level of the firm’s economic performance will occur in the nonlinear dynamic economic system at the time moment, when in Ledenyov D O, Ledenyov V O (2015k):

1. The present land, labour and capital resources are (added and absorbed) / (released and radiated) in the form of quanta, decreasing or increasing the general energy entropy in the nonlinear dynamic economic system (the nonlinear medium);

2. The disruptive scientific/technological/financial/social/political innovation(s) is/are introduced into or withdrawn from the nonlinear dynamic economic system (the nonlinear medium), creating the resonance conditions to amplify/attenuate the value of the firm’s economic performance, during the evolution process of the economy of scale and scope in the time domain (Note: the resonance can result in the increase/decrease of the energy of the electromagnetic wave in the electrodynamics science);

3. The firm’s business processes population inversion mechanism is present, when a) the every business process in the firm can be conditionally compared to the electron in the atom, b) the discrete increase of business process value in the firm can be conditionally associated with the discrete increase of electron’s energy in the atom during the energy pumping process in the laser, c) the land, labour and capital resources release at the population inversion mechanism
realization in the firm can be conditionally regarded as the light radiation at the population inversion mechanism action in the laser;

4. The derived formula to describe the discrete-time EBITDA changes during the firm’s economic performance variations in terms of the quantum theory of the firm is

\[ \Delta EBITDA(t) = EBITDA(t)_m - EBITDA(t)_n \]

\[ \Delta \text{firm's value}(t) = \text{firm's value}(t)_m - \text{firm's value}(t)_n \]

where: \( \omega \) – Ledenyov constant,

\( \omega \) – cyclic velocity,

\( t \) – time,

EBITDA – the Earnings Before Interest Tax Depreciation Amortization,

Firm’s value – the firm’s market capitalization minus the firm’s long term investments and debt.

5. The Ledenyov distribution of a number of excited firms’ business processes of certain value at the selected level (state) in the economy of scale and scope in terms of the quantum microeconomics theory is

\[ \frac{N_m}{N_n} = \exp \left( \frac{EBITDA(t)_m - EBITDA(t)_n}{\lambda \text{micro}T} \right) \]

\[ \frac{N_m}{N_n} = \exp \left( \frac{\text{firm's value}(t)_m - \text{firm's value}(t)_n}{\lambda \text{micro}T} \right) \]

where: \( \lambda \text{micro} \) – Ledenyov constant,

\( N_m \) – number of firms’ processes of certain value at the state (m),

\( N_n \) – number of firms’ business processes of certain value at the state (n),

\( N = N_m + N_n \) – general number of firms’ processes of certain value in the economy of scale and scope,

\( t \) – time,

\( T \) – temperature of the economy of scale and scope, which corresponds to the level of entropy of the economy of scale and scope (the level of information/business activities by the firms),

EBITDA – the Earnings Before Interest Tax Depreciation Amortization,

Firm’s value – the firm’s market capitalization minus the firm’s long term investments and debt.
In other words, let us emphasis the fact that the quantum theory of the firm states that there may be the discrete-time induced transition(s) between the different levels of the firm’s EBITDAs (the firm’s values) in the nonlinear dynamic economic system at the time, when the following things are present in Ledenyov D O, Ledenyov V O (2015k):

1. The land, labour and capital, which can be added and absorbed / released and radiated in the form of quanta in the nonlinear dynamic economic system (the nonlinear medium);

2. The discrete-time fluctuational processes, which can appear in the form of the disruptive scientific/technological/financial/social/political innovation(s) that absorb or release the available land, labour and capital resources, creating the resonance, in the nonlinear dynamic economic system (the nonlinear medium) during the evolution process of the firm in the economy of scale and scope in the time domain;

3. The firm’s business processes population inversion mechanism, which occurs at the following condition: \( \frac{N_2}{N_1} > 1 \).

Most importantly, the firm can be classified as the private company or the public company, going from the company ownership rights. In the case of the public company, the company’s stock is issued at the stock exchange at the initial public offering process (IPO), traded freely among the investors at the stock exchange, and valued by the open market at the stock exchange. The main reason for the private company to become the public company is to get an access to the financial capital, which is needed to finance the company’s present/further business processes towards both the sustainable effective operation and/or the new products/services introduction in the selected markets in Ledenyov D O, Ledenyov V O (2014b).

The Initial Public Offering (IPO) process, including: the company initial valuation by an independent established audit firm, the IPO valuation at the stock exchange, the emission of the shares of the company’s stock at the stock exchange, the company’s stock re-evaluation by the open market at the stock exchange, has been researched in Ledenyov D O, Ledenyov V O (2014b). In general, it is necessary to remember that the initial listing requirements for the public companies at the stock exchanges on the various capital markets are different. The IPO techniques, including: the fixed-price offerings, the auctions, the book-building, depend on many economic factors in Ledenyov D O, Ledenyov V O (2014b). The IPO initial underpricing, the long-run performance and the after-market liquidity existing problems may have many different origins in Ledenyov D O, Ledenyov V O (2014b). The cost of acquiring capital at the stock exchange for the company can be calculated, using the techniques in Ideas At Work (2006), Ledenyov D O, Ledenyov V O (2012d), Schnoor (2006) (see Chapter 8).
The valuation of the initial public offering of the company equity at the stock exchanges in the imperfect highly volatile global capital markets with the induced nonlinearities is a complex task from all points of view. The Discounted Cash Flow (DCF) is a most widely used model of the direct valuation of the IPOs. Cogliati, Paleari, Vismara (2010) propose an equation to value the IPO with the DCF model:

\[
EV_{IPO} = FCFF_{IPO} \left[ \sum_{i=1}^{T} \left( \frac{1 + g_1}{1 + WACC} \right)^i + \left( \frac{1 + g_1}{1 + WACC} \right)^T \sum_{i=1}^{\infty} \left( \frac{1 + g_2}{1 + WACC} \right)^i \right]
\]

Cogliati, Paleari, Vismara (2010) suggest an equation to estimate the expected growth rates, implied in the IPO prices:

\[
P_{IPO} = \frac{FCFF_{IPO}}{WACC \cdot NSH_{pre}} \left[ \frac{(1 + g_1) \left[ (1 + WACC)^T - 1 + (1 + g_2) (1 + g_1)^{T-1} \right]}{(1 + WACC)^T} \right] - \frac{D_{IPO}}{NSH_{pre}}
\]


Another point of special interest is the underpricing of the initial public offering of the company equity at the stock exchanges in the imperfect highly volatile global capital markets with the induced nonlinearities.
The underpricing the initial public offering of the company equity at the stock exchanges in the imperfect highly volatile global capital markets with the induced nonlinearities in the IPO process can be written as in Pennacchio (2013)

\[ \text{Underpricing} = \left( \frac{P - P_{IPO}}{P_{IPO}} \right) \times 100, \]

where \( P \) is the closing price in the first day of trading, and \( P_{IPO} \) is the offer price of the stocks.

We propose the Ledenyov theory on the origins of the underpricing and long term underperformance effects in Ledenyov D O, Ledenyov V O (2014b), which states that the underpricing and long term underperformance can be explained by the changing information absorption capacity by the investors on the company equity value in the conditions of the asymmetric information flows, depending on both:

1. The internal factors:
   a) The investor’s ability to conduct the creative imperative integrative intelligent conceptual co-lateral adaptive logarithmic thinking with an application of the inductive, deductive and abductive logics analysis as far as the fundamental value of company equity is concerned;
   b) The ultra fast decoding of acquired information on the fundamental value of company equity;
   c) The ultra fast processing of acquired information on the fundamental value of company equity.

2. The external factors:
   a) The presence of the asymmetric information on the fundamental value of company equity between the investors and the underwriters (issuers);
   b) The agency problems in relation to the fundamental value of company equity.


One of the most intriguing questions to understand is: What would be the long term performance of the initial public offering of the company equity at the stock exchanges in the conditions of the imperfect highly volatile global capital market with the induced nonlinearities? The aftermarket performance is measured, using the Buy-and-Hold Abnormal Returns (BHAR), which are calculated for the stock $i$ over a time period $T$ as in Loughran and Ritter (1995), Cogliati, Palaei, Vismara (2010)

$$BHR_{iT} = \prod_{t=1}^{T} \left( 1 + R_{i,t} \right) - 1,$$

$$BHAR = \frac{1}{N} \sum_{i=1}^{N} \left[ \prod_{t=1}^{T} \left( 1 + R_{i,t} \right) - \prod_{t=1}^{T} \left( 1 + R_{M,t} \right) \right],$$
where $R_{i,t}$ is the return of stock $i$ at the time $t$, and $N$ is the number of stocks in the portfolio.


Now, let us shortly discuss the firm’s stock option, which can be considered as an investment product (an investment asset class and an investment instrument) for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, because the firm’s stock options are constantly issued, traded and exercised at the stock options market.

Let us make a clear general definition of the option by saying that the option is a financial contract to buy/sell the underlying financial security at a predetermined price on a specified date. There may be a big number of different types of the options in the finances:

1. The traded firms’ stock options;
2. The allocated employee’s/executive’s firms’ stock options;
3. The traded equity options: Asian Options, Barrier Options, Compound Options, Look-back Options, Vanilla Stock Options, Vix Options.

In general, we can say that the call/put traded options can be issued for the different asset classes in the capital markets in the finances. However, in this research discussion, we would like to focus on the firm’s stock options trading at the stock exchanges in the capital markets in particular in Investopedia (2016). The firms’ stock options trading at the stock options exchanges can gain some financial profit or bring some unexpected financial losses to the trader/investor, depending on the concrete circumstances in the capital markets at the certain time moment in Black (1975), Lakonishok, Inmoo Lee, Pearson, Potoshman (2007), Investopedia (2016).

The option pricing models in the capital markets in the finances has been researched in Bierman (1967), Black, Scholes (1973), Merton (1973), Cox, Ross, Rubinstein (1979), Hull (1997), Scott (1997), Taylor (December 2007). The firm’s stock option value depends on various factors, including the firm’s stock price, the firm’s characteristic microeconomic / macroeconomic variables in the economy of the scale and the scope within which the firm operates in Baule, Tallau (2013).

There may be observed the certain financial variables interdependencies between:

1. The firm’s stock options price/volume traded at Chicago Board Options Exchange (CBOE) and the firm’s stock price/volume traded at New York Stock Exchange (NYSE);
2. The firm’s stock options price/volume traded at Chicago Board Options Exchange (CBOE) and the firm’s market valuation;

at the selected stock exchange(s) in the capital market(s) in Easley, O’Hara, Subrahmanya Srinivas (1998), Kalok Chan, Peter Chung, Wai-Ming Fong (2002), Timraz, Al-Shubiri (2012), Baule, Tallau (2013).

Going to the next topic, let us comment that, in some cases, the executives/employees can be compensated by the employee/executive stock options, which represent a right to buy a share of stock at a fixed price (an exercises/strike price) before a specified date after the vesting period and they cannot be sold to the outside investors in Lewellen (1968), Saly (1994), Heath, Huddart, Lang (May 1999), Hall, Murphy (2000, 2003), Uchida (2006), Campbell (Winter 2007), Babenko, Lemmon, Tserlukkevich (2011), Perobelli, de Souza Lopes, Da Silveira (2012).

Considering the next subject, let us say that there may be issued the equity options in the capital markets. More information on the equity options will be presented in next sub-chapter.

The company stock options have been researched in Weinberg, Patton (1963), James Boness (April 1964), Bierman (September 1967), Lewellen (1968), Hirshleifer (1970), Black, Scholes (1973), Black (1975), Merton (1973, 1997), Fisher (March 1978), Klemkosky (1978),
4.6 Financial security as investment product.

The financial security can also be treated as an investment product (an investment asset class and an investment instrument) for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, because the financial securities are constantly traded at the financial securities market.

The most popular investor’s idea is to foresee the financial securities values changes dynamics; then to invest the financial capital into the selected financial securities at a certain time moment; after that to wait for some time period, and finally to sell the financial securities at the financial securities market, having made an increased return premium in the short or long time periods.

In general, the financial securities may include the structured credit products such as the financial derivative with the changing value, which depends on the values of other basic financial variables. The financial derivative is regarded as an insurance contract frequently. There are many types of derivatives, which give the fixed income investors a fully rated and leveraged exposure to the main credit derivatives indices in Ledenyov D O, Ledenyov V O (2013a):

1. Credit Derivatives: Collateralized Debt Obligations (CDO), Constant Proportion Debt Obligations (CPDO), and investment protection mechanisms such as the Synthetic Collateralized Debt Obligations (SCDO), Credit Default Swaps (CDS), Credit Default Swap Index (CDSI), Loan only Credit Default Swaps (LCDS), Credit Default Swaps of ABS (ABCDS), Variance Swaps (VS), Constant Proportion Portfolio Insurance (CPPI), Contracts for Difference (CFD).

The credit derivative makes it possible to transfer the credit, interest rate, price, currency, liquidity risks of a financial loan to other financial investor without the real sale of the financial loan in Lucas, Goodman, Fabozzi (2006, 2007). The Collateralized Debt Obligations (CDO) are based on the pool of bonds: 1) the corporate bonds, secured against the company’s balance sheet, or 2) the covered bonds, secured against the pools of mortgages or public-sector loans. The structure of the pool of bonds consists of both the riskiest slice and the conservative slice. The pieces of the pool of bonds are sold to the financial investors in the form of the CDOs. The
Synthetic Collateralized Debt Obligations (Synthetic CDO) replaces the pools of bonds with the Credit Default Swaps (CDS). The swaps insure against a bond default. Owners of bonds can buy CDS on their bonds to protect themselves.

2. Equity Derivatives: Futures, Asian Options, Barrier Options, Compound Options, Look-back Options, Vanilla Stock Options (put and call options), Vix Options.

The futures contract is an agreement to buy or sell an asset for a certain price at a specified time moment. The Call Option is an option to buy a certain asset by a certain date for a certain price (the Strike Price), and the Put Option is an option to sell a certain asset by a certain date for a certain price (the Strike Price), and the Stellate Option is a double option to buy or sell a certain asset by a certain date for a certain price (the Strike Price). It is necessary to distinguish the American Options vs. European Options: the American option can be exercised at any time during its life and the European option can be exercised only at maturity. Also, it is necessary to remember the distinction between the Options vs. Futures/Forwards Contracts: the Futures/Forward Contract gives the holder the obligation to buy/sell at a certain price, and the Option gives the holder the right to buy or sell at a certain price.

3. Other Derivatives: Interest Rate Swaps.

4.7 Foreign currency as investment product.

The foreign currency(s) can be qualified as an investment product (an investment asset class and an investment instrument) for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, because the foreign currencies are constantly indexed, traded and exchanged between the traders/investors in the foreign currencies exchange markets in Ellis, Metzler (editors) (1949), Machlup (1949), Robinson (1949).

We can easily describe an investment process scenario by the private/institutional investors by saying that the increased return premium can be generated by introducing a selected investment product by means of a selected investment vehicle into a preferred investment medium, pursuing an investor’s expectation to obtain an increased return premium in the foreign currencies exchange markets in the short or long time periods in Ledenyov V O, Ledenyov D O (2016s). In other words, in a practical case, the basic investment idea by the private/institutional investors is to make a best possible assumption on the foreign currencies exchange rates change...
dynamics in the time; then to invest the financial capital into the selected foreign currency(s) at a
certain time moment; after that to wait for ultra short/short/long time period, and finally to  sell
the foreign currency at the electronic trading process, deriving an increased return premium in
the foreign currencies exchange markets (FX) in the short and long time periods in Ledenyov V
O, Ledenyov D O (2016s).

Let us write a formula for the spot exchange rate $S_{t}^{m}$ of the Currency$^1$ in relation to the
Currency$^2$ in FX markets in Morgenegg (1990), Müller, Dacorogna, Olsen, Pictet, Schwarz,
Morgenegg (1990), Dacorogna, Müller, Nagrel, Olsen, Pictet (1993), Peters (1994), Ghysels,
O (2016s):

$$S_{t}^{m} = \left[ \frac{\text{Currency}^1_{t}}{\text{Currency}^2_{t}} \right]^{m}, \ t \geq t_0, \ m > 0,$$

where $S_{t}^{m}$ is the spot exchange rate,

$\text{Currency}^1$ is the currency no 1,

$\text{Currency}^2$ is the currency no 2,

$m$ - the month,

$t$ - the time.

Let us introduce a formula for the change of the spot exchange rate in the time domain in
FX markets, $\Delta S_{t}$ in Ledenyov V O, Ledenyov D O (2016s):

$$\Delta S_{t} \equiv S_{t} - S_{t-1} = \left[ \frac{\text{Currency}^1_{t}}{\text{Currency}^2_{t}} \right] - \left[ \frac{\text{Currency}^1_{t-1}}{\text{Currency}^2_{t-1}} \right],$$

where $\Delta S_{t}$ is the change of spot exchange rate over time,

$\text{Currency}^1$ is the currency no 1,

$\text{Currency}^2$ is the currency no 2,

$t$ - the time.

Let us show a formula for the calculation of the electronic trading frequency in FX
markets and explain that the electronic trading in FX markets can be performed at the ultra high
frequencies (UHF) in Ledenyov V O, Ledenyov D O (2016s)

$$f = \frac{\text{Number of ticks}}{\text{Time period}},$$

where $f$ is the frequency.
Finally, we would like to comment that an accurate characterization of the foreign currencies exchange rates at the ultra high frequencies electronic trading in the FX markets can be achieved, using in Ledenyov V O, Ledenyov D O (2016s):

1. The mathematical analysis methods (the probability and statistics distributions formulas);
2. The financial analysis methods (the macroeconomics and microeconomics formulas);
3. The electronic analysis methods (the Stratanovich-Kalman-Bucy filtering algorithm in the Stratanovich – Kalman – Bucy filter formulas), and
4. The quantum analysis methods (the Ledenyov quantum econophysical wave equation formula).


4.8 Intellectual property as investment product.

The intellectual property can be characterized as an investment product (an investment asset class and an investment instrument) for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, because the intellectual property can be traded and licensed at the foreign currencies exchange markets.

The protection of the intellectual property rights was legally introduced at the 1883 Paris Convention in Paris, France in Schmitt (2016). Presently, the intellectual property should be considered as an important investment product (a strategic asset class) in Kite (2009), Palfrey (October 2011), including the patents, trade secrets, copyrights, and trademarks in Blair, Cotter (June 2005), Holland, III, Reed, Lee, Kimmel, Peterson (2007), Palfrey (October 2011). Indeed, the intellectual property is a key determinant in the processes of the wealth creation and the wealth management by the firms in Schmitt (2016).

The intellectual property is regulated by the intellectual property law in Howe, Griffiths, Sherman, Pottage, Gangjee, Bently, Hudson, Dreier, Breakey, Balganesh, Carrier, Burrell, Hudson, Lametti, Dussollier (September 2013). The nature of the juridical rights, which can be considered as the intellectual property rights, has been debated in Templeman (1998).

The intellectual property valuation, exploitation and infringement damages have been researched in Smith, Parr (2005), Holland, Benedikt (2014). The intellectual property licensing has been discussed, to some extent, in Parr (2007).

Finalizing our research polemics on the investment products in the capital markets in the finances, we would like to add a short comment that a full list of possible investment products is not limited to the above listed investment products, asset classes and the investment instruments. More clearly, the financial capital investment can be done by the private/institutional investors into the antique/modern arts, the rare/modern books, the old/modern Swiss mechanical watches, the retro/modern automobiles, the retro/modern yachts, and many other valuable things, which constitute the wealth from the economic point of view.

Looking forward, we would like to express our research opinion that the **digital currencies**, including the Bitcoin and the Ethereum, can be considered as one of the perspective investment products, asset class and the investment instrument for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. Presently, the Bitcoin and the Ethereum can be traded/exchanged at the digital currencies exchange markets, exhibiting the increasing valuation trend in the global capital markets.

In Chapter 4, we have discussed a big number of the most attractive investment products for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. We began our consideration with the oldest well known investment products, moving forward to the newest and perspective investment products.

In Chapter 5, we will consider the investment vehicles for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, providing the terms definitions with the brief research discussions.
Chapter 5

Investment vehicles for financial capital investment in capital markets

The investment vehicle is a real/virtual financial firm, which is established to administer the allocated financial capital by making the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. There are many types of investment vehicles with the various financial resources, distinctive organizational structures and different investment strategies, which aim to obtain the increased return premiums in the capital markets in the finances in the short/long time periods.

Fig. 25 shows graphically the investment vehicles in the capital markets in the finances.

Fig. 25. Investment vehicles in capital markets in finances.
Using our cognitive thinking, let us imagine a new star with the multiple radiating beams of light in the finances galaxy. In this case, we make the two simple assumptions that:

1. The star is created by the numerous investment vehicles;
2. The radiating beam of the light with the different wavelength corresponds to the certain investment vehicle in the capital markets.

5.1 Investment bank as investment vehicle.

The investment bank is an investment vehicle, which is founded to collect, borrow, administer, invest, increase the customers’ financial capital by making the financial capital investments in the capital products in the capital markets with the aim to get an increased return premium in the short and long time periods. In other words, the investment bank is a classic example of the financial organization, which operates with the main goal to invest the financial capital in the numerous investment projects and to maximize the return-on-the-investment in the capital markets in the selected time periods.

The theory of investment banking closely describes the investment bank operation principles Morrison, Wilhelm (2007, November 15 2008). The investment bank has an organization structure with many departments, including the investment department, actions department, fixed income instruments department, financial management department in Corovai (2015). A presence of the investment fund management capability within the investment bank is an important characteristics of investment bank in Ferguson (1996). Hence, the investment bank can create, promote and sale a number of the investment products, including the securities and the credit derivatives in Ferguson (1996). The investment banks compete for both the lucrative investment opportunities realization and the capital market share with other investment banks (the internal competition) as well as the investment funds (the external competition) in the capital markets in Ferguson (1996). However, in practice, some investment banks can be considered as relatively inefficient investment vehicles due to various objective/subjective reasons. Therefore, the private investors may also be interested to invest their financial resources, using some other investment vehicles in the global capital markets. Summarizing our discussion on the investment banking, we would like to comment that the investment banks as an investment vehicle for the financial capital investment in the capital markets with the aim to get increased return premium in the short and long time periods have been researched in Howell (1953), O'Donnell (1957), Pontecorvo (1958), Mandelker, Raviv (1977), Beatty, Ritter (1986), Smith (1986), Keeley, Pozdena (June 19 1987), McDonough (1987), Walter, Smith (1989), Carter, Dark (1992), Chemmanur, Fulghieri (1994), Sussman (1994), Clark (April 1995),

5.2 Investment fund as investment vehicle.

The investment fund is an investment vehicle, which is usually established to collect and to administer the financial capital by making the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. There may be many possible types of the investment funds, including:

1. The private equity fund (it focuses on the startups);
2. The venture capital fund (it invests in the startups);
3. The focus fund (its manager has to own the shares of fund);
4. The aggressive fund (it focuses on the shareholder value maximization);
5. The special situations fund (it invests in the selected companies);
6. The “alpha” fund (the “alpha” is a term for the added-value by a top manager);
7. The covered call fund (it uses the derivatives to reduce the investment risk);
8. The mezzanine fund (it is a fund of the funds);
9. The mutual fund (it pools the financial resources and invests in the stocks);
10. The index fund (it pools the indices’);
11. The pension fund (it specializes in the pension investment in various companies);
12. The sovereign wealth fund (it is created by the state-backed investors).

Among all the existing types of the investment funds, the private equity funds deserve a special attention, because they focus on the early stage financing and the growth capital investing in the startup companies, playing a considerable role in both the search for a chairman of the board of directors and the development of a sustainable business model of the startup company. We can say that the private equity fund model relies on the loading up a startup company with the financial debt. More clearly, the private equity fund invests the financial equity into the startup company, forcing the startup company to use an optimal business model, to change the management team and to accept the implied financial obligations. The private equity fund
continues to administer all the product/service development phases by the startup, monitoring all the meetings by the board of directors and discussing all the business process developments. The private equity fund creates the necessary leverage for the startup company by presenting the abundant financial capital to the startup at the cheapest rates for the certain time periods and by optimizing the startup’s business model. We can certainly highlight a fact that the private equity fund does the financial engineering, focusing on the shareholder value maximization as opposed to the quarterly earnings increase.

Tab. 1 displays the financial parameters to characterize the private equity fund.

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**Tab. 1.** Financial parameters to characterize private equity fund.

Fig. 26 shows the private equity investment scheme.

**Fig. 26.** Private equity investment scheme.
Aiming to maximize the return-on-investment (ROI), the investment banks/funds/firms frequently attempt to sell the hedge fund replication products to the investors, providing the private/institutional investors with an access to the hedge funds’ high return premiums at the significantly lower costs in Takahashi, Yamamoto (2008), Ledenyov D O, Ledenyov V O (2013h).

Roncalli, Weisang (2008) proposed a theoretical representation for the procedure of the hedge fund investment portfolio strategies replication to capture the nonlinear return on investments, which can be decomposed into the following two stages:

\[ r_k^{HF} = \sum_{i=1}^{m_1} W_k^{(i)} r_k^{(i)} + \sum_{i=m_1+1}^{m_1+m_2} W_k^{(i)} r_k^{(i)} + \eta_k, \]

\[ r_k^{Clone}(d) = \left(1 - \sum_{i=1}^{m} \hat{W}_{k+d+1|k+d}^{(i)} \right) r_k^{(0)} + \sum_{i=1}^{m} \hat{W}_{k+d+1|k+d}^{(i)} r_k^{(i)}. \]

In this case, the investment banks/funds/firms must have the technical capabilities to track the hedge funds’ investment strategies, applying the so called Bayesian filters in Javaheri, Lautier, Galli (2002), Roncalli, Weisang (2008), Takahashi, Yamamoto (2008), Ledenyov D O, Ledenyov V O (2013g):

1. The Stratonovich – Kalman – Bucy filters;
2. The Particle filters.


5.3 Hedge fund as investment vehicle.

The **hedge fund** is also an investment vehicle in the form of an unregulated/weekly regulated/self regulated investment fund, which is created for the financial capital investment in the capital markets with an aim to get the increased return premium and to achieve the positive absolute returns in the short and long time periods, using various active investment strategies in Mitra (2009), Ledenyov D O, Ledenyov V O (2013h).

The first hedge fund was established by Albert Wislow Jones in 1949, implementing the main investment strategy towards the hedged equity investments in the capital markets. Winslow attempted to eliminate the market risks, introducing the hedging technique in the finances. The hedging is an act of the market risk mitigation at the financial capital investment by making an investment in the weakly related investment products in Fung (1999a), Mitra (2009), Ledenyov D O, Ledenyov V O (2013h). Presently, the hedge funds improve the efficiency and liquidity of the global financial markets, however they may also create the certain risks to financial stability in view of possible volatility increase as a result of the risky investments in Papademos (2007).

Let us consider the problem on the hedge fund’s investment return premium calculation, which is the measurable investment return. Takahashi, Yamamoto (2008) write the following formula to evaluate the hedge fund’s investment return premium

\[ R_i = \alpha_i + \sum_k \beta_{ik} F_k, \]

where

- \( R_i \) is the return of fund \( i \);
- \( F_k \) is the return of factor \( k \);
- \( \beta_{ik} \) is the exposure of fund \( i \) to factor \( k \);
- \( \alpha_i \) is the rest of return \( R_i \).

The investment return premium by the hedge funds can also be written as in Freed, McMillan (2011)

\[ R^f = \alpha^f + B^f X_T + \epsilon^f, \]

where

\[ B^f = \begin{bmatrix} \beta_{1f}^f, \beta_{2f}^f, ..., \beta_{nf}^f \end{bmatrix}, \]

\[ X_T = \begin{bmatrix} X_{T1}, X_{T2}, ..., X_{Tn} \end{bmatrix}. \]
In the case of the portfolio of hedge funds, the investment return premium of a portfolio of the hedge funds is

$$\sum_{i=1}^{n} w_i R_i = \sum_{i=1}^{n} \alpha_i + \sum (w_i \beta_{ik} + \ldots + w_n \beta_{nk}) F_k,$$

where

- $w_i$ is the weight on fund i.

Gibson, Wang (2010) write the formula for the hedge fund portfolio return as

$$r_{i,t} = \alpha_{i,0} + \alpha'_{i,1} z_{t-1} + \beta_{i,0} f_t + \beta'_{i,1} (f_i \otimes z_{t-1}) + \epsilon_{i,t},$$

$$f_i = \alpha_f + A_f z_{t-1} + \epsilon_{f,t},$$

$$z_i = \alpha_z + A_z z_{t-1} + \epsilon_{z,t},$$

where

- $r_{i,t}$ is the return of hedge fund i in excess of riskless rate in month t;
- $z_t$ is the vector of M business cycle variables observed at the end of month t;
- $f_t$ is a vector of K zero-cost benchmarks;
- $\beta_{i,0}$ is the fixed component of fund risk loadings;
- $\beta_{i,1}$ is the variable component of fund risk loadings;
- $\epsilon_{i,t}$ is fund-specific event, which is assumed to be uncorrelated across hedge funds and over time, and normally distributed with mean zero and variance $\Psi_i$.

Gibson, Wang (2010) note that the problem of the optimal hedge fund investment portfolios formation can be solved by the optimization of the investment portfolio, namely each investor forms his/her portfolio by maximizing the conditional expected value of a quadratic utility function

$$U(W_t, R_{p,t+1}, \alpha_t, b_t) = a_t + W_t R_{p,t+1} - \frac{b_t}{2} W_t^2 R_{p,t+1}^2,$$

where

- $W_t$ denotes the time t invested wealth;
- $b_t$ reflects the absolute risk aversion parameter;
- $R_{p,t+1}$ is the realized excess return on the optimal of hedge funds computed as

$$R_{p,t+1} = 1 + r_{ft} + w_i' r_{i,t+1}$$

where
• $r_\text{f}$ being the risk-free interest rate;
• $r_{t+1}$ denoting the vector of excess fund returns;
• $w_t$ denoting the vector of optimal hedge fund allocations.

The optimization problem reduces to the equation

$$w_t^* = \arg \max_{w_t \geq 0} \left\{ w_t' \mu_t - \frac{1}{2} \left( \frac{1}{\gamma_t - r_\text{f}} \right) w_t' \Lambda_t^{-1} w_t \right\},$$

where

• $\gamma_t = (b_tW_t)/(1 - b_tW_t)$ is the relative risk-aversion parameter,
• $\Lambda_t = [\Sigma_t + \mu_t \mu_t']^{-1}$, with $\mu_t$ and $\Sigma_t$ being respectively mean vector and variance matrix of future hedge fund returns;
• the possibility of leveraging and short selling is excluded when forming optimal hedge funds’ portfolios.


In general case, the problem on the optimization of the investment portfolio return premiums by the hedge funds can be solved with an application of the Probabilistic Global Search Lausanne (PGSL) algorithm, Multi-level Co-ordinate Search (MCS) algorithm, Matlab Direct Search algorithm, Matlab Simulated Annealing algorithm, Matlab Genetic algorithm in the case of a Fund of the Hedge Funds (“FoHF”) in Minsky, Obradovic, Tang, Thapar (2009).

In Fig. 27, the dependence of the investment return premiums on the different investment strategies implementation by the hedge fund over a certain time period is shown. This dependence is created, going from the research in Boyson, Stahel, Stulz (2008), Ledenyov D O, Ledenyov V O (2013h).
Let us make a plausible explanation on the modern hedge fund organization structures in details. The hedge funds maximize the investment return premium by optimizing the internal operations efficiency due to in Ledenyov D O, Ledenyov V O (2013h):

1. The optimization of internal organizational expenses, connected with the internal operations, by outsourcing the trading transactions to the prime brokers (the investment banks);
2. The optimization of external organizational expenses, connected with the taxation, by minimizing the taxes due to the registration in the tax heavens with the low income taxation level.

There are many possible hedge fund organization structures models with the certain advantages and disadvantages in Mitra (2009), Cao, Ogden, Tiu (2011), Ledenyov D O, Ledenyov V O (2013h):

1. The traditional investment bank model;
2. The inside-only hedge fund model;
3. The straddling hedge fund model;
4. The straddling “feeder” fund of funds model;
5. The stand-alone outside hedge fund model;
6. The outside “feeder” fund of funds model.


1. The convertible arbitrage: An investment in the investment products such as the convertible fixed income securities (the bonds) for the long time and to company common stock (the stock) for the short time to get an increased investment premium over the time;
2. The distressed securities: An investment in the investment products such as the financial securities, impacted by a distressed situation, to get an increased investment premium over the time;
3. The long/short equity hedge: An investment in the investment products such as the long/short equity to get an increased investment premium over the time;
4. The equity market neutral: An investment in the investment products such as the financial securities with a total net exposure of zero to get an increased investment premium over the time;
5. The event driven: An investment in the investment products such as the financial securities with the significant transactional activity, including the spin-offs, mergers and
acquisitions, industry consolidations, liquidations, reorganizations, bankruptcies, recapitalizations and share buybacks, to get an increased investment premium by predicting the price movement over the time;

6. The global macro: An investment in the investment products such as the interest rates, foreign exchange rates and physical commodities with the extreme price valuations in stock markets, predicting their price movements, to get an increased investment premium over the time;

7. The merger arbitrage: An investment in the investment products such as the companies securities with the extraordinary corporate transaction activities: the acquisition or merger proposals, exchange offers, cash tender offers and leveraged buy-outs, to get an increased investment premium over the time;

8. The relative value arbitrage: An investment in the investment products such as the financial securities to make the spread trades to get an increased investment premium from a relationship between the two related securities instead of from the market direction over the time.

9. The emerging markets: An investment in the investment products such as fixed income securities in emerging markets around the world to get an increased investment premium over the time.

10. The fixed income arbitrage: An investment in the investment products such as the interest rate swap arbitrage, US and non-US government bond arbitrage, forward yield curve arbitrage, and mortgage-backed securities arbitrage to get an increased investment premium over the time.

11. The managed futures: An investment in the investment products such as the listed financial and commodity futures markets and currency markets around the world to get an increased investment premium over the time.

12. The diversified debt: An investment in the investment products such as the diversified debt to get an increased investment premium over the time.

13. The multi-strategy: An investment in the different investment products, dynamically allocating the financial capital among the selected investment strategies to get an increased investment premium over the time.

14. The fund of funds: An investment in the investment products such as the other hedge funds to get an increased investment premium over the time.

The hedge funds organization, investment strategies, investment return premiums and related research topics in the finances have been researched in Brown, Harlow, Starks (1996), Brown, Goetzmann, Park (1997), Brown, Goetzmann, Ibbotson (1998), Brown, Goetzmann,
5.4 Pension fund as investment vehicle.

The pension fund is an investment vehicle, which is founded to collect, borrow, administer, and most importantly increase the financial capital by making the financial capital investment in the capital markets with the goal to get an increased return premium in the short and long time periods.

A main purpose of the pension fund is to make the retirement income provision for the beneficiaries. Speaking clearly, the public/private pension funds provide the employer-sponsored pension benefits to the beneficiaries in the frames of the defined benefit plan, the defined contribution plan and the hybrid scheme plan in Evans, Orszag, Piggott (editors) (January 1 2008). The private/public pension fund makes the centralized financial capital contributions collection, then it invests the collected financial capital into the various investment products (the investment asset classes) with the help of the experienced fund managers, and after some time it expects to get the positive return-on-the-investment (ROI) in Clark (July 13 2000, March 27 2003, 2008), Evans, Orszag, Piggott (editors) (January 1 2008). Most importantly, the pension fund investment policy is usually directed toward the beneficiary’s wealth maximization, depending, to a certain extent, on the type of the selected plan: the defined contribution plan, the defined benefit plan, the hybrid scheme plan in Bodie (October 1988), Bodie, Kane, Marcus (1989). The Boards of Trustees oversees all the financial capital investments by the pension fund
managers, having the statutory authority over the pension fund investment activities in Kakabadse N, Kakabadse A, Kouzmin (2003).

The public/private pension funds compete with other investment vehicles in the capital markets, however they are considered to be relatively inefficient in view of the following reasons: the weak control over the selected plans by the pension fund managers, the high operating costs by the public/private pension funds and the existing difficulties with finding of the highly skilled/experienced pension fund managers in Impavido (2008). The public/private pension funds are not immune from the high volatility in the capital markets, which is caused by the economic variables fluctuations in the economies of the scales and the scopes in Antolin (2008).

5.5 Mutual fund as investment vehicle.

The mutual fund is a pooled investment vehicle, which is founded to collect, borrow, pool together, process, and increase the borrowed financial capital by making the financial capital investment into the selected investment products in the chosen investment mediums in the capital markets with the goal to get an increased return premium in the short and long time periods.

The mutual fund’s distinctive features for the prospective investor, comparing to other investment vehicles, include in Sharpe (January 1966), Prather, Bertin, Henker (2004), Anderson, Ahmed (2005):

1. The professional management by fund managers;
2. The professional marketing by fund managers;
3. The professional distribution by fund managers;
4. The small-medium-big investments acceptance;
5. The investment assets classes diversification;
6. The investment transaction cost savings;
7. The total investment risk reduction.

In fact, the family of mutual funds can be created within the main mutual fund in Ciamarra, Hornstein (2015). The mutual fund as an investment vehicle can be described in terms of the following economical parameters in Sharpe (January 1966):

1. The small/medium/big investors clientele;
2. The financial capital value under the management;
3. The investment strategies;
4. The former/present financial performance;
5. The management fee level.

The various financial metrics can be applied to analyse the mutual fund performance over the time in Soongswang, Sanohdontree (2011):

1. The traditional fund performance evaluation measures;
2. The data envelopment analysis (DEA) measure;
3. The Pearson’s correlation coefficients;
4. The cover of six different investment horizons.

In real life situation, the mutual funds, generally, like to invest the financial resources into the large firms shares, assuming to reach the high return-on-investment at the low market risk. However, it is necessary to remember that the mutual fund’s performance depends on a number of discretely changing macroeconomic/microeconomic factors in the financial system in the
selected economy of the scale and the scope in Sharpe (January 1966), Jensen (June 1968), Arditti (1971), Fama (June 1972), Scott, Klemkosky (1975), Kon, Jen (April 1979).

5.6 Venture capital fund as investment vehicle.

The venture capital (VC) is considered to be an important source of corporate financing in the economy of the scale and the scope. The venture capital concept on the startup firms funding by venture capital from the venture capital funds was created by George Doriot, General, Harvard Business School, Harvard University and by Karl Compton, President, Professor, Massachusetts Institute of Technology in the USA in 1946 in Allen (2012).

Thus, the venture capital fund is an investment vehicle, which is created for the wealth management by making the venture capital investment in the startup companies with the aim to get an increased return premium in the capital markets in the short and/or long time periods. The American Research and Development (ARD) fund was a first VC fund in Allen (2012). The VC fund typically operates in the capital markets, which are impacted by various types of nonlinearities due to the asymmetric information flows between the economic agents in Jaffee, Russell (1976), Leland, Pyle (1977), Stiglitz, Weiss (1981), Stiglitz (1988), Zhang (2007b), Diaconu (2012). The VC fund can manage the financial capital from many venture capital firms by investing it into the selected startups, which are working on the entrepreneurial ideas to deliver the product/services to the certain customers at selected markets and contributing to an overall growth of national economies in Kirzner (1973), Lucas (1978), Audretsch, Keilbach (2004), Samila, Sorenson (2011). The founders and owners of the successful startup firm are called as the unicorn(s), if the total valuation of the startup is above one billion US dollars.
Discussing the early research results on the venture capital investments in the USA, let us explain that the rise/fall of venture capital was described in Gompers (1994). The optimal investment of venture capital was discussed in Gompers (1995, 1996). The empirical analysis of venture partnership agreements was done in Gompers, Lerner (1996). The various types of risks at the venture capital investing were reviewed in Gompers, Lerner (1997). The various investment strategies in the corporate financing, using the venture capital, have been analyzed in Gompers, Lerner (1998a, b). The analysis of compensation in the US venture capital partnership and business interests has been completed in Gompers, Lerner (1999a, b). The full venture capital funding cycle has been described in Gompers, Lerner (1999c). The various determinants of corporate venture capital success have been provided in Gompers, Lerner (2000a). The possible impact of fund inflows on private equity valuation has been reflected in Gompers, Lerner (2000b). The venture capital revolution has been described in Gompers, Lerner (2001). The new ventures funding has been studied in Gompers, Lerner, Scharfstein (2005). The venture capital investment practices have been discussed in Gompers (2007). The venture capital investment cycles have been precisely characterized in Gompers, Kovner, Lerner, Scharfstein (2008). The allocation of venture capital to the successful companies has been shown in Gompers, Kovner, Lerner (2009), Gompers, Lerner, Scharfstein, Kovner (2010). The syndication of VC investments has been investigated in Lerner (1994a, b). The investment practices by the venture capitalists have been researched in Lerner (1995). The selected research topics on the government as source of venture capital funding in the frames of the SBIR program have been considered in Lerner (1999). Kortum, Lerner (1998) proposed that the venture capital can increase the level of innovation in the society. Kortum, Lerner (2000) assessed the contribution by the VC to the innovation in the hi-tech industry. Lerner, Schoar, Wongsunwai (2007) researched some organizational aspects of the venture capital firm. Lerner (2008) made a few thoughtful research comments on the impact by the economic crisis on the venture capital funding dynamics in the USA. The empirical analysis of venture capital contracts has been performed in Kaplan, Strömberg (2000, 2002, 2003). The advanced researched on the of venture capital contracts has been continued in Kaplan, Strömberg (2004). The private equity returns on investments have been investigated in Kaplan, Schoar (2005). The annualized returns of venture-backed public companies, categorized by stage of financing, have been researched in Shachmurove Y (2001). The annualized and cumulative returns on venture-backed public companies, categorized by industry, have been investigated in Shachmurove A, Shachmurove Y (2004). The annualized returns of ventured-backed public companies, stratified by decades and by stage of financing, have been considered in Shachmurove E, Shachmurove Y (2004). The
entrepreneurship, innovation, trade and the growth mechanism of the free-enterprise economies in Shachmurove Y (2007a). The venture capital distribution over the various geographical regions have been analyzed in Shachmurove Y (2007b). The investment activity of venture capital in the United States in the years 1996 through 2005 has been summarized in Shachmurove Y (2007). The access to venture capital and the performance of venture capital-backed star-ups in Silicon Valley have been analyzed in Zhang (2007). The influences by the legal differences and experience on the financial contracts have been researched in Kaplan, Martel, Strömberg (2007, 2009). The different stages of financing through the evolution of firms from early business plans to public companies have been analyzed in Kaplan, Sensoy, Strömberg (2009). The past, present, and future of venture capital has been described in Kaplan, Lerner (2010). Orman (2008) developed a theoretical model to study the effectiveness of various possible organizational arrangements for the innovative startups and some issues in the startups activities financing by the VC funds in the USA. The effect of the current financial crisis on the venture capital investments in the US Internet firms has been analyzed in Block, Sandner (2009). The decline of the United States venture capital industry, including some propositions on what the federal government should do about it, has been analyzed in Aberman (2009).

Researching the venture capital investments in Canada, the convertible preferred equity puzzle in Canadian venture capital finance has been found in Cumming (2000). The determinants of venture capital portfolio size have been described in Cumming (2001). The venture capital exits in Canada and the United States have been analyzed in Cumming, MacIntosh (2000). The venture capital investment duration in Canada and the United States has been calculated in Cumming, MacIntosh (2001). The private equity investments in Canada have been overviewed in Cumming, MacIntosh (2002a). The cross-country comparison of full and partial venture capital exits has been done in Cumming, MacIntosh (2002b). The extent of venture capital exits in Canada and the United States has been analyzed in the frames of the venture capital contracting and the valuation of high-tech firms research in Cumming, MacIntosh (2002c). The economic and institutional determinants of venture capital investment have been identified in Cumming, MacIntosh (2002d). The law and finance analysis of venture capital exits in emerging markets has been investigated in Cumming, Fleming (2002). A cross-country comparison of full and partial venture capital exits has been completed in Cumming, MacIntosh (2003). The liquidity risk and venture capital finance in Cumming, Fleming, Schwienbacher (2005). The venture capitalist value-added activities, fundraising and drawdowns have been analyzed in Cumming, Fleming, Suchard (2005). The legality and venture capital exits have been discussed in Cumming, Fleming, Schwienbacher (2006). The crowding out private equity in
Canada has been analyzed in Cumming, MacIntosh (2006). The contracts and exits in venture capital finance have been researched in Cumming (2008). The preplanned exit strategies in venture capital have been discussed in Cumming, Johan (2008). The style drift in private equity has been considered in Cumming, Fleming, Schwienbacher (2009). The private equity returns and disclosure around the world have been studied in Cumming, Walz (2010).

Considering the venture capital investments in Europe, it is worth to point out that the chronological history of the VC capital market in Germany has been surveyed in Franzke, Grohs, Laux (2003), making a comparative analysis between the VC capital market in Germany and the VC capital markets in the US, UK and France. The implication of the VC on the VC funded companies in Germany has been researched in Keilbach, Engel (2003), analyzing the 50,000 German firms of which roughly 1% is venture funded. Keilbach, Engel (2003) found the multiple evidences that the companies with the higher innovative output (measured by patent applications, corrected for size) and with the higher educated management have a larger probability of being venture funded. The venture capital, ownership structure, accounting standards and IPO underpricing in the cases of German companies have been investigated in Elston, Yang (2010). The underpricing, wealth loss for the pre-existing shareholders and the cost of going public for the venture capital backed startups has been extensively researched in Ferretti, Meles (2011). The first comprehensive comparative analysis between the success of European and American VC-backed portfolio companies has been provided in Kraeussl, Krause (2011). The survival of venture capital backed companies in France has been researched in Pommet (2012). The causal effect by the venture capital backing on the underpricing of the Italian IPOs has been investigated in Pennacchio (2013).

Reviewing the venture capital investments in Asia, it should be noted that the venture capital in Japan has been analyzed in Clark (1988). The venture capital, bank shareholding, and IPO underpricing in Japan have been studied in Packer (1996). The Japanese IPOs have been researched in Pettway, Kaneko (1996). The investment and operating performance of Japanese IPOs have also been investigated in Cai, Wei (1997). The role by the venture capital in the IPOs in Japan has been researched in Hamao, Packer, Ritter (1999), who made the following comment: “In Japan, most of the major venture capital firms are subsidiaries of securities firms and banks.” Hamao, Packer, Ritter (1999) made the interesting observation on the role of VC during the IPO process in Japan, writing that the venture capital plays a certification role in alleviating informational uncertainty about the IPO at the time of issue. The venture capital industries of East Asia have been described in Kenney, Han, Tanaka (2002). The venture capital industry in Singapore has been overviewed in Koh F C C, Koh W T H (2002). Baygan (2003)
analyzed the trends in South Korean VC markets and examined the VC policies in South Korea, stating that the Korean venture capital market has grown dramatically in recent years, starting from a negligible base in the early 1990s and almost tripling between 1998 and 2001. Korea now ranks among the leading OECD countries in venture capital investment as a share of GDP and third in the share of venture capital being channeled to start-up enterprises (after the United States and Canada). Venture capital contributed to a proliferation of start-ups in the high-technology sectors such as the information and communications technology (ICT), which accounted for 64% of venture investments in 2001. Baygan (2003) also highlights an interesting fact that the government created the venture capital market in 1998 through a direct injection of the equity capital, a creation of the generous tax incentives and an establishment of the equity guarantees, and a designation of the certain small firms as the venture businesses. The R&D networks of the small and medium size companies in Japan have been researched in Motohashi (2006). The comparative analysis of the biotechnology startups funding by the venture capitalists between the State of Japan and the USA has been completed in Motohashi (2010). The venture capital affiliation with the underwriters and the underpricing of the initial public offerings in Japan has been researched in Arikawa, Imad’eddine (2010).

Analyzing the venture capital investments in Africa, it has to be mentioned that the practical recommendations on the venture capital programme for the South Africa have been formulated in Stillman, Sunderland, Heyl, Swart (1999). The investment criteria, used by the South African venture capitalists in their venture screening and evaluation processes, have been analyzed in Van Deventer, Mlambo (2008, 2009). The challenges and prospects in the early-stage process of the venture capital funding in South Africa have been presented in Jones, Mlambo (2009). The rise and fall of South African venture capital industry have been discussed in Lingelbach, Murray, Gilbert (2009).

1. The general partners (GPs) are the Venture Capital firms;
2. The limited partners (LPs) are the institutional investors (the banks, pension funds, insurance companies and foundations) and the private investors (the wealthy individuals);
3. The venture capital is a financial capital (an equity financing resource) to invest into the start-up company with the focus on the early stage product/service development, the high risk business plan realization, pre-initial public-offering business creation;
4. The venture capital fund is an investment vehicle with the lifetime of 8-10 years;
5. The venture capital firm is a partnership among the venture capitalists to provide an expertise in the financial capital investment, the business strategy creation, the business management and the human resources management in the start-up company;
6. The venture capitalist is an active investor-financier with the capital markets knowledge, the entrepreneurial process experience, and the network of business contacts, who performs a function of the intermediation between the private/institutional investors and the start-up in the conditions of the asymmetric information flows;
7. The startup company is a privately held early stage hi-tech company with the business plan and the high growth business potential.
8. The venture capital industry is an industry created of the VC funds, which has a cyclical business nature.

Fig. 28 shows the venture capital organization scheme.

![Venture Capital Organization Scheme](image-url)
Let us formulate the innovative start-ups financing problem in the frames of the theory of corporate finance in Tirole (2006). The main three problems in the startups funding are outlined in Orman (2008):

1. The big upfront financial resources requirement at the time, when there will be no the cash flows for a long time;
2. The big substantial uncertainty on the final potential outcomes in forms of developed products or services;
3. The presence of intangible assets in start-up company, which cannot be used as collaterals to get the financing.

All of the above listed issues can potentially reduce the willingness by financiers to provide financing to the new ventures, causing the credit-rationing in Stiglitz, Weiss (1981). Therefore, the VC financing represents a possible solution for the above mentioned financial problems in the cases of the innovative high-tech start-up companies.

There is a number of the different possible investment stages in the venture capital financing. Therefore, let us provide some information on the different VC financing stages in the process of the innovative startup company development in Geronikolaou, Papachristou (2008):

1. The seed financing, intended for new firms for the initial concept evaluation;
2. The start-up financing (aiming at the development of the firm’s product before the firm has sold any products);
3. The expansion financing (aiming to assist the growth and expansion of the firm).

Sau (2007) proposes a general scheme of the most innovative start-ups financing:

1. The insider capital, informal private equity and easy-term public financing (Seed);
2. The venture capital financing (Start-up);
3. The self-financing, bank and/or business credit (Early Growth);
4. The direct issue of bonds and public equity (Sustained Growth).

Gompers (2002) distinguishes a few investment stages in the innovative startup company:

1. The start-up stage: the phase, when the company has a business plan for the product or service development;
2. The development stage: the phase of product/service development, when the revenues from sales are not generated;
3. The beta stage: the phase of the product testing by a limited number of customers. For example: the device testing;
4. The shipping stage: the phase at which the product/service is being sold to customers, generating the small revenues stream with the expenses still exceeding the revenues;
5. The profitable stage: the phase at which the company is selling products or services, generating a positive net income;

6. The restart stage: the phase at which the firm is recapitalized at a reduced valuation, pursuing the product or marketing focus shift.

The necessary and sufficient condition for the startup firm to obtain the financing from the uninformed investors can be written as in Da Rin, Nicodano, Sembenelli (2004, 2005)

\[ \gamma(I - A) \leq p_H R_u = p_H \left[ R - \left( \frac{B}{p_H - p_L} \right) \right], \]

where \( I \) is the cost of the investment, \( A \) is the firm’s own equity capital which is pledged as collateral, \( I - A > 0 \) is the amount of capital, which is necessary to borrow for the firm, \( p_H \) is the probability to deliver the return \( R \), \( B \) denotes the private benefits for the entrepreneurs, \( R_u = R - R_f \) is the share of return to uninformed investors, \( R_f \) is the share of return, retained by the firm.

Therefore, the market value of the loan (the left hand side) cannot exceed the firm’s expected income (the right-hand side). Firms are then able to raise finance from uninformed investors if and only if in Da Rin, Nicodano, Sembenelli (2004, 2005)

\[ A \geq \bar{A}(\gamma) = I - \left( \frac{p_H}{\gamma} \right) \left[ R - \left( \frac{B}{p_H - p_L} \right) \right], \]

where \( A \) is increasing in \( \gamma \).

The amount of funds borrowed by monitored firms \( I_{vc} \) adjusts to satisfy the incentive compatibility constraint of the venture capitalist in Da Rin, Nicodano, Sembenelli (2004, 2005)

\[ I_{vc}(\beta) \geq \frac{c p_H}{\beta(p_H - p_L)}, \]

where \( \beta \) is the rate of return to venture capital, \( \beta = p_H R_{vc}/I_{vc} \).

The necessary and sufficient condition for a firm to be financed by both uninformed investors and venture capitalists is then in Da Rin, Nicodano, Sembenelli (2004, 2005)

\[ A \geq \bar{A}(\gamma, \beta) = I - I_{vc}(\beta) - \left( \frac{p_H}{\gamma} \right) \left[ R - \left( \frac{b + c}{p_H - p_L} \right) \right], \]

where \( c \) is the monitoring cost.

Let us consider the typical venture capital investment scheme at the venture capital investment deal making process by the venture capital fund in Tyebjee, Bruno (1984), Da Rin,

Fig. 29 shows the venture capital investment scheme at the venture capital investment deal making process by the venture capital fund.

Fig. 29. Venture capital investment process scheme.
Let us discuss the asymmetric information problem between the various market agents at VC investment process. The impact by the investments on the economy performance has been studied in Akerlof, Stiglitz (1966). The theory of the innovation has been researched in Stiglitz (1969). The fact that the competition and entrepreneurship are important factors for the economy growth has been outlined in Kirzner (1973). The theory of firm has been well formulated in Jensen, Meckling (1976), Lucas (1978). The problems of the imperfect information, uncertainty and credit rationing between the different market agents in the conditions of market economy have been considered in Jaffee, Russell (1976). The existence of the credit rationing problem in the markets with the incomplete information has been also confirmed in Stiglitz, Weiss (1981), Stiglitz (1988). The new theory of the firm, taking to the account the asymmetric information flows, has been proposed in Greenwald, Stiglitz (1990). It has been also discovered that the imperfect information affects both the internal organization of the firms and the external relations with the labor, capital and product markets in Greenwald, Stiglitz (1990). The asymmetric effect of the diffusion processes has been explained in Richiardi, Gallegati, Greenwald, Stiglitz (2007). Leland, Pyle (1977), Amit et al (1990), Fried, Hisrich (1994), Gompers (1995), Zhang (2007b) highlighted the fact that the VC investment is characterized by an asymmetric information flows between the equity investors and the entrepreneur. This information asymmetry may prevent the venture capitalists from the investing of financial capital in the start-ups. There are two possible ways to overcome this problem in Tyebjee and Bruno (1984), Zhang (2007b): 1) the stage by stage investments of the financial capital by the venture capitalist into the startup; and 2) the evaluation of the startup owners by their entrepreneurial history. Pennacchio (2013) stresses an important role of the venture capitalists in the IPOs, saying that the analysis of the venture capital backing’s effect on the IPO underpricing is a suitable way to investigate whether the venture capitalists are able to reduce 1) the asymmetric information in the IPO process and 2) the oscillations of the company stock price in the case of the IPO process. Ledenyov D O, Ledenyov V O (2013i) propose that the information signals can be mixed and self-modulated during the asymmetric information flows in the information transmission channels between the various market agents, resulting in an origination of the different types of the nonlinearities such as the high order harmonics, which may have a considerable impact on the VC’s decision making process on the venture capital investments in the diffusion-type financial system. Ledenyov D O, Ledenyov V O (2013i) think that these nonlinearities have to be taken to an account during the venture capital optimal investment portfolio strategies selection process, which is all about making the right investment choices, using the econophysical econometrical analysis.

5.7 Angel investor as investment vehicle.

The **angel investor** or the **business angel** is an investment vehicle under the management by a private investor (a high-net-worth individual), who intends to make his/her own financial capital investment in the early-stage high-risk private unquoted startup-companies with the aim to get an increased return premium in the capital markets in the short and long time periods; and to take an active part in the business management as an advisor/member of the board of directors in the startup of interest in Wetzel (1981, 1983), Mason, Harrison (2008), Lerner, Schoar, Sokolinski, Wilson (August 2015), Landström, Mason (2016a, b).

The business angel term was coined in Wetzel (1981, 1983). The main conditional distinction between the angel investors and the venture capitalists is in their investment practices: the angel investors provide the small amounts of capital in order of US$50k–US$5m to the early-stage high-risk startups, whereas the traditional venture capitalists have almost abandoned the early-stage high-risk startups investment opportunities space in Van Osnabrugge (2000), Mason (2016). The angel investing as an investment vehicle for the private equity investing is almost 33 years old, whereas the venture capital investing is around 60 years old in Wetzel (1981, 1983), May, Manhong Mannie Liu (2015).
The startup’s financing chain from the company’s foundation phase to the company’s maturity phase may include the following stages in the time domain in Mercil (2006):

1. The founders financing at initial stage;
2. The angel investors financing at product/service prototype stage;
3. The venture capitalists financing at product/service rollout stage;
4. The corporate investors financing at product/service rollout stage;
5. The investment banks financing at growth stage;
6. The IPO financing at expansion/maturity stage.

Indeed, the angel investors play a significant role in the inclusive financing of the early-stage startups in the economies of the scales and scopes, because they provide the seed capital for the hi-tech business ventures at the time, when these companies have a limited access to the financial resources from the traditional financial banks and institutions in Rubenstein (1958). In other words, the business angels stimulate the R&D and business activities in the early-stage high-risk startups by deploying the relatively small amounts of seed capital toward the highly innovative transformative technological solutions development in the selected startups. In addition, the business angels can contribute the so-called smart capital in the form of the product/service knowledge, business experience and contacts networks to the selected startup. These startups may potentially create the innovative products/services for the consumers, adding the economic value to and increasing the economic output of the economies of the scales and the scopes in Jensen (2002).

There may be the business angel networks (BANs) to effectively match the solo angel investors / the angel investors group(s) / the angel investors syndicates to the perspective early-stage high-risk startup companies with the aim to form the effective investment relationships in the economies of the scales and the scopes in EBAN (European Business Angel Network) (2005). The BANs increase the transparency, improve the efficiency, and decrease the search time toward the business deal making/brokering in the business angel investment market.

The startup’s financing process by the business angel(s) has the following investment stages in Mason, Rogers (1997), Landström, Mason (2016a, b):

1. The startup’s application stage;
2. The startup’s pre-screening stage;
3. The startup’s detailed due diligence stage;
4. The BA’s investment entry into selected startup stage;
5. The BA’s investment exit from selected startup stage.
In some cases, the business angels can form a group of the business angels to make the crowd-investing (the crowd-funding), which is a new form of the financing, when the a number of the small investors finance the startup business plan by collecting the necessary funds on the Internet in Sidman (2015), Hornuf, Schwienbacher (October 29 2016).

Of course, the creation and introduction of the progressive economic regulation policies frameworks by the governments can further stimulate the business angels activities to make the financial/knowledge capital investments into the perspective early-stage high-risk private unquoted startup-companies within the corresponding business ventures clusters in the economies of the scales and the scopes.


5.8 Investment boutique firm as investment vehicle.

The investment boutique firm represents an investment vehicle in the form of a small brokerage investment advisory firm on the wealth management towards the financial capital growth by making a limited number of the financial capital investments into the capital markets with the aim to get an increased return premium in the short and long time periods.

In other words, the investment boutique firm is a small brokerage investment advisory firm with the specialization in both the single corporate finance client sector (the telecommunications sector, the media sector, the retail sector) or the ultra-high net worth individuals, performing the private equity management and the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods in Hall (2007), Morrison, Wilhelm (Winter 2007).

Goodhart, Schoenmaker (March 2016) proposed to differentiate the four-tiers in the investment banking system in the capital markets in the finances, positioning the investment boutique firm at the tier four:

1. The global investment banks-giants;
2. The regional investment banks;
3. The national investment banks;
4. The small specialist advisory wealth management investment boutiques.

It makes sense to comment that the investment boutique firms industry has a different development dynamics, comparing to the investment banking industry in the global financial centers in the recent years in Hall (2007). In some cases, the investment boutique firms successfully compete with and challenge the big investment banks in the global capital markets. In other cases, the investment boutique firms pick up the outsourced businesses from the big investment banks such as the M&A advisory services or financial assets trading in the global capital markets in Morrison, Wilhelm (Winter 2007). The investment boutique firms in the finances have been researched in Thrift (1994), Luenberger (1997), Hall (2007), Morrison, Wilhelm (Winter 2007), Office of Career Services August (2012), Weihong Song, Wei Jie, Lei Zhou (2013), Goodhart, Schoenmaker (March 2016), Thomson Reuters (2016), Wikipedia (2016).

Finally, reviewing the ongoing trends in the investment vehicles in the finances, we would like to highlight the recent important developments such as a presence of an increasing number of the **private investment offices** in the financial industry around the World. The private investment office is an investment vehicle, a narrow specialized investment boutique firm and an investment advisory firm on the wealth management, which takes care about the accumulated wealth by the ultra-high-net-worth individuals. The main objective by the private investment office is to increase the financial capital by making the highly selective financial capital investments into the high-quality investment products in the capital markets with the aim to get an increased return premium in the short and long time periods.

In Chapter 5, we have already discussed the numerous investment vehicles for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

In Chapter 6, we will conduct a research discussion on the investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.
Chapter 6

Investment mediums for financial capital investment in capital markets

The investment medium is an financial environment, where the allocation of the financial capital to the investment product with an application of the investment vehicle is conducted in the process of the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. There are many different types of the investment mediums with the various characteristic properties, which also serve as the mediums of exchange in the capital markets in the finances.

Fig. 30 shows the investment mediums in the capital markets in the finances.

Fig. 30. Investment mediums in capital markets in finances.
Exploring the finances universe, let us assume that one of the observable stars has the multiple light emitting beams, radiating the light in the surrounding space. In this case, the following two theoretical premises can be made:

1. The star is formed of the different investment mediums;
2. The radiating beam of light with the different wavelength corresponds to a certain investment medium in the capital markets.

Let us consider the investment mediums (the exchange mediums) by paying a lot of attention to the notable research results on the subject of research interest.

6.1 Land exchange as investment medium.

Let us stick with the notion of the book and begin our consideration by saying that the land exchange can be regarded as one of the oldest investment mediums, which was created by the humans in the initial economies of the scales and the scopes on our planet. Indeed, the sellers of the land tried to make the direct land sales deals with the buyers of the land for the farming purposes mainly at the land exchanges in the primitive economies of the scales and scopes. At the later time, the trading land types included the farming land, the forest land, the building construction land, etc.


6.2 Real estate exchange as investment medium.

Undoubtedly, the real estate exchange can be considered as an investment medium, which was established by the economic agents in the initial economies of the scales and the scopes at the ancient times. Obviously, the real estate exchange was an exchange medium, where the numerous business deals on the real estate properties between the sellers of the real estate and the buyers of the real estate were completed. The real estate property includes the private homes, business shops, business centers, trade markets, public buildings and cathedrals, built of the different materials such as the wood, clay, stone, red bricks and concrete.


**6.3 Stock exchange as investment medium.**

Let us follow on with a comprehensive discussion on the history of the firms’ stock exchange, which is one of most attractive investment mediums from the investor’s point of view. We would like to be focusing on the historical heritage, the regulatory aspects, and the operation principles, considering the European, American and Asian stock exchanges mainly. Most importantly, we would like to conduct the research discussion, using the obtained research findings in Ledenyov D O, Ledenyov V O (2013f).

The Amsterdam Stock Exchange is probably the oldest stock exchange, which was founded in Amsterdam in the Netherlands in 1602 in Joseph Penso de la Vega (1668, 1996),
Viveen (2013), Shiryaev (1998a). The Amsterdam Stock Exchange has had the multiple periods of sustainable development and sharp decline, reflecting the historical economical development stages in The Netherlands in recent centuries in Landes (1998).

In the seventeenth century, the Britain succeeded the Netherlands as the biggest economy, throwing in the age of innovation by the way of the industrialization in Landes (1998), Viveen (2013). At that time, the British financial system was emulated to some degree from the Dutch financial system, for example, Munro (2003) writes: “Many English observers were praising the Dutch financial system as the one to emulate.” The London Stock Exchange (LSE) has its historical beginnings since 1700 in Michie (1999, 2001). The LSE as a financial institution was established with a main goal to facilitate the development of the financial securities exchange market, and it has a long history of operations since early 1801 in Maddison (1875), Morgan, Thomas (1961), Michie (1988), Michie (1999, 2001), Neal (2005). The first LSE regulation framework was officially printed in February, 1812 in Neal (2005). Since that time, the LSE played one of the key roles in the first global capital market creation in Neal (2005). The LSE remained the world's most innovative stock exchange in the global capital market until recently in Neal (2005), however it gives up slowly to the Asian stock exchanges, because of the multiple impacts by the globalization process and the UK’s Brexit political initiative.

The Paris Stock Exchange (PSE) represents the core of the financial securities exchange market in France since 1801 in Courtois (1855), Maddison (1875), Arbulu (1998a, b), Petit (2006), Hautcoeur, Riva (2007), Gallais-Hamonno, Georges (2007), Le Bris, Hautcoeur (2011). In the IXX-XX centuries, the Paris Stock Exchange evolved to become a stock exchange with the big perspectives for the European investors in Arbulu (1998a, b). Presently, the Paris Stock Exchange tries to attract the new public listed companies from the London Stock Exchange, attempting to become a new growing international center in Europe.

The New York Stock Exchange (NYSE) conducts its operations in New York, USA since 1817 in Shiryaev (1998a). The NYSE is one of the biggest companies’ stock exchanges in the world, because of both: 1) it has one of the most advanced technical infrastructures, and it has an access to the biggest economy of the scale and the scope in the USA. The New York Stock Exchange was modernized extensively, implementing the several electronic trading technology upgrade phases in recent decades. The NYSE is regarded as a financial industry leader with the considerable expertise in the financial securities trading as explained in numerous analytic reports by the financial experts. Besides, in the present time, the NYSE works intensively to attract the new companies to conduct the IPO from mainland China, Hong Kong, Singapore,
Aiming to overcome the severe consequences of economic downturns in the USA such as the IT industry bubble crush in 2001 and the financial industry collapse in 2008.

The Tokyo Stock Exchange (TSE) was founded in Tokyo, Japan in 1878 in Hamao, Hoshi, Okazaki (2005). The TSE represents a most innovative platform for the companies’ stock exchange, mainly dealing with the public listed companies in Japan. The relative isolation of the financial system in Japan from the rest of the World makes it difficult for the foreign companies to be listed at the TSE. The negative interest rates by the central bank in Japan are mainly stipulated by the presence of:

1. The high rate of the state budget deficit,
2. The practice of sales of the government bonds to the Japanese firms mainly, and
3. The lack of desire by the central bank to disseminate the Japanese Yen as a mean of payment around the World.

Therefore, a number of the listed foreign companies at the TSE is relatively small presently.

The global stock exchanges have various efficiencies of operations, which are mainly defined by the structure of organizational rules, listed companies valuations, national financial systems state and by some other factors in agreement with the theory of financial exchange organization in Davis, Neal (1998), Pirrong (1999, 2000). There is a considerable increase of the listing requirements for the companies at the global stock exchanges, aiming to make the companies as transparent as possible for the investors during the investment decision making process toward the investment portfolios building in Davis, Neal, White (2003), Elton, Gruber (1995). The global investors pursue a plenty of the different investment strategies at the modern stock exchanges, which can be characterized by the Return-on-Investment (ROI) and other parameters in Lowenfeld (1907, 1910), Gregory, Harris, Michou (2001). The most innovative stock exchanges include the Amsterdam, London, Melbourne, Frankfurt, Paris, Frankfurt, New York, Toronto, Tokyo, Shanghai, Hong Kong and Singapore stock exchanges in Hart, Moore (1996), Goetzmann, Ibbotson, Peng (2000), Le Bris, Hautcoeur (2011).

Today, the competition among the various stock exchanges for both 1) the public companies and 2) the investors increases exponentially as a result there is a trend toward the stock exchanges integration, which is realized by the means of the Mergers and Acquisitions (M&A) process between the different stock exchanges in Di Noia (2001). For example, the Amsterdam Stock Exchange merged with the Brussels Stock Exchange (BSE) and the Paris Stock Exchange to establish the Euronext in 2000 in Ledenyov D O, Ledenyov V O (2013f).

Let us sum up our discussion on the companies stock exchanges as an investment medium by saying that an accurate characterization of the stock market indexes trends dynamics
in the conditions of the nonlinear capital flows during the electronic trading by the companies shares at the stock exchanges in the global capital markets becomes an important research task at our time in Ledenyov D O, Ledenyov V O (2013f). During the accurate characterization, the dependence of the stock market indexes on the company valuation, the dependence of the stock market indexes on the foreign currencies exchange rates, the dependence of the stock market indexes on the interest rates, the dependence of the stock market indexes on the strategic commodities, and the impact by the nonlinear capital flows on the stock market indexes must be taken to an account in Ledenyov D O, Ledenyov V O (2013f).

Jordan, Ritter (2008a), Bradley, Chan, Kim, Singh (2008b), Busaba, Benveniste, Guo (2001),
Hoffmann-Burchardi (2001), Holmén, Högfeldt (2001), Houge, Loughran, Suchanek, Yan
(2001), Maksimovic, Pichler (2001), Purnanandam, Swaminathan (2001), Rehkugler, Schenek
(2001), Schatt, Roy (2001), Schatt, Broye (2003), Sentis (2001), Sentis (2002), Sentis (2004),
(2004), Biais, Bossaerts, Rochet (2002), Biais, Faugeron-Crouzet (2002), Blondell, Hoang,
(2002), Cheng, Mak, Chan (2002), Deloof, de Maeseneire, Inghelbrecht (2002), Easton, Taylor,
Giudici, Roosenboom (2002), Giudici, Roosenboom (2005), Houg, Loughran, Suchanek,
Xuemin Yan (2002), Kim, Kitsabunnarat, Nofsinger (2002), Kiss, Stehle (2002), Kutsuna,
(2002), Xie (2002), Baginski, Wahlen (2003), Barondes, Nyce, Sanger (2003), Bartlett, Shulman
(2003), Binay, Pirinsky (2003), Bourjade (2003, 2008), Clarke, Dunbar, Kahle (2003), Derrien,
Womack (2003), Doeswijk, Hemmes, Venekamp (2005), Ellul, Pagano (2003), Goergen,
Khurshed, McCahery, Renneboog (2003), Gounopoulos (2003), Gulati, Higgins (2003), Higgins,
Gulati (2003), Hoberg (2003), Hong, Kubik (2003), Huyghebaert, Van Hulle (2003), Jelic,
Briston (2003), Kaneko, Pettway (2003), Karolyi, Stulz (2003), Kraus, Burghof (2003),
Lemmens (2003, 2007), Lemmens (2004, 2007), Manigart, de Maeseneire (2003), Neuhaus,
Schremper (2003), Nounis (2003), Ofek, Richardson (2003), Peristiani (2003), Pham, Kalev,
Steen (2003), Roosenboom, Van der Goot (2003), Roosenboom, Van der Goot, Mertens (2003),
Roosenboom, Van der Goot (2005), Roosenboom (2007), Smart, Zutter (2003), Van Bommel,
Vermaelen (2003), Van der Goot (2003), Weber, Willenborg (2003), Arugaslan, Cook,

Let us add a few words on the firms’ stock options exchange, which is an investment medium for the firms’ stock options trade/exchange by the experienced investors in the capital markets. The Chicago Board Options Exchange (CBOE) represents a main platform for the stock options trading in the USA. The operating rules for the Chicago Board Options Exchange (CBOE) are described in Chicago Board Options Exchange (1996).

6.4 Foreign currencies exchange as investment medium.

Moving to the next topic, we would like to continue our research discussion with a consideration on the foreign currencies exchange, which can also be described as one of the investment mediums in the capital markets in the finances in Ledenyov V O, Ledenyov D O (2016s).

The foreign currencies exchange markets have been established, pursuing a goal to facilitate the international trade by the goods and services between the various states with the different financial systems and the distinctive units of payment in XIX – XXI centuries in Ellis, Metzler (editors) (1949), Machlup (1949), Robinson (1949). Going from the research in Ellis, Metzler (editors) (1949), Machlup (1949), Robinson (1949)), we can definitely say that the growing international trade resulted in:

1. The constant need to exchange the foreign currencies;
2. The strong necessity to rate the foreign currencies;
3. The necessity to establish the foreign currencies exchange markets.

In our time, the global investors like to conduct the investments in the foreign currencies in the global capital markets, making their assumptions on the foreign currencies exchange rates trends dynamics as well as pursuing the only main goal to get the increased return premiums in the foreign currencies exchange markets in the short and long time periods in Goodhart (1992), Goodhart, Hall, Henry, Pesaran (1993), Goodhart, O'Hara (1995), Goodhart, O’Hara (1997).
As we already know, in the Schumpeterian technical and social innovations disruption age, there is a big number of unlimited opportunities toward a new era of the ultra high frequency electronic trading in the foreign currencies exchange markets has been created due to an increasing application of the computations processing in the range of ultra high frequencies in the modern finances in Ledenyov V O, Ledenyov D O (2016s).

Of course, there is a number of scientific methods for an accurate forecast of the foreign currencies exchange rates oscillations dynamics during the ultra high frequency electronic trading in the foreign currencies exchange markets in the short and long time periods in Ledenyov V O, Ledenyov D O (2016s). More specifically, the investors’ assumptions on the FX rates can be significantly improved, using the modern techniques on a precise characterization on the foreign currencies exchange rates at the ultra high frequencies electronic trading in the foreign currencies exchange markets in the short and long time periods, which can be realized with an application of the mathematical, financial, electronic and quantum analysis methods in Ledenyov V O, Ledenyov D O (2016s).

Müller, Eichengreen, Portes (editors) (1989), Van Hagen (1989), Allen, Taylor (1990), Allen,
Karjalainen (1999), Courakis, Taylor (1990), Diebold, Nason (1990), Flood, Hodrick (1990),
Foster, Viswanathan (1993), Holthusen, Leftwich, Mayer (1990), De Long, Shleifer, Summers,
Waldmann (1990), Domowitz (1990, 1993), Domowitz, Steil (1999), Johansen, Juselius (1990),
(1990, 1995), Mishkin (1990), Müller, Dacorogna, Olsen, Pictet, Schwarz, Morgenegg (1990),
Müller, Dacorogna, Dave, Pictet, Olsen, Ward (1993), Müller, Dacorogna, Dave, Olsen, Pictet,
Black (1991), Bossaerts, Hillion (1991), Burnham (1991), Campbell, LaMaster, Smith, Van
(1991), Lee, Ready (1991), Messe, Rose (1991), Subrahmanyam (1991), Spiegel,
Subrahmanya (1992, 1995), Williamson (1991), Bekaert, Hodrick (1992), Choi, Elyasiani,
Kopecky (1992), Choi, Elyasiani (1997), Curcio, Goodhart (1992), Curcio, Goodhart,
Guillaume, Payne (1997), De Grauwe, Decupere (1992), De Grauwe, Grimaldi (2006a, b),
Flood, Huisman, Koedijk, Mahieu (1996, 1998), Gosh (1992), Guillaume, Dacorogna, Dave,
Muller, Olsen, Hamon, Jacquillat (1992), Guillaume, Pictet, Dacorogna (1995), Guillaume,
Dacorogna, Dave, Muller, Olsen, Pictet (1997), Hansen (1992), Holden, Subrahmanyam (1992),
Pascual (2004, 2005), Dacorogna, Muller, Nagrel, Olsen, Pictet (1993), Dacorogna, Muller,
Bartram, Karolyi (2006), Bhanumurthy (2004), Brandt, Kavajecz (2004), Breedon, Vitale
Hui, Yeung, Fung, Lo (2007), Hui, Fong (2007), Hui, Genberg, Chung (2009), Kim, Yoon
Bauwens, Omrane, Giot (2005), Campa, Goldberg (2005, 2006a, b), Chui, Gerlach, Yu (2005),
DeGrauwe (editor) (2005), Dueker, Neely (2005), Eichengreen (2005), El-Shagi, Rübel (editors)
(2005), Fung, Lien, Tse, Tse (2005), Hau, Rey (2005), Inoue, Kilian (2005), Marsh, O’Rourke
Kočenda, Poghosyan (2009), LeBaron (2006), Mende (2006), Mende, Menkhoff (2006), Muller,
(2007), Fung, Yu (2007), Genberg, He, Leung (2007a, b), Genberg, Hui (2009), Hong Kong
Monetary Authority (2007), Jiang, Ma, Cai (2007), Leung, Ng (2007, 2008), Mitchell, Pedersen,
Yu, Fung, Tam (2007), Acemoglu, Rogoff, Woodford (editors) (2008), Baglioni, Monticini
(2008), Barndorff-Nielsen, Hansen, Lunde, Shephard (2008), Bartram (2008), Beaupain, Durré
(2008), Berger, Chaboud, Chernenko, Howorka, Wright (2008), Brunnermeier, Nagel, Pedersen
(2008), Burnside (2008), Burnside, Eichenbaum, Kleshcheliski, Rebelo, Hall L, Hall H (2008),
Lindley (2008), Liu, Tsang (2008), Liu, Fung, Tse (2008), Lo, Sapp (2008, 2010), Ramadorai
(2008), Sebastián (2008), Terada, Higashio, Iwasaki (2008), Adrian, Etula, Shin (2009),
6.5 Financial securities exchange as investment medium.

The high investment culture among the private/institutional investors is a golden key to
the long-term prosperity of the economy of the scale and the scope. As we know the investors
frequently like to invest the financial capital into the numerous financial securities with the help
of various investment vehicles in the different investment mediums such as the financial
securities exchanges in the capital markets in the finances.

Actually, there are the two big groups of the financial securities exchanges, where the
most innovative investment products such as the financial securities, including the credit
derivatives, are traded among the financial dealers/organizations in Heckinger, Mengle (2013),
Steigerwald (2013), Heckinger, Ruffini, Wells (2014):

1. The over-the-counter (OTC) derivatives exchanges, where the derivatives
contracts (the swaps) are confidently negotiated/exchanged between the counterparties. All the
OTC derivatives contracts are cleared/settled on the bilateral basis or on the Counterparty
Clearing House basis;

2. The listed derivatives exchanges, where the derivatives contracts are openly
traded/exchanged among all the interested parties.

The financial futures derivatives contracts were openly traded/exchanged at the Chicago
Mercantile Exchange since 1972. Presently, the financial derivatives contracts are traded at in
1. The Chicago Mercantile Exchange (Group CME Group);
2. The Chicago Board Options Exchange (CBOE);
3. The Deutsche Börse AG;
4. The European Exchange (Eurex);
5. The Hong Kong Stock Exchange;
6. The London Stock Exchange (LSE);
7. The Moscow International Currency Exchange (MICEX-RTS);
8. The National Stock Exchange of India (NSEI);
9. The New York Stock Exchange (NYSE Euronext);
10. The Singapore Stock Exchange;
11. The Tokyo Stock Exchange (TSE);
12. The Toronto Stock Exchange (TSE).

The statistics on the trading by the financial derivatives contracts is conducted by the World Federation of Exchanges (WFE).

6.6 Commodities exchange as investment medium.

Focusing on the forthcoming issue, we would like to explain that the commodities exchange is one of the investment mediums in the capital markets in the finances. The commodities exchanges have been created to facilitate the commodities trading on a global scale.

There are the following commodity exchanges in Demidova-Menzel, Heidorn (August 2007), Yamori (September 7 2009):

1. The Commodity Exchange (COMEX);
2. The New York Mercantile Exchange (NYMEX);
3. The Chicago Board of Trade (CBOT);
4. The Tokyo Commodity Exchange (TCE);
5. The Tokyo Grain Exchange (TGE).

6.7 Precious metal exchange as investment medium.

Considering the next topic of our research interest, it makes sense to explain that the precious metals exchange and the industrial metals exchange can also be defined as the existing investment mediums in the capital markets in the finances, where the precious metals are being valued, traded, sold and bought at the certain open-market prices by the metal traders as requested by the investors/industrialists around the World.

In general, let us make a few short remarks that the precious metals, including the gold, silver, platinum and palladium, are classified as the commodities asset class in Anikin (1988), Figuerola-Ferretti, McCrorie (2016). The precious metals synthesis, application, and industrial consumption in the economy of the scale and the scope has been studied in Hourwich (1902, 1903). The precious metals valuation in the economy of the scale and the scope has been studied in Goodman (1956), Crowson (1987), Kaufmann, Winters (1989), Aggarwal, Lucey (2007). The precious metals prices dependences on various oscillating economic variables such as the industrial consumption in the real sector of the economy of the scale and the scope have been researched in Fama, French (1988), Labys, Achouch, Terraza (1999). The precious metals prices
dependences on various fluctuating financial variables such as the foreign currencies exchange rate in the finances have been researched in Crowson (1987). The precious metals prices dependencies on some other commodities such as the diamonds have been researched in Rand Kwong Yew Low, Yiran Yao, Faff (2016). The precious metals forward/spot exchange rates dynamics has been studied in Hammoudeh, Yuan, McAleer, Thompson (2009), Aggarwal, Lucey, O'Connor (2014). The investment into the precious metals by buying the physical precious metal or by investing into the precious metals funds or by occurring the precious metals mining companies stocks has been researched in Jaffee (1989), Demidova-Menzel; Heidorn (August 2007b). The precious metals safe haven and hedging properties for the private/institutional investors have been researched in Worthington, Pahlavani (2007), Rand Kwong Yew Low, Yiran Yao, Faff (2016).

Completing a comprehensive review of academic literature, we can evidently argue that the precious metals exchanges have been established to facilitate the precious metals trade in the economies of the scales and scopes on the national/global scales. There are the following main precious metals exchanges in the World in Sephton, Cochrane (1990), Demidova-Menzel, Heidorn (August 2007):

1. The Commodity Exchange (COMEX);
2. The New York Mercantile Exchange (NYMEX);
3. The Chicago Board of Trade (CBOT);
4. The London Metal Exchange (LME).

6.8 Intellectual property exchange as investment medium.

Finally, ensuring a consistency in our research discussion, we would like to say a few words on the intellectual property exchange, which can be undoubtedly classified as one of the perspective investment mediums in the capital markets in the finances.

We believe that the creation of the intellectual property exchanges will further facilitate the intellectual property selling, buying, licensing by the inventors, the IP rights holders, the entrepreneurs, the interested firms around the World. In our opinion the intellectual property exchanges will be established in the clusters with the hi-tech and financial firms mainly.

Looking forward, we would like to make a research comment that the digital currencies exchange can be considered as one of the perspective investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. At this time, the Bitcoin and the Ethereum digital currencies began to be valued/traded/exchanged at the digital currencies exchanges in the global capital markets.

In Chapter 6, we focused on the investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. So far, we have gained a reasonably comprehensive knowledge on the investment products, vehicles, and mediums destined for application in the global capital markets.

In Chapter 7, we will tackle the research problem on the financial risk calculation, estimation and mitigation techniques in the process of the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.
Chapter 7

Financial risk of investment portfolio at financial capital investment in capital markets

A modern prosperous society can be accurately characterized by an existing level of investment attractiveness of its economy of the scale and the scope. The financial capital would be invested by the investor into the investment products with an application of the investment vehicles in the investment medium in the case, if the investor’s expectation to get the high return-on-investment could be realized at a high probability level in the selected economy of the scale and the scope. The probability can be calculated by the investor, taking into an account the macro-/micro- economic variables in the frames of the modern investment portfolio theory during the wealth management process in the finances in Ledenyov D O, Ledenyov V O (2013a).

Fig. 31 shows a hypothetical investment portfolio with the diversified asset classes for the financial capital investment in the capital markets in the economies of the scales and scopes in the short and long time periods, which must be created by the investor with the goal to get an increased return premium.

Fig. 31. Hypothetical investment portfolio with diversified asset classes for financial capital investment in capital markets in economies of scale and scope in short and long time periods.
Typically, the investors create an investment portfolio with the diversified assets classes to minimize all the existing financial, economic, political risks as well as to maximize the return on the financial capital investment in the capital markets in the economies of the scales and the scopes in the short and long time periods. The investment portfolio building during the wealth management process can be regarded as a quite challenging task, because the financial capital flows in the open, non-linear and complex diffusion-type financial systems with the positive or negative feedback loop mechanisms, resulting in the assets prices fluctuations in view of the macro-/micro- economic variables oscillations in the economies of the scales and the scopes in Mosekilde (1996, 1996-1997), Beinhocker (2006), Mandelbrot (2004).

The Modern Portfolio Theory (MPT) is based on a fundamental concept that the price changes by the different interrelated investment assets must be taken into account in the process of the investment portfolio building in Markowitz (1952, 1956, 1959, 1987). In other words, Markowitz (1952) proposed that the investment portfolio’s risk depends on the variance of the investment portfolio’s expected return premium.

The Modern Portfolio Theory (MPT) introduces an idea of the Efficient Frontier (EF) in the finances in Markowitz (1952, 1956, 1959, 1987). Let us assume that we have a set of the selected investment assets, then, the maximum portfolio returns are limited by the upper concave boundary in the case of the increasing risk magnitude. A dependence between the investment return premium and the investment risk is represented by the concave curve, which is concavely increasing with the risk factors growth in Markowitz (1952, 1956, 1959, 1987), Shiryaev (1998a, b), Hull (2005-2006, 2010, 2012), Mitra (2009), Ledenyov D O, Ledenyov V O (2013a).

Let us define the weighted expected return of a portfolio $R_p$ as in Mitra (2009)

$$ R_p = \sum_{i=1}^{N} w_i \mu_i, $$

then the portfolio’s variance $\sigma_p^2$ can be written as

$$ \sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij} w_i w_j, $$

where

- $N$ is the number of assets in a portfolio;
- $i, j$ are the asset indices and $i, j \in \{1, \ldots, N\}$;
- $w_i$ is the asset weight, subject to the constraints:

$$ 0 \leq w_i \leq 1, $$

$$ \sum_{i=1}^{N} w_i = 1; $$
• $\sigma_{ij}$ is the covariance of asset i with asset j;
• $\mu_i$ is the expected return for asset i.

Speaking clearly, Markowitz (1952) considers the two characteristics of capital $X_1(b)$:

1. $EX_1(b)$ is the mathematical expectation;
2. $DX_1(b)$ is the dispersion.

In agreement with the mean variance analysis by Markowitz (1952), the investment portfolios with a set of points $(EX_1(b), \sqrt{DX_1(b)})$ between the point $\alpha$ and the point $\beta$ on the efficient frontier curve have the maximum mean value of capital at the minimum value of dispersion in Fig. 32.


Let us list the main research findings in the Modern Portfolio Theory (MPT) in the finances in the chronological order:


2. Tobin (1958) introduced the Tobin's mutual fund theorem, stating that the investment portfolio’s assets allocation problem can be viewed as a decision to allocate between the riskless asset and the risky portfolio. Tobin (1958) showed that the efficient frontier becomes a straight line in the presence of a risk-free asset;

3. Mandelbrot (1963) investigated the scaling properties of the certain speculative prices changes;

4. Fama (1963) discussed the Mandelbrot’s research proposals and the stable Paretoian hypothesis;

5. Sharpe (1964) summarized the research results by Markowitz (1952) and Tobin (1958) by introducing the Separation Theorem, in which the process of investment choice has the two possible phases:
   1) The choice of a unique optimum combination of risky assets; and
   2) The separate choice, concerning an allocation of funds between such a combination of a risky assets and a single riskless asset;


7. Engle (2003, 2006) analyzed and summarized all the important research findings in the Modern Portfolio Theory (MPT) in Markowitz (1952), Tobin (1958), Sharpe (1964);

8. Demidova-Menzel; Heidorn (August 2007) briefly described the limitations in the case of application of a standard deviation of the investment returns as an investment portfolio risk measure in the Modern Portfolio Theory (MPT). A main criticism is in the fact that a standard deviation of the investment returns as an investment portfolio risk measure in the MPT is assumed to be described by the bell-shaped Gauss distribution, but the real observed deviations of the investment returns for the certain investment asset classes in the investment
portfolio can be better characterized by the different types of statistical distributions. For example, the real observed deviations of the investment returns in the case of the commodity asset class in the investment portfolio can be accurately characterized by a right skewed distribution instead of a normal distribution. Therefore, an application of the standard deviation of the investment returns as an investment portfolio risk measure in the Modern Portfolio Theory (MPT) is limited by a set of the certain investment assets classes only;

9. Hassine, Roncalli (2013) analyzed and summarized all the research findings in the Modern Portfolio Theory (MPT) in the Markowitz (1952), Tobin (1958), Sharpe (1964);


Going to the next point, let us discuss some important investment portfolio theories in the finances in details. The Capital Asset Pricing Model (CAPM) theory has been introduced with the purpose to accurately determine the expected return premiums on the selected assets in the investment portfolio during the financial capital investment in the capital markets in the economies of the scales and the scopes in Sharpe (1964), Lintner (1965), Mossin (1966).

The CAPM main idea is that, in the investment portfolio, the numerous investment products (the investment asset classes/the investment instruments) with the various associated market risks can generate the different expected return premiums during the financial capital investment in the capital markets in the economies of the scales and the scopes. In the CAPM theory, all the investors have both the similar objectives and the same accumulated information in Sharpe (1964), Lintner (1965), Mossin (1966), Engle (2003, 2006). The Capital Asset Pricing Model (CAPM) theory applications have been researched in Sharpe (1965, 1966, 1968, 1992, 1994), Sharpe, Alexander, Bailey (1999). The dynamic Consumption CAPM (CCAPM) theory has been proposed to extend the static Capital Asset Pricing Model (CAPM) theory by providing a theoretical framework to evaluate the market portfolio dynamically in Merton (1973).


\[
R_a = R_f + \beta (R_m - R_f) + \epsilon,
\]

where
• $R_a$ is the expected return of an asset;
• $R_f$ is the risk-free rate of return;
• $R_m$ is the expected market return;
• $\epsilon$ is the error term;
• the systematic risk with respect to the tangency portfolio $\beta = \frac{\sigma_{am}}{\sigma_{mm}}$;
• $\sigma_{am}$ is the market and asset’s covariance;
• $\sigma_{mm}$ is the market’s variance.

The Sharpe ratio attempts to provide the portfolio risk measure in terms of the quality of the portfolio’s return at its given level of risk. The Sharpe ratio is a return-to-risk measure in the frames of the Capital Asset Pricing Model (CAPM) theory in Sharpe (1966), Mitra (2009):

$$S = \frac{R_p - R_f}{\sigma_p}$$

where $\sigma_p$ is the portfolio return’s standard deviation.

The tangency investment portfolio is an investment portfolio that maximizes the Sharpe ratio as shown on the efficient frontier from the mutual fund theorem in Sharpe, Alexander, Bailey (1999). The maximum Sharpe ratio of the investment portfolio is situated on the efficient frontier in Hassine, Roncalli (2013)

The modified version of the Sharpe ratio can be written as in Fung and Hsieh in (1999b, 2000b), Mitra (2009)

$${\textit{Modified Sharpe Ratio}} = \frac{R_p}{\sigma_p}.$$

The Jensen’s alpha is essentially an intercept of the regression of the excess returns on the risk factors, such as the Fama-French three factors in Jensen (1968), Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences (2013). It can be interpreted as the portfolio risk measure to quantify the portfolio return premiums above that predicted by CAPM in Jensen (1968), Economic Sciences Prize Committee of Royal Swedish Academy of Sciences (2013), Mitra (2009):

$$\alpha = R_p - [R_f + \beta_p (R_m - R_f)].$$

The Treynor ratio can be interpreted as the ”quality” of portfolio return for a given level of risk, but the risk is measured on a CAPM theory basis and written as in Mitra (2009):

$${\textit{Treynor Ratio}} = \frac{R_p - R_f}{\beta_p}.$$
The Fama, French Three Factor Model with the two new factors: 1) the book-to-market value; and 2) the price-earnings ratio for the listed companies, aiming to predict the expected return premiums in Fama, French (1993), Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences (2013). The three factor model accounts for these higher premiums in the following equation in Fama, French (1993), Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences (2013), Mitra (2009):

$$R_\alpha = R_f + \beta_{p1}(R_m - R_f) + \beta_{p2}SMB + \beta_{p3}HML + \epsilon,$$

where

- SMB is the difference in return for small and large sized companies;
- HML is the difference in return for high book to market value and low book to market value companies;
- $\beta_{p1}, \beta_{p2}, \beta_{p3}$ are regression gradients (slopes).

The Sharpe’s Asset Class Factor Model has been proposed for the return premium measurement, which is a weighted average of a small number of asset classes instead of a weighted average of a large number of individual asset returns, in the cases of the mutual/hedge funds in Sharpe (1992), Fung, Hsieh (1997), Mitra (2009). The Sharpe’s Asset Class Factor Model can be expressed as in Sharpe (1992), Fung, Hsieh (1997), Mitra (2009):

$$R_p = \sum_k w_k F_k + \epsilon,$$

where

- $w_k = \sum_j x_j \lambda_j$;
- $\epsilon = \sum_j x_j \epsilon_j$;
- $j$ is the asset class;
- $k$ is the total number of asset classes;
- $x_j$ is the weighting of asset class $j$;
- $\lambda_j$ is the factor loading for asset $j$ (change in fund return/change in asset $j$ return);
- $\epsilon_j$ is the error term for asset $j$.

Going to the next topic, as we know the investment portfolio can be created by investing the different investment products (the investment asset classes) with the help of the different investment vehicles in the different investment mediums in the capital markets in the economies of the scales and the scopes. For example, the investment portfolio can include the publicly traded shares of the public company’s stock. In this case, the investor / firm’s owner(s) may be
interested to understand: How can the financial institution / public company / firm manage all the risks, and calculate the cost of capital, and compute the cost of equity?

In the practical case of the financial institution / company’s risk management, the risk can be mitigated, going from the principles of diversification, hedging and total risk measurements. An actual risk management concept is reflected in the Economic Capital and Credit Modeling theories in which the dependence between the total risk and the investment return premium is derived in Ideas At Work (2006), Ledenyov D O, Ledenyov V O (2012d):

1. Cost of Capital is calculated using the Weighted Average Cost of Capital (WACC) model, which includes the following financial variables and ratios: Levered Beta, Debt/Total Capitalization, Tax Rate, Unlevered Beta, Targeted Capital Structure, Risk Free Rate, Market Risk Premium, Spread over Risk Free Rate. The Weighted Average Cost of Capital (WACC) is the weighted average of the marginal costs of all sources of capital. The formula for estimating WACC is as follows in Schnoor (2006):

\[
WACC = K_d (1 - T) D / V + K_e E / V + K_p P / V
\]

where:
- \( K_d \) = the pre-Tax Cost of Debt;
- \( T \) = the Marginal Tax Rate of the entity being valued;
- \( D/V \) = the Long-term target Net Debt to Total Capitalization;
- \( K_e \) = the market-determined Cost of Equity Capital;
- \( E/V \) = the Long-term target Market Value of Equity to Total Capitalization;
- \( K_p \) = the Cost of Traditional Preferred Stock;
- \( P/V \) = the Long-term target Market Value of Preferred Stock to Total Capitalization.

2. Cost of Equity is calculated using the Capital Asset Pricing Model (CAPM), which includes the following financial variables and ratios: Beta = Firm Specific Risk / Market Risk, Cost of Equity = Risk Free Rate + Beta, Multifactor Models of Asset Returns. In CAPM theory in Jarrow (1988), Lintner (1965), Sharpe (1964), Sharpe, Alexander, Bailey (1999), the beta is a measure of risk: a measure of stock price volatility relative to the overall benchmark market index. The beta changes from 0 to 2 (beta=0, risk=0; beta=1, then risk=average market risk (a stock moves up or down in the same proportion as the overall market); beta=2, then risk=well above average market risk). The company’s Cost of Equity, \( K_e \), is calculated using the Capital Asset Pricing Model (CAPM) in Schnoor (2006):

\[
K_e = R_f + \beta \left( \text{market risk premium} \right)
\]
where: • $K_e$ = the market-determined Cost of Equity Capital;
• $R_f$ = the Risk Free Rate;
• $\beta$ = the company’s beta. The beta is a measure of stock price volatility relative to the overall benchmark market index. In other words, the beta is the price volatility of a financial instrument relative to the price volatility of a market or index as a whole. Beta is most commonly used with respect to equities. A high-beta instrument is riskier than a low-beta instrument. If the stock moves up or down in the same proportion as the overall market, it has a Beta of 1.0. A stock with Beta of 1.2 is considered riskier than the overall market. Higgins (2007) states that the beta can also be considered as an angle of incline:

$$\beta = \frac{P_{jm}y_i}{y_m}$$

where:
• $P_{jm}$ is the non-diversified risk.

Continuing our discussion on the risk factors, let us consider all the existing risks in the finances in the details. We would like to draw attention to the fact that there are many types of risk, which have to be taken to an account by the investor at the investment process in the capital markets in the finances. Let us distinguish the two big classes of risks in the finances:

1. The microeconomic risks:
   1) the business plan risk,
   2) the financial credit risk,
   3) the financial transaction risk,
   4) the business operation risk,
   5) the business management risk,
   6) the business revenue generation risk;

2. The macroeconomic risks:
   1) the local/global market risk,
   2) the central bank interest rate risk,
   3) the financial liquidity risk,
   4) the foreign exchange risk,
   5) the environmental risk,
   6) the geopolitical risk.

Fig. 33 shows the financial, economic and political risks, which have to be accounted by investor in the process of creation of the hypothetical investment portfolio with diversified
Fig. 33. Financial, economic, social and political risks to account at creation of hypothetical investment portfolio with diversified asset classes for financial capital investment in capital markets in economies of scale and scope in short and long time periods.

As we can see, there are many different categories of risk, which have to be taken into account by an investor during the investment process in the capital markets in the finances. In the finances, the Basel III capital requirements have been formulated in Basel Committee on Banking Supervision (2006, 2009), Bernanke (2009a, b, c, d, e), Ledenyov V O, Ledenyov D O (2012d). In addition, it makes sense to note that many advanced models to account for the numerous risk factors and calculate the total risk magnitude in the capital markets in the finances have been developed. However, one of the interesting points to understand is that most these theoretical models have been created to operate with the positive interest rates and they have not been developed to work properly in the case of the negative interest rates, which are normally set
by the central banks. The negative interest rates are present in Japan and some other countries presently in Higuchi (2016).

Let us write the the investment portfolio total risk computing algorithm as a dial in the Swiss watch, including the microeconomic risks: the business plan risk, the financial credit risk, the financial transaction risk, the business operation risk, the business management risk, the business revenue generation risk; as well as the macroeconomic risks: the local/global market risk, the central bank interest rate risk, the financial liquidity risk, the foreign exchange risk, the environmental risk, the geopolitical risk.

Fig. 34 demonstrates the investment portfolio total risk computing algorithm as a dial in the Swiss watch.

![Fig. 34. Investment portfolio total risk computing algorithm as dial in Swiss watch.](image)

In the computer science, it is a commonly accepted practice to create a block scheme of the computing algorithm. Thus, let us write the the investment portfolio total risk computing algorithm as a block scheme, including the microeconomic risks such as the business plan risk, the financial credit risk, the financial transaction risk, the business operation risk, the business...
management risk, the business revenue generation risk, as well as the macroeconomic risks such as the local/global market risk, the central bank interest rate risk, the financial liquidity risk, the foreign exchange risk, the environmental risk, the geopolitical risk.

Fig. 35 presents a block scheme of the investment portfolio total risk computing algorithm.

Fig. 35. Block scheme of investment portfolio total risk computing algorithm.
Continuing our discussion on the investment portfolio, let us assume that we make the financial capital investment in the publicly traded shares of the company’s stock. Then, let us remind again that the electromagnetic signal processing theory in which the electromagnetic signal can be accurately characterized by the multiple measured parameters such as the amplitude, frequency, period and phase has been developed in the electrical, electronic and computer engineering sciences in Ledenyov D O, Ledenyov V O (2015a).

The investment product/asset value in the investment portfolio changes over the time, because of the macro-/micro-economic variables oscillations, including the demand/supply fluctuations. In a general case, it is a well accepted practice to characterize the investment asset value changes by the the continuous-time signals, corresponding to the Value of Share 1 \((t)\), Value of Share 2 \((t)\), and Value of Share 1 \((t)\). Let us illustrate the concept by performing the spectrum analysis of the three continuous-time signals by the three fluctuating selected shares’ values over the certain time period \(S_1(t), S_2(t), S_3(t)\). The Value of Share 1 \((t)\) and the Value of Share 2 \((t)\) are correlated in the time; the Values of Shares 1, 2 \((t)\) and the Value of Share 3 \((t)\) are uncorrelated in the time.

Fig. 36 shows the correlated and uncorrelated continuous-time oscillations of the three selected shares values over the certain time period \(S_1(t), S_2(t), S_3(t)\). The Value of Share 1 \((t)\) and the Value of Share 2 \((t)\) are correlated in the time; the Values of Shares 1, 2 \((t)\) and the Value of Share 3 \((t)\) are uncorrelated in the time.

![Fig. 36. Correlated and uncorrelated continuous-time oscillations of three selected shares values in time \(S_1(t), S_2(t), S_3(t)\).](image-url)
Thus, the correlated and uncorrelated investment assets can be included in the investment portfolio during the financial capital investment in the capital markets in the economies of the scales and the scopes. However, we would like to stress that the investment assets values in the time domain change abruptly in the capital markets in the economies of the scales and the scopes. The sharp disruptive events of various nature, including the technological, economical, financial, social, political disruptions, may have the multiple (in)direct instant impacts on the investment assets prices changes in the time domain.

We would like to propose the Ledenyov discrete-time investment assets values oscillations theory in the investment portfolio in the finances. We think that the dynamics of fluctuations of the investment assets’ values in the investment portfolio in the capital markets in the economies of the scales and the scopes in the time domain has a discrete nature. Therefore, the investment assets values oscillations can be accurately approximated by the discrete-time digital signals in Oppenheim, Schafer (1989), Simon, Hinedi, Lindsey (1995), Proakis, Manolakis (1996), Prisch (1998), Wanhammar (1999), Sklar (2001), Rice (2008), Ledenyov D O, Ledenyov V O (2015a).

Fig. 37 illustrates the correlated and uncorrelated discrete-time oscillations of the three selected shares values over the certain time period $S_1(t)$, $S_2(t)$, $S_3(t)$. The Value of Share 1 ($t$) and the Value of Share 2 ($t$) are correlated in the time; the Values of Shares 1, 2 ($t$) and the Value of Share 3 ($t$) are uncorrelated in the time.

![Fig. 37. Correlated and uncorrelated discrete-time oscillations of three selected shares values in time $S_1(t)$, $S_2(t)$, $S_3(t)$](image-url)

Fig. 38 illustrates the correlated and uncorrelated complex discrete-time oscillations of the three selected shares values over the certain time period $S_1(t)$, $S_2(t)$, $S_3(t)$. The Value of Share 1 (t) and the Value of Share 2 (t) are correlated in the time; the Values of Shares 1, 2 (t) and the Value of Share 3 (t) are uncorrelated in the time.

**Fig. 38.** Ledenyov correlated and uncorrelated complex discrete-time oscillations of three selected shares values in time $S_1(t)$, $S_2(t)$, $S_3(t)$. 
Going to the next point, let us say that the Ledenyov correlated and uncorrelated complex discrete-time oscillations of the shares values in the investment portfolio depend on the instantly changing macro-/micro- economic variables in the capital markets in the economies of the scales and the scopes over the selected time period. For example, the GDP(t), GNP(t), GIP(t), PPP(t) fluctuations in the economies of the scales and the scopes in the time domain may cause the correlated and uncorrelated complex discrete-time oscillations of the shares values in the investment portfolio.

Fig. 39 pictures the old theoretical conception to describe the GDP(t), GNP(t), PPP(t) fluctuations in the economy of the scale and the scope by the on the continuous-time waves. The Juglar economic cycle, Kondratieff economic cycle, Kitchin economic cycle, Kuznets economic cycle in the form of the continuous-time waves with the different amplitudes, frequencies, periods and phases can be seen in Juglar (1862), Kondratieff (1922, 1925, 1926, 1928, 1935, 1984, 2002), Kitchin (1923), Kuznets (1973a, b).

![Diagram](image)

**Fig. 39.** Continuous-time waves of GDP(t)/GNP(t)/PPP(t) fluctuations in economy of scale and scope.
Recently, the new theory on the Ledenyov discrete-time digital waves of GDP(t)/GNP(t)/GIP(t)/PPP(t) fluctuations in the economy of the scale and the scope has been proposed in Ledenyov D O, Ledenyov V O (2015d, e, f), Ledenyov D O, Ledenyov V O (2016r), Ledenyov V O, Ledenyov D O (2016s). In our opinion, there are the Ledenyov complex discrete-time digital waves with the different amplitudes, frequencies, periods, phases proposed in Ledenyov D O, Ledenyov V O (2015d, e, f, 2016r, s), which more accurately characterize the economic output fluctuations comparing to the Juglar continuous-time wave in Juglar (1862), the Kondratieff continuous-time wave in Kondratieff (1922, 1925, 1926, 1928, 1935, 1984, 2002), the Kitchin continuous-time wave in Kitchin (1923), the Kuznets continuous-time wave in Kuznets (1973a,b).

In Fig. 39, we would like to illustrate the new theoretical conception on the Ledenyov discrete-time waves of the GDP(t)/GNP(t)/GIP(t)/PPP(t) fluctuations with the four types of the waves:

1. The simple discrete-time digital wave, Wave 1 (W1);
2. The complex discrete-time digital wave, Wave 2 (W2);
3. The complex discrete-time digital wave with multiple distortions, Wave 3 (W3);
4. The complex discrete-time digital wave with the multiple distortions, which is transmitted in the form of the bursts, Wave 4 (W4).

We think that the Ledenyov complex discrete-time digital waves may have the complex wave forms with the different amplitudes, frequencies, periods, phases as in case of the complex discrete-time digital wave with the multiple distortions (see Wave 3 (W3), Wave (W4) in Fig. 38). We believe that the Ledenyov complex discrete-time digital waves can finely approximate the long, medium and short fluctuations of the economic output in the economies of the scales and the scopes.

In the case of the long/medium/short waves of the economic output fluctuations, we think that there are the Ledenyov complex discrete-time digital waves, which are propagated in the form of the transmitted bursts of the complex discrete-time digital signals similar to the transmitted bursts of the spread spectrum signals in Dixon (1976), Viterbi (May 1979), Pickholtz, Milstein (May 1982), Simon, Omura, Scholtz, Levitt (1985, 1994), Simon, Moher (2008), Rappaport (January 2010), Miao, Zander, Sung, Slimane (2016). Speaking more clearly, during the spectral analysis of the economic output fluctuations in the economics, the long/medium/short Ledenyov complex discrete-time digital waves of the economic output fluctuations may be present in the form of transmitted complex discrete-time digital signal bursts.
Fig. 40 presents the Ledenyov discrete-time waves of GDP(t)/GNP(t)/PPP(t) fluctuations in the economy of the scale and scope. The simple discrete-time digital wave is denoted as Wave 1 (W1), the complex discrete-time digital wave is marked as Wave 2 (W2), the complex discrete-time digital wave with the multiple distortions is presented as Wave 3 (W3), the complex discrete-time digital wave with the multiple distortions, which is transmitted in the form of the bursts, is shown as Wave 4 (W4).

Fig. 40. Ledenyov discrete-time digital economic output waves in economy of scale and scope in time.

Let take a close look on the Ledenyov complex discrete-time digital economic output wave, aiming to understand its nature, generation techniques and econophysical properties.

Fig. 41 shows the Ledenyov discrete-time digital economic output wave, which is generated by the complex high order digital modulations techniques with an application of the disruptive financial/economic/social/political innovations and propagated in the form of the signal bursts in the economy of the scale and the scope. The Ledenyov discrete-time digital economic output wave can be distorted by various economic financial technological political events in the economy of the scale and the scope.
Fig. 41. Ledenyov discrete-time digital economic output wave, which is generated by complex high order digital modulations techniques with application of disruptive financial/economic/social/political innovations and propagated in form of bursts.

For example, the Chinese civilization economy of the scale and the scope with 4000 years of history can be accurately characterized by the Ledenyov long complex discrete-time digital wave, propagating in the form of the discrete-time signal bursts over the centuries. We can assume that, at a certain time period, there was a signal burst with the complex discrete-time digital signal, corresponding to the intensive development stage with the disruptive events such as the inventions of the paper, writing, arithmetic. At the subsequent time period, there was no a signal burst with the complex discrete-time digital signals, because of the destruction phase in the Chinese economy of the scale and the scope. At the next time periods, the complex discrete-time digital signal, corresponding to the intensive development stage with the disruptive events such as the globalization, the growing international trade, the new innovative technologies inventions in the electronics, the new innovative industries creation was observed again and again. We can consider the Roman civilization as another possible example to illustrate the Ledenyov long complex discrete-time digital wave, propagating in the form of the signal bursts over the centuries.
Now, let us formulate the Ledenyov investment assets theorem: The investment assets can sharply/instantly/discretely correlate/uncorrelate in the investment portfolio during the financial capital investment in the capital markets in the economies of the scales and the scopes in the short and long time periods, depending on the various financial/economic variables fluctuations caused by the disruptive financial/economic/social/political innovations.

This is an important theorem, because there is a principal distinction between:

1) The investment assets, which are approximated by the continuous-time signals with the slow correlation/uncorrelation properties on the one side, and

2) The investment assets, which are approximated by the discrete-time digital signals with the ultrafast correlation/uncorrelation properties on the other side.

In general, it means that the investment portfolio managers must use the Ledenyov complex discrete-time digital signals processing theory to analyze the spectrum of the investment assets signals, calculating the total risk of the investment portfolio and the total stability of the investment portfolio.

Going to the next point, we would like to say a few words about the well known modern theoretical and practical approaches to model the market volatility and evaluate the risk of the investment portfolio in Barone-Adesi, Giannopoulos, Vosper (1999); McNeil, Frey (2000).

We would like to focus our attention on the three broad categories of existing models:

1. The parametric models:

1) The risk metrics: The basic concept of the Value-at-Risk (VaR) in the investment portfolio has been introduced in JP Morgan (1994), Mitra (2009). The VaR has become the standard measure to quantify the risk in the finances. It evaluates the value-at-risk by the “variance-covariance method” (the delta-normal method), assuming that the standardized residuals are normally distributed, but that is not a case in the real-life investment scenarios in Manganelli, Engle (2001);

2) The generalized autoregressive conditional heteroskedasticity (GARCH): It models the financial and economic variables (the interest rates and the equity prices), applying the big observation window on the sequential events, using the weighted averages and giving more weight to the recent events and less weight to the distant events in the time domain in Bollerslev (1986). It performs the Monte Carlo simulation with the stochastic differential equations (SDE) in Engle (1982a, 2003). It evaluates the difference, using an Exponentially Weighted Moving Average in the Integrated GARCH model in Engle (1982a, 2003):

\[ \sigma_t^2 = \lambda \sigma_{t-1}^2 + (1 - \lambda) y_{t-1}^2 \]
with $\lambda$ usually set equal to 0.94 or 0.97.

2. The nonparametric models:

1) The historical simulation: It uses the rolling observation windows of sequential events over the selected time periods to estimate the investment portfolio return premiums. Aiming to compute the Value-at-Risk (VaR) the next time period, the rolling observation window has to be moved forward by one observation, and then the entire procedure must be repeated.

2) The hybrid model: It applies the historical simulation and the GARCH model;

3. The semi-parametric models:

1) The extreme value theory in Mitra (2009);

2) The conditional autoregressive value at risk (CAViaR): It uses the GARCH model with some improvements and computes directly the quantile of the distribution in Engle, Manganelli (1999), Manganelli, Engle (2001);


Considering the next topic in our discussion, let us discuss the problem on the stability of the investment portfolio. From our previous considerations, we know that the investment portfolio must be built, using the diversified asset classes to increase the investment return premium and to reduce the total risk on the invested financial capital in the capital markets at the same time, because there is a certain inter-dependence between:

1. The expected investment return premium on the invested financial capital in the investment portfolio with the diversified asset classes in the capital markets in the short and long time periods from one side, and

2. The macro-/micro- economic/financial risk factors associated with the invested financial capital in the investment portfolio with the diversified asset classes in the capital markets in the short and long time periods from other side.

However, let us point to an interesting scientific observation that the investment portfolio, perfectly optimized from the risk point of view, can also be qualified as the investment portfolio, which is inherently unstable from the stability point of view.

For example, let us assume that we have conducted the financial engineering process and the risk mitigation process, designing an investment portfolio with the diversified asset classes to reduce the total risk magnitude. This investment portfolio is expected to deliver an increased investment return premium in the capital markets in the short and long time periods. However, let us explain that:

1. The any selected pair of assets in the investment portfolio may be un-correlated (stable), reducing the total risk magnitude of the investment portfolio; or

2. The any selected pair of assets in the investment portfolio may be correlated (unstable), decreasing the total stability magnitude of the investment portfolio at the same time.

In other words, the investment portfolio may have the low total risk magnitude, but it can be inherently unstable at the same time. Therefore, in this case, the investor may not be able to obtain the increased investment return premium on the invested financial capital in the investment portfolio with the diversified asset classes in the capital markets in the short and long time periods, because the investment portfolio is inherently unstable in Ledenyov D O, Ledenyov V O (2013a).
Therefore, the highly performing investment portfolio with the diversified asset classes in the capital markets in the short and long time periods can be created by doing the following two things in Ledenyov D O, Ledenyov V O (2013a):

1. The optimization of the investment portfolio in terms of its total risk factors decrease;
2. The optimization of the investment portfolio in terms of its stability magnitude increase.

We propose the Ledenyov investment portfolio stability theorem in the finances in Ledenyov D O, Ledenyov V O (2013a): The investment portfolio is considered to be stable in the case, when any pair of the randomly selected assets is stable, satisfying the Lyapunov stability criteria: The two randomly selected assets must have the two close trajectories at the start and continue to have the two close trajectories always in Lyapunov (1892, 1966, 1992).

It is necessary to understand that the problem on the stability of the investment portfolio can be considered as the frames of the discrete system stability theory in the nonlinear dynamic chaos science in Kuznetsov, Leonov (2005). Therefore, we propose to use the dynamic regimes modeling on the bifurcation diagram, based on the nonlinear dynamic chaos theory, with the purpose to make the accurate characterization of the dynamic properties of the combining risky investments in the investment portfolio, namely to precisely characterize the stability of investment portfolio in Ledenyov D O, Ledenyov V O (2013a).


Continuing our research discussion on the investment portfolio stability, let us note that Shiryaev (1998a, b) reviewed the nonlinear chaotic models, highlighting a well known fact that the diffusion-type financial systems can be characterized as the chaotic diffusion-type financial
systems or the deterministic nonlinear diffusion-type financial systems. Shiryaev (1998a, b) considered the nonlinear dynamic diffusion-type financial system, which can be described by the logistic equation

\[ x_n = \lambda x_{n-1} (1 - x_{n-1}), \quad n \geq 1, \quad 0 < x_0 < 1, \]

where the nonlinear dynamic diffusion-type financial system has a number of the stable and unstable states at the increase of parameter \( \lambda \), resulting in the transition to the chaos state at the parameter \( \lambda = 3.6 \).

Shiryaev (1998) noted that the below expression is true in the case of all the parabolic systems, where \( F = 4.669201 \) is the Feigenbaum number

\[ \frac{\lambda_k - \lambda_{k-1}}{\lambda_{k+1} - \lambda_k} \to F, \quad k \to \infty. \]

Fig. 42 shows the 3D bifurcation diagram for the accurate characterization of dynamic properties of the combining risky investments in an investment portfolio in the nonlinear dynamic financial system, obtained in Matlab in Ledenyov D O, Ledenyov V O (2013a).

Fig. 42. 3D bifurcation diagram for accurate characterization of dynamic properties of combining risky investments in investment portfolio in nonlinear dynamic financial system, created in Matlab (after Ledenyov D O, Ledenyov V O (2013a)).
We completed the above computer simulation with the aim to obtain the 3D bifurcation diagram to illustrate the dynamic properties of the combining risky investments in the investment portfolio in the nonlinear dynamic financial system in the time domain Ledenyov D O, Ledenyov V O (2013a).

In Chapter 8, we will consider the research problem on the quantum winning virtuous investment strategies creation and execution for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.
Chapter 8

Quantum strategies of investment portfolio at financial capital investment in capital markets

A financial process of the financial capital investment in the capital markets in the economies of the scale and the scope includes, at least, the eight main stages. All these phases must be clearly distinguished, fully understood and finely processed by the prospective investors:

1. The financial investment capital allocation;
2. The financial investment strategy creation;
3. The optimal investment opportunity finding;
4. The financial investment risk evaluation;
5. The financial investment capital investing;
6. The increased return premium generation;
7. The increased financial capital collection;
8. The financial investment capital increase.

We would like to take a more detailed unbiased view on the process of the investment strategy creation in this chapter, integrating all the modern scientific discoveries in the natural/social sciences with the aim to find an optimal investment strategy in the course of our discussion on the topic of research interest.

In a century of competition between the globalization trend and the protectionism trend in Wolf (2004), we believe that the technological, social, and political disruptive innovations may create or destroy the investment opportunities in the economies of the scales and the scopes around the World instantly. Therefore, the problem on the creation of the optimal investment strategy in the capital markets can be considered as one of the central problems in the finances. Let us begin our research thinking on the quantum winning virtuous investment strategy creation by elegantly comparing all the important scientific topics in the finances with the shining high quality diamonds of the white, yellow, pink, red, black colors. Highlighting an undisputable unquestionable importance of the quantum winning virtuous investment strategy creation process, we would like to make a persuasive philosophical statement that the fundamental strategy theory could be conditionally classified as a crystally clear pink diamond of highest quality, shining brightly, colorfully and attractively in a spectrum of illuminating lights
Indeed, the research topic on the quantum winning virtuous investment strategy creation generates a considerable scientific interest among the authoritative strategy thinkers, experts and professors in the globally integrated World in Ledenyov V O, Ledenyov D O (2016s). Of course, the research on the quantum winning virtuous investment strategy creation is in a state of constant progressive development through a chain of the scientific evolutionary visions transformations in the best minds of the leading strategy thinkers, experts and professors in Ledenyov V O, Ledenyov D O (2016s).

Considering the strategy theory advancements, we can distinguish the following new theoretical approaches in the fundamental strategy theory in Ledenyov V O, Ledenyov D O (2016s):

1. The classical philosophical views on the fundamental strategy theory, which consider the continuous-time processes in the economies of the scales and scopes in the mechanical devices disruption century in Chandler (1962, 1998; 1977, 1993; 1994; 2001; 2005);

2. The analogue philosophical views on the fundamental strategy theory, which deal with the continuous-time processes in the analogue creative economies of the scales and scopes in the analogue devices disruption century in Ledenyov D O, Ledenyov V O (2015b);

3. The digital philosophical views on the fundamental strategy theory, which deal with the discrete-time processes in the digital creative economies of the scales and scopes in the digital devices disruption century in Ledenyov D O, Ledenyov V O (2015b);


Of course, there are some other original scientific approaches, which can be certainly used to improve the fundamental strategy theory in the frames of the finances, economics, business administration, econophysics, psychology sciences during the scientific learning process. They have been researched, to a certain extent, during an intensive research process with an application of the accumulated knowledge base in the frames of the finances, economics, business administration, econophysics, psychology sciences in Chandler (1962, 1998; 1977, 1993; 1994; 2001; 2005), Chandler , Daems (1980), Andrews (1971a, b, 1980, 1981a, b, 1984), Rumelt (1974, 1982), Porter (1979, 1980, 1982a, b, 1983, 1985, 1987a, b, 1991, 1994a, b, 1996a, b, 1997, 2001a, b, 2008, December 2013), Porter, Harrigan (1981), Porter, Salter (1982),

In these circumstances, the most striking fact to be mentioned is that the fundamental strategy theory learning curve during the strategy knowledge accumulation process in the finances, economics, business administration, econophysics, psychology sciences in the time scale may exhibit, at least, the three possible dependences:

1. The linear dependence, when the level of strategy knowledge increases linearly in the selected time period (it can be realized in real life at the short time periods only);

2. The exponential dependence, when the level of strategy knowledge increases exponentially and steadily in the selected time period (it can be observed in real life over the long time periods);

3. The S-type nonlinear dependence, when the level of strategy knowledge increases nonlinearly in the selected time period, namely the strategy knowledge accumulation or destruction processes in the selected time period may have place (it can be observed in real life over the long time periods).

Fig. 43 presents the fundamental strategy theory learning curve as a linear dependence of the strategy knowledge accumulation on the time in the simplest possible case. In addition, Fig. 43 shows that the fundamental strategy theory learning curve can also be represented as the
exponential dependence or the S-type nonlinear dependence of the strategy knowledge accumulation/destruction processes on the time in more complex cases to account for the nonlinear data gaining/losing by the financial investors during the strategy knowledge accumulation process in the long term perspectives.

![Fig. 43. Dependence of strategy knowledge accumulation/learning on time: 1) Linear, 2) Exponential, 3) S-type nonlinear.](image)

Now, let us introduce the Ledenyov multidimensional strategy space with XYZ coordinates. In this case, we can represent the strategy as a Ledenyov strategy vector, which points to a certain direction in the XYZ multidimensional strategy space. In other words, we propose to think about the strategy vector as the strategy vector of action, which is directed toward the certain direction in the XYZ multidimensional strategy space. Speaking clearly, we can set our strategic goal to reach an increased return premium on the financial investments in the capital markets by drawing the strategy vector with the direction to the certain point in the XYZ multidimensional strategy space. Then, we could say that a real implementation of the created strategy would require an application of the well defined practical actions toward the completion of our outlined strategic goal. This geometric representation of the strategy in the
terms of the Ledenyov strategy vector in the Ledenyov multidimensional strategy space with the XYZ coordinates will be quite useful during the forthcoming discussion on the complex multivector strategies definition, meaning, creation and their practical implementation in real life situations in the finances.

Fig. 44 represents the strategy as the Ledenyov strategy vector of action, which points to the certain direction in the Ledenyov multidimensional strategy space with XYZ coordinates.

![Strategy Vector](image)

**Fig. 44.** Ledenyov strategy vector in Ledenyov multidimensional strategy space with XYZ coordinates.

Moving forward, let us say that we can think about the complex strategy, employing the complex strategy concept in the cases, when the complex strategy may include a big number of the Ledenyov strategy vectors with the discretely changing directions in the Ledenyov multidimensional strategy space in the time domain. For example, let us illustrate the complex strategy concept by assuming that we would like to move from point A to point B by the Rolls Royce automobile, using an existing highways network on our European continent. First of all, we must create the simple strategy of our automobile movement from the point A to the point B by drawing the automobile movement vector from the point A to the point B on the map. Let us imagine that there are many natural barriers, including the mountains, hills, valleys, rivers between the point A and point B, hence in this case, we would be forced to drive towards the
slightly different directions to reach the final destination point on our travelling way. Therefore, we must create the Ledenyov complex strategy vector for our automobile movement from point A to point B by drawing the multiple automobile movement vectors with the slightly different directions between the point A and the point B on the map. In other words, the complex strategy may include a number of the strategy vectors, changing in the Ledenyov XYZ multidimensional strategy space over the time.

Fig. 45 demonstrates the complex strategy concept in which the Ledenyov complex multivector strategy includes a number of the Ledenyov strategy vectors, changing in the Ledenyov XYZ multidimensional strategy space over the time.

![Figure 45](image)

**Fig. 45.** Ledenyov complex multivector strategy as number of Ledenyov strategy vectors in Ledenyov multidimensional strategy space with XYZ coordinates, changing in the space – time domains.

Obviously, in the finances, the Ledenyov complex multivector strategy can be efficiently frequently used to reach the pre-determined strategic goals by the private and institutional investors during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.
For instance, the Ledenyov complex multivector strategies can be formulated and executed to reach the certain return premium target level or the certain profitability target level or the certain net income target level at the financial institutions, investment funds, investment boutiques, etc. There may be a number of the financial/economic/political factors, which must be taken to an account in the process of the Ledenyov complex multivector strategy creation by the investors at the financial institutions for a number of possible applications at various social/financial/economic settings in the selected time periods.

Fig. 46 shows the geometric representation of the Ledenyov parallel complex multivector strategy and Ledenyov sequential complex multivector strategy in the Ledenyov multidimensional strategy space with XY coordinates, changing in the space – time domains.

**Fig. 46.** Geometric representation of Ledenyov parallel complex multivector strategy and Ledenyov sequential complex multivector strategy in Ledenyov multidimensional strategy space with XY coordinates, changing in space – time domains.

Going from the modern scientific findings and our research understanding, we prefer to divide all the Ledenyov complex multivector strategies in the two specific categories:

1. The Ledenyov parallel complex multivector strategies;
2. The Ledenyov sequential complex multivector strategies.

For example, in one case, the investor may pursue the Ledenyov parallel complex multivector strategies at the same time period by investing the financial capital in the diversified investment products, using various unrelated investment vehicles in the investment mediums in...
the capital market over the selected limited time. In this case, let us assume that investor will execute the investment strategies in parallel.

In other case, the investor can pursue the Ledenyov sequential complex multivector strategy at the same time period by investing the financial capital in the preferable investment products, using various unrelated investment vehicles in the investment mediums in the capital market at the selected limited time period. In this case, let us assume that investor will alter the investment strategies sequentially.

However, in the real life situation, the investor can also pursue the Ledenyov mixed parallel-sequential complex multivector strategies:

1. by investing the financial capital in the diversified investment products, using various unrelated investment vehicles in the investment mediums in the capital market over the selected limited time in parallel; as well as

2. by changing sequentially the investment strategies during the financial capital in the preferable investment products, using various unrelated investment vehicles in the investment mediums in the capital market at various time moments.

Fig. 47 shows the geometric representation of the Ledenyov mixed parallel-sequential complex multivector strategies in the Ledenyov multidimensional strategy space, changing in space – time domains.

**Fig. 47.** Geometric representation of Ledenyov mixed parallel-sequential complex multivector strategies in Ledenyov multidimensional strategy space with XY coordinates, changing in space – time domains.
In a big number of cases, the Ledenyov complex multivector strategies can be used in the game theory applications in Cournot (1838, 1897), Edgeworth (1881), von Neumann (1928, 1959), von Neumann, Morgerstern (1944).

Fig. 48 shows the decision tree, which can be used to make the strategic decisions on the complex multivector strategies in the frames of the game theory in Fudenberg, Tirole (1991).

![Decision tree in game theory.](image)

Fig. 48. Decision tree in game theory.

We think that the investor’s decision (the economic agent’s decision) to change the direction of the strategy vector in the multidimensional strategy space during the strategic operation is forced/encouraged by the strategic analysis of the numerous (un)related factors and (un)objective reasons in the frames of the (non)cooperative games in the economic environment within the limited information dataset at the selected time periods as researched in the finances, economics and business administration sciences. However, in our opinion, the game theory may have a number of theoretical limitations. One of the most notable limitation is the only use of the inductive logic, the deductive logic, and in some cases, the abductive logic during the decision making process with an application of the decision trees in the strategic games analysis in Cournot (1838, 1897), Edgeworth (1881), von Neumann J (1928, 1959), von Neumann, Morgerstern (1944), Hayek (September 1945), Nash (1950a,b, c, 1951, 1953), Shapley (1953), Williams (1954), Simon (1955), Luce, Raiffa (1957, 1989), Shubik (1953a, b, c, 1954, 1955, 1956, 1958a, b, c, 1959, 1975, 1981, 1987, 1988, July 12 2000, May 2001), Brewer, Shubik (1979), Shubik, Levitan (1980), Tucker, Luce (editors) (1959), Blackett (1962), Farquharson (1969), Morse, Kimball (1970), Arrow (1971), Howard (1971), Alchian, Demsetz (December 1972), Maynard Smith, Price (1973), Maynard Smith (1974, 1982), Aumann, Shapley (1974), Harsanyi (1974), Selten (1975, 1988), Selten, Harsanyi (1988), Jensen, Meckling (October 1976,


At this point of our research discussion, let us precisely define the quantum logic (the probability logic), the inductive logic, the deductive logic, the abductive logic in Ledenyov D O, Ledenyov V O (2015n, s):

1. The Ledenyov quantum logic (the probability logic) – the logic of what may occur – reasons through computing of events probabilities distributions. Quantum logic allows a and b to be realized, depending on a and b events probabilities distributions equal to square of the Schrödinger’s wave function in Ledenyov D O, Ledenyov V O (2015n, s).

2. The inductive logic – the logic of what is operative — reasons from the specific to the general. Induction allows inferring a entails b from multiple instantiations of a and b at the same time.
3. The deductive logic – the logic of what must be — reasons from the general to the specific. Deduction allows deriving b as a consequence of a. In other words, deduction is the process of deriving the consequences of what is assumed.

4. The abductive logic – the logic of what could possibly be true – reasons through successive approximation. Abduction allows inferring a as an explanation of b, because of this, abduction allows the precondition a to be inferred from the consequence b.

Applying our innovative scientific thinking, we propose the Quantum Thinking Process (QTP) algorithm, which can be considered as the “computing kernel” to make the logic decisions in the case of the decision making process by the investors during the financial capital investment in the diversified investment products by means of various investment vehicles in the different investment mediums in the capital markets in the economies of the scales and scopes. Thus, let us list the main distinctive features of the Quantum Thinking Process (QTP) algorithm:

1. The parallel application of the inductive logic, deductive logic, abductive logic;
2. The subsequent application of the Ledenyov quantum (probabilistic) logic;
3. The highly sophisticated decision making technique to select the best decision during the decision making process.

Fig. 49 shows the block scheme of the Ledenyov quantum thinking process algorithm.

**Fig. 49.** Block scheme of Ledenyov quantum thinking process algorithm.
The Ledenyov Quantum Thinking Process (LQTP) algorithm is an integral part of the Ledenyov Quantum Winning Virtuous Strategy Search (LQWVSS) algorithm. Let us formulate the Ledenyov Quantum Winning Virtuous Strategy Search Algorithm:


1. to get an increased return premium during the financial capital investment in the capital markets in the short and long time periods;

2. to make a positive financial impact in the society in the frames of the socially responsible investment (SRI) that integrates the social, environmental, and ethical considerations into the investment decision making process at the financial capital investment in the capital markets in the short and long time periods in Waddock, Graves, (1994), Arora, Gangopadhyay (1995), Sparkes (1998, 2004, 2008), Johnson, Greening (1999), Lyndenburg (2002), Cox,

3. to share a part of the increased investment return premium on the realization of the shared value principles initiatives, aiming to reduce an inequality between all the modern society members and to improve a quality of life of all the developed society members in Porter, Kramer (December 2006).

We can illustrate the Ledenyov quantum winning virtuous strategy search algorithm by drawing the action stages on an imagined dial in the Swiss mechanical watch. We prefer to place the described actions in the positions of the hours, ranging from 1 to 12, on an imagined dial of the Swiss mechanical watch. Then, let us assume that the arrow will switch clockwise from 1 to 12 at an imagined dial in the Swiss mechanical watch. This way, we can illustrate the 12 most significant activities to create the quantum winning virtuous investment strategy in the finances.

Fig. 50 illustrates the Ledenyov quantum winning virtuous strategy search algorithm as a set of the strategic actions, shown on an imagined dial of the Swiss mechanical watch.

![Fig. 50. Ledenyov quantum winning virtuous strategy search algorithm as a set of strategic actions on imagined dial of Swiss mechanical watch.](image-url)
Making a step forward, let us create a block scheme of the Ledenyov quantum winning virtuous strategy search algorithm as it is commonly accepted in the financial engineering science and the computer science. In other words, we will simply represent a set of the strategic actions on an imagined dial of the Swiss mechanical watch in the form of the block scheme.

Fig. 51 depicts the block scheme of the Ledenyov quantum winning virtuous strategy search (LQWVSS) algorithm.

Fig. 51. Block scheme of Ledenyov quantum winning virtuous strategy search algorithm.
Let us move ahead with the consideration of a practical realization and application of the Ledenyov Quantum Winning Virtuous Strategy Search (LQWVSS) algorithm, discussing the concrete practical meaning of every action block in the above block scheme:


7. The application of the quantum thinking process with the inductive, deductive, abductive logics: The investor has to apply the inductive logic, the deductive logic and the abductive logic to make his/her decision on a set of strategic choices such as the optimal available investment choices on the financial capital investment in the capital markets in Ledenyov V O, Ledenyov D O (2016s), Martin (1998-1999, 2005-2006);

8. The application of the quantum thinking process with the quantum (probabilistic) logic: The investor has to apply the quantum (probabilistic) logic to make his/her decision on a set of strategic choices such as the optimal available investment choices on the financial capital investment in Ledenyov V O, Ledenyov D O (2016s);


10. The creation of the quantum winning virtuous strategy: The investor has to create the quantum winning virtuous strategy by placing the strategy vector toward the direction of the optimal strategic choice among a set of strategic choices such as the optimal available investment choices on the financial capital investment in the capital markets in Ledenyov V O, Ledenyov D O (2016s);

11. The implementation of the quantum winning virtuous strategy: The investor has to execute the quantum winning virtuous strategy by completing all the activities to reach the goal(s), which are set by the strategy vector as far as the financial capital investment in the capital markets in concerned in Ledenyov V O, Ledenyov D O (2016s);

12. The result achievement and desire satisfaction: The investor has to evaluate the obtained result against the initial goals as far as the financial capital investment in the capital markets in concerned, satisfying the initially expressed investment desire in Ledenyov V O, Ledenyov D O (2016s).
Finally, we would like to make a concluding remark that Ledenyov Quantum Winning Virtuous Strategy Search (LQWVSS) algorithm can be implemented in the form of the software program and executed at the high performance computing systems to numerically solve the challenging research problem on the investment strategy creation and execution during a process of the financial capital investment in the global capital markets.

Conclusion

The financial capital investment as a research subject in the finances has always been treated similarly to a “newly discovered star” in the finances galaxy, attracting a considerable research interest and originating original thoughts by the economists, financiers, philosophers, thinkers and scientists over the recent centuries. The great scientific minds tried to explore and understand the capital origination, accumulation and distribution principles in the financial systems in the economies of the scales and scopes in various social economical political settings and systems at the different historical time periods in the World in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Ricardo (1817, 1821), Bentham (1839), Mill (1862), Marx (1867, 1893, October 1994), Bagehot (1873, 1897), George (1879, 1881, 2009), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), Bachelier (1900), Slutsky (1910), von Mises (1912), Keynes (1930 1934, 1936), Schumpeter (1939), Obstfeld, Rogoff (1996), Krugman, Wells (2005), Stiglitz (2005, 2016), Piketty (August 2013), Dodd (2014).

Undoubtedly, the financial capital investment in the capital markets in the finances has been considered as a financial conundrum with a big number of the changing financial variables and the unanswered questions by the economists, financiers, investors, philosophers, thinkers and scientists over the centuries, who attempted to formulate, re-think and solve the problem on the financial capital investment in the nonlinear diffusion-type financial systems from the social and natural sciences perspectives over the years in Markowitz (1959, 1987), Fabozzi, Markowitz (editors), Cootner (1964), Merton (1992), Shiryaev (1998a, b), Hull (2010, 2012a, b).

Of course, as we know, the nature of the processes of the financial capital origination, accumulation and distribution has been comprehensively studied and understood, to some degree, highlighting the unequal fragmented capital distributions in the form of increasing financial capital gaps between the different social hierarchy layers in various countries in Stiglitz (2015), Piketty (August 2013, August 15 2014). A general expressed opinion is that this inequality in the financial capital distributions appears due to a number of factors, including the ineffective economic policies introduction by the governments, the increased investment return premium generation by the successful market agents, and the low level of capital gains taxation by the tax authorities in the conditions of the nonlinear diffusion-type financial system, because of various existing economic/social/political reasons in the economies of the scales and the scopes.

This book represents the three decades of multidisciplinary research excellence by the authors in the finances, econometrics and econophysics. Indeed, we decided to discuss a
challenging problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, keeping in mind the fact that a serious progress has been achieved in the finances, econometrics and econophysics sciences, for instance: a) the origination of the numerous groundbreaking financial innovations in the capital markets in the finances, b) the creation of the sophisticated theoretical financial capital investment models and theories in the econometrics/econophysics sciences, c) the development of the innovative theoretical financial capital investment models and theories in the quantum econophysics science, and d) the introduction of the advanced theoretical financial capital investment models and theories in the discrete and stochastic mathematics science.

Chapter 1 discusses briefly the history of creation of the financial capital markets, the evolution of the financial capital markets and the present state of the financial capital markets in Asia, Europe and North America from the ancient time to the present time, going from the academic literature perspective. The main historical facts to emphasis are:

1. The introduction of the money to the first financial system in the ancient time of the Song dynasty and the Yuan Dynasty in mainland China;
2. The significant historical scientific role by the Austrian school of economic and financial thinking toward the creation of the fundamental theory on the modern global financial system operation;
3. The considerable impact by the Chicago school of the economic and financial thinking toward the creation of the modern global financial system in the global capital market.

Chapter 2 formulates a problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

The main research findings to keep in mind are:

1. The investment as an act of allocation of the financial capital in order to gain the profit in the form of the increased return premium, advantage or interest;
2. The fact that the problem on the investment of the financial capital in the capital markets can only be solved, introducing a number of the financial and economic variables to characterize the financial capital in the differential equations in the advanced theoretical models in various sciences;
3. The axiom that the financial capital investment in the capital markets can be accurately characterized by measuring and analyzing the statistical distributions of the discrete-time financial/economic events by the oscillating financial/economic variables in the finances, economics, and econometrics sciences.
4. The proposition that the financial capital investment in the capital markets can be precisely described by measuring and researching the signals by the oscillating financial/economic variables in the finances, economics, and econophysics sciences;

5. The suggestion to characterize the financial capital investment in the capital markets by registering and studying the scaling properties of the discrete-time events by the oscillating financial/economic variables in the finances, economics and econophysics sciences.

Chapter 3 solves a problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

The main innovative research proposals to summarize are:

1. The innovative proposition to use the multilayered approach during the consideration of the investment problem, characterizing the different layers of the investment process;

2. The proposed investment problem solution, applying the investment process algorithm with the different embedded investment layers;

3. The definition and list of the possible investment products in the capital markets;

4. The definition and list of the possible investment vehicles in the capital markets;

5. The definition and list of the possible investment mediums in the capital markets.

Chapter 4 focused on the investment products for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

The main innovative research outcomes to pay attention are:

1. The land as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;

2. The real estate as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;

3. The commodity as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;

4. The bond as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;

5. The firm’s stock and the stock options as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;

6. The financial security as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;
7. The foreign currency as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;
8. The intellectual property as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods;
9. The bitcoin as an investment product for financial capital investment in capital markets with aim to get increased return premium in short and long time periods.

Chapter 5 considered the investment vehicles for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

The main innovative research analysis results to remember are:

1. The investment bank as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
2. The investment fund as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
3. The hedge fund as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
4. The pension fund as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
5. The mutual fund as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
6. The venture capital fund as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
7. The angel investor as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
8. The investment boutique as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;
9. The private investment office as an investment vehicle for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

Chapter 6 defined the investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

The main innovative research proposals to memorize are:

1. The land exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

2. The real estate exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

3. The stock exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

4. The foreign currencies exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

5. The financial securities exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

6. The precious metals exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

7. The intellectual property exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods;

8. The digital currencies exchange as an investment medium for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

Chapter 7 introduced the financial risk calculation and mitigation techniques during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.
The main innovative scientific findings to think about are:

1. The modern portfolio theory (MPT) in Markowitz (1952, 1956, 1959, 1987);
2. The efficient frontier (EF) theoretical conception in the Modern Portfolio Theory (MPT) in Markowitz (1952, 1956, 1959, 1987) and its limitations in the real-life practical applications;
3. The investment portfolio accurate characterization by both 1) the total risk value, which is a sum of all the risks of the selected assets in Markowitz (1952, 1956, 1959, 1987) and 2) the total stability magnitude, which is a sum of all the stabilities of the selected assets in Ledenyov D O, Ledenyov V O (2013a);
4. The representation of the asset classes in the investment portfolio as the electronic signals, which can be characterized by the correlated and uncorrelated complex discrete-time digital oscillations with the certain amplitudes, frequencies, periods, and phases. The spectrum analysis with an aim to minimize the total risk, to maximize the stability of the investment portfolio, and to create the efficient optimized investment portfolio;
5. The Ledenyov investment assets theorem on the ultrafast (un)correlation properties of the investment assets in the investment portfolio;
6. The Ledenyov investment portfolio stability theorem on the stability of the investment portfolio;
7. The Ledenyov discrete-time digital short/medium/long waves of the economic output fluctuations in the economies of the scales and the scopes;
8. The Ledenyov bursts with the discrete-time digital waves to characterize the economic output fluctuations in the economies of the scales and the scopes at the very long observation time periods;
9. The most important research result is that the diversification of the investment portfolio must be conducted across all the investment products, the investment vehicles, the investment mediums at the same time (The early research findings focused on the diversification among the investment products/asset classes/instruments only);
10. The final comment is that an efficient optimized investment portfolio includes the carefully selected diversified investment products, investment vehicles and investment mediums for the financial capital investment in the capital markets in the economies of scale and the scope in the short and long time periods, aiming to decrease the total risk of the investment portfolio, to increase the total stability of the investment portfolio and to get the increased return premium in Ledenyov D O, Ledenyov V O (2013a).
Chapter 8 proposed the new research approaches to the quantum winning virtuous strategies creation and execution with the use of the quantum logic, inductive logic, deductive logic and abductive logic during the capital investment in the capital markets in the short and long time periods.

The main innovative research ideas to memorize are:

1. The conceptual design of the Ledenyov Quantum Winning Virtuous Strategy Search (QWVSS) algorithm with the use of the quantum logic, inductive logic, deductive logic and abductive logic for the capital investment in the capital markets in the short and long time periods;

2. The conceptual design of the Ledenyov Quantum Thinking Process (QTP) algorithm with the use of the quantum logic, inductive logic, deductive logic and abductive logic for the capital investment in the capital markets in the short and long time periods;

3. The definition of the Ledenyov quantum logic (the probability logic) for the decision making in frames of Ledenyov Quantum Winning Virtuous Strategy Search (QWVSS) algorithm for the capital investment in the capital markets in the short and long time periods;

4. The theoretical conception on the strategy vector in the multidimensional strategy space in frames of the fundamental theory on the complex strategy in the multidimensional strategy space.

We conclude by saying that this book discussed some aspects of the complex problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. It explained how the investment process works, opening the unlimited opportunities for the individual and institutional investors towards the private/institutional wealth accumulation, the optimal wealth management and the social prosperity building on a global scale.
Acknowledgement

Our sincere gratitude goes to all our colleagues-researchers, including the professors from the leading universities, the academics from the national academies of sciences, the researchers from the big multinational corporations and small startups, the subject experts from the professional consulting firms, the governmental officials from the government agencies, the financiers from the central banks, the analysts from the analytic “think tanks”, the policy makers from the management consulting firms, and the senior executives from the international financial organizations for presenting us with the multiple wonderful global opportunities to deliver our invited speeches, public lectures, research talks, scientific presentations on the subject of our research interest during the expert level seminars, scientific symposiums, international conferences, and business meetings in the Eastern and Western Europe, North America, East Asia, Middle East, and Australia over the last 27 years.

Traditionally, we like to conduct the Q&A sessions after the invited lectures, hence we thank all the young inquisitive researchers, talented graduate students and their experienced professors from the leading universities for a big number of interesting questions during the questions and answers (Q&A) sessions after our presentations. We do consider all the questions as quite useful and encouraging, because the new groundbreaking innovative research ideas originate in our minds in the process of debate frequently. The multiple research inputs by the academicians, practitioners, subject experts allowed us to think differently on the multi-dimensional scientific problems and encouraged us to work intensively and persistently toward the research book completion this year.

We gratefully acknowledge the insightful thoughtful ideas on the subject of our research interest, expressed by Dr. Ben Shalom Bernanke, former Chairman of the Board of Governors of the Federal Reserve System in an electronic copy of his Ph. D. Thesis: “Long-term commitments, dynamic optimization, and the business cycle” as well as the copies his innovative research articles, analytic research reports, informative slide presentations, minutes of research discussions on the various financial topics and strategic economic issues within the scope of our research interest. Of course, the modern science evolves steadily and consistently, hence our understanding on the nature of the business cycles changes accordingly from the continues-time wave to the discrete-time digital waves of the economic output fluctuations in the time domain.

We are very grateful to Prof. Robert F. Engle III, Department of Finance, New York University in New York, USA for his scientific visionary statements, interesting discussions and comprehensive research data on the Stratonovich – Kalman – Bucy filtering algorithm, in
particular, the thoughtful discussion on the derivation of the probability density function as a sum of its predictive or conditional densities in the case the state-space model in Engle (2006) has to be mentioned. We absolutely agree with Prof. Robert F. Engle III wise research opinion that the modern finances can certainly be researched with an application of the digital signal processing techniques in the electronics science.

Speaking about the electronics and economics sciences, one of the interesting historical facts can be mentioned. Namely, the Danish school of scientific thinking in the analogues signals processing at Technical University of Denmark, Lyngby, Denmark as well as the Swedish school of scientific thinking on the digital signals processing at Linköping University, Sweden have had a considerable impact on the first author’s scientific vision formation in the natural and social sciences. Scandinavian period in the first author’s research work can be regarded as a most fruitful, because it allowed to make the innovative research in the electronics and economics sciences in parallel in 1995, 1996-1997. As Prof. Lars Wanhammar, Linköping University likes to state: “the signal processing is fundamental to the information processing, and includes various method of the information extraction”, which may be used to make the assumptions in the electronics, finances, economics sciences.

It is a real privilege for the second author to deliver his personal cordial thanks to Prof. Janina E. Mazierska, Electrical and Computer Engineering Department, James Cook University in Townsville in Australia, who helped the second author to cultivate the logical scientific thinking to tackle the complex scientific problems on the analogue and digital signal processing, the accurate measurements of physical parameters, the nature of the nonlinearities in the microwave superconductivity, applying the interdisciplinary scientific knowledge since 2000.

We found that the integrative thinking is a quite useful theoretical approach to solve the financial engineering problems, hence we sincere thank Profs. Roger L. Martin, the Rotman School of Management at the University of Toronto in Toronto, Canada for the numerous long-hours scientific discussions on the strategy, integrative thinking and financial engineering in the electronic trading laboratory at the Rotman School of Management at U of T in Toronto, Canada in 1998-1999 and 2005-2006. Of course, our private discussions included a number of generals topics such as the wine, music and tennis.

We appreciate Prof. John C. Hull for the useful exchanges by the research opinions on the financial derivatives during our innovative research at the electronic trading laboratory at the Rotman School of Management at U of T in Toronto, Canada in 1998-1999 and 2005-2006, which proved to be increasingly important for the optimized computer algorithms creation, the software programs writing, and the computer modeling.
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 enigmatic influence on the presented research opinions by the authors. Let us repeat that the first author’s visit to University of Czernowitz in Ukraine in March 2015 is just a clear confirmation of the above statements.

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 some other notable scientists, hence we studied and absorbed the modern research approaches and findings on the creative destruction before making our innovative scientific vision. Let us say that Prof. Clayton M. Christensen presented the very Scandinavian approach to the understanding of the research problem on the creative disruption and evolutionary economics in his lecture notes, research articles and numerous books. It is nice to see that Prof. Clayton M. Christensen continues to be very active in the field of his research interest, making his business foresights, writing his new research books, lecturing at Harvard Business School, and conducting the executive program in the summer time.

The authors would like to explain that the quantum strategy represents a new research subject for a big number of the leading research institutions and universities, hence we sincerely acknowledge an enormous interest to our innovative research on the quantum strategy application in the finances from the side of Prof. Michael E. Porter, Founding Director, Strategy Institute, Harvard Business School, Harvard University, USA. It is wonderful to see that Prof. Michael E. Porter, Founding Director, Strategy Institute, Harvard Business School, Harvard University finds the enough time to write his numerous research articles and books despite of his heavy administrative work load at the Strategy Institute, Harvard Business School, Harvard University. We are very grateful to Prof. Michael E. Porter, Bishop William Lawrence University Professor, Harvard University, who is considered by the authors as a father of the modern business strategy, for his valuable personal efforts and time to write and discuss a number of his interesting informative research articles and books as well as to create the lecture notes, providing us with his professional expertise, exceptional quality professional advices and wise opinions in the field of competitive strategy in the 21st century. In fact, Prof. Michael E. Porter is regarded by the authors as a “guiding star” in the strategy science galaxy.

Our Swiss watches collecting lifestyle, encouraged the second author to visit the Patek Philippe museum in Genève, Switzerland in 2016, resulting in an interesting research proposition
to present the quantum strategy search algorithm in the form of an imagined dial in the Swiss mechanical time-pieces. Indeed, we found that the international students, professors and executives in the business administration education programs at various complexity levels can memorize the information on the Ledenyov Quantum Winning Virtuous Strategy Search (LQWVSS) algorithm, presented in the form of an imagined dial in the Swiss mechanical time-pieces, much more better, comparing to the generally accepted block-schemes, which may better suit the needs by the students enrolled in the computer science education programs.

One of the most important lessons, which we learned in the processes of our education and research at the universities over the years is that the innovative groundbreaking research ideas matter a lot in the modern society. The innovative research ideas lead to the “quantum leaps” in the social-scientific-economic-financial progress in the developed countries. Fortunately, we obtained the multidisciplinary knowledge, completing the university degrees in the Radio-Physics and Electronics at V.N. Karazin Kharkiv National University in Kharkiv, Ukraine in 1993 and 1999. Therefore, we would like to share an opinion that all our discoveries have been made due to the multi-disciplinary knowledge application, which is considered by the authors as a key factor on the way toward the modern society building.

Continuing our research discussion, let us explain the origins of some innovative research ideas, which are presented in this book in the finances:

1. We think that the multiple layers research analysis approach can be successfully applied to research the different investment layers in a process of capital investment in the capital markets in the finances science, including the investment product, vehicle, medium layers, in analogy to the complex hetero-junction structures research in the electronics;

2. The research on the analogue/digital signals processing in the electronics engineering science allowed us to formulate the Ledenyov discrete-time digital business cycles theory in which the discrete-time disruptive innovations can sharply change the economic output waveform in the economics science;

3. The research on the quantum transitions by the quantum objects in the atom in the quantum physics facilitated the creation of the discrete-time quantum business cycles theoretical model in the frames of the quantum macroeconomics theory and the quantum microeconomics theory in the economics science. In this case, we not only consider the discrete-time digital waveform of the economic output fluctuations, but study the discrete-time transition phenomena and its quantum properties, focusing on the number of disruptive events and their economic properties during the transition from the one level of the economic output to the another level of the economic output in the economy of the scale and the scope as explained in the book;
4. The research on the time division duplex (TDD) / frequency division duplex (FDD) direct sequence spread spectrum (DSSS) wireless communication devices and the Code Division Multiple Access (CDMA) wireless communication devices in the electrical and computer engineering science made it possible to formulate the theory on the Ledenyov long complex discrete-time digital wave, propagating in the form of the transmitted discrete-time spread spectrum signal bursts in the economy of the scale and the scope in the economics science. In this case, the every transmitted signal burst contains the Ledenyov discrete-time digital wave of GDP(t)/GNP(t)/PPP(t) fluctuations, which is modulated by the disruptive technological/social/political innovations in the economy of the scale and the scope in the scale-time domains. There may be the time periods, when the discrete-time spread spectrum signal bursts are present (the intensive economic development phase) or they are absent (the economic stagnation/downturn/crisis phase).

5. As we know the financial capital investment can be done into such an investment product as the foreign currencies, which are constantly traded in the FX markets in the finances. The research on the microwave signals generation/propagation/attenuation/processing in the electronics allowed us to propose an interesting idea on a possibility of realization of the ultra high frequency (UHF) electronic trading in the FX markets in the finances;

6. The foreign currencies exchange indexes in the foreign currencies exchange markets can fluctuate instantly. In this case, the research on the discrete-time digital signals in the digital signal processing theory in the electronics science gave us an opportunity to make a suggestion on a possibility of realization of the nonlinear signal filtering of the foreign currencies exchange indexes, using the Stratonovich-Kalman-Bucy filter and the particle filter in the Stratonovich-Kalman-Bucy nonlinear signals filtering theory in the finances;

7. The hedge fund is a well known investment vehicle in the modern finances. Thus, the research on the discrete-time digital signals in the digital signal processing theory in the electrical and computer engineering science allowed us to suggest that the tracking of the hedge fund’s investment strategies by various investment funds can be efficiently done, using the Stratonovich-Kalman-Bucy nonlinear signals filtering theory in the finances;

8. The research on the analogue signal processing theory and the digital signal processing theory in the electronics science encouraged us to formulate the Ledenyov investment assets theorem in the finances science;

9. The research on the stability in the mathematics science and the complex systems stability in the electrical and computer engineering science allowed us to introduce the Ledenyov investment portfolio stability theorem in the finances science;
10. The research on the quantum random number generators on the magnetic flux qubits (1024 QRNG_MFQ chipset) in the quantum physics helped us to better understand the random fluctuations of the financial variables in the finances;

11. The theoretical conception on the quantum money in the finances was proposed as a result of our intensive research work in the quantum physics, superconductivity, optics and low temperature physics sciences over the recent decades;

12. A recent invention of the quantum logic for an application in the decision making theory in the business administration, law making, finances, and economics sciences is a result of our intensive research work in the quantum physics over 25 years.

It worth to comment that the scientific thinking school in Bunyakovsky (1825a, b, c, 1846), who was born in Town of Bar, Region of Vinnytsia, Ukraine; influenced the authors’ strategic scientific vision creation and helped to develop the authors’ tactical approaches to the scientific problems solutions in the case of the problem on the forecast in the capital markets.

Speaking about Kharkiv, we can say that Prof. Niels Bohr, Copenhagen University, Denmark visit to Kharkov, Ukraine in 1933 led to the creation of the econophysics science, and the second author’s visits to Roskilde, Lyngby, Denmark and Copenhagen, Denmark in 1995, 1996-1997 resulted in the new quantum theories formulation in the econophysics science.

The authors acknowledge the multiple scientific discussions on the econophysics and the quantum mechanics with Oleg P. Ledenyov in Kharkiv, Ukraine over the recent decades. Our farther, Oleg P. Ledenyov, researched the absorption phenomena, including the absorption of the electromagnetic signals in the high pure metals / superconductors at the ultrasonic frequencies at the low temperatures; the absorption of the electromagnetic signals in the superconductor crystals/thin films at the ultra high frequencies at the low temperatures; the absorption of the electromagnetic signals in the quantum liquids such as the liquid Helium at the ultra high frequencies at the low temperatures; and the absorption of the chemical elements and their isotopes in the soft condensed matter in the physics in Kharkiv, Ukraine for the five decades. Therefore, it was interesting for us to make the advanced research on the absorption of information by the investors during the financial capital investment in the capital markets in the economics and the finances.

The first author thanks for a wonderful opportunity to deliver the invited research seminar, answer the multiple research questions, and make an exchange by the innovative research opinions on the nonlinear signals processing at Electrical and Computer Engineering Department, James Cook University, Townsville, Australia in April, 2016.
Looking forward, we can see an existence of a serious contradiction in the minds of the reputable economists in the economics science. The problem is that all the classic theories in the economics and finances sciences are based on an assumption that the financial and economic processes in the economies of the scales and the scopes can be classified as the continuous-time processes. The fact is that a big number of the economists created the outdated economic theories dealing with the continuous-time financial and economic processes in the economies of the scales and the scopes. However, presently, we came to an understanding that all the financial and economic processes in the economies of the scales and the scopes are the discrete-time digital processes. Therefore, it is necessary to recognize a profoundly important fact that a new way of thinking and a new mentality must be applied to understand and accurately characterize the discrete-time digital processes in the economies of the scale and the scope in the frequency/scale/time domains. In this context, we formulated our new innovative theories in the economics and finances sciences.

Finally, the authors thank a senior management team at The Mathworks for the license and kind permission to get a remote access to the software libraries with the different implementations of the digital signal processing algorithm, including the Stratonovich – Kalman - Bucy filtering algorithm, as well as the bifurcation algorithms in the Matlab, at the Mathworks servers in the USA.

It is not conceivable to write this book without the multiple useful research inputs from and encouragements by many brilliant people, who are not listed in the acknowledgement, because of various reasons. Indeed, playing the tennis at the tennis courts or the golf at the golf play grounds with our respected research collaborators, business partners, family friends in various countries around the World, we have already conducted many thousands of thoughtful discussions on the topics of our research interest, hence we would like to thank all our global Friends for their brilliant ideas, interesting opinions, numerous comments, wise suggestions and shared experiences on the subject of our research interest in the economics, finances, and econophysics.
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Investment in Capital Markets creates a strategic vision on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods. The book is written with a main goal to explain the pros and cons of the financial capital investment in the capital markets, discussing the sophisticated investment concepts and techniques in the simple understandable readable general format language. We would like to highlight the three interesting facts about the book: 1. It is centered on the consideration of the modern investment products, the investment vehicles and the investment mediums for the financial capital investment in the capital markets; 2. It is focused on the financial risk calculation and mitigation techniques for the financial capital investment in the capital markets. 3. It is aimed to describe the quantum winning virtuous investment strategies creation and execution techniques during the financial capital investment in the capital markets. The investors, financiers, economists, financial analysts, financial traders, financial advisers, lawmakers, policy analysts, subject experts, professors, and students will certainly enjoy a breathtaking splendid learning journey with the explained new ideas, established concepts and outlined future prospects toward the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

Key Features:

* Discovers the capital markets history from the ancient time to the present time.

* Formulates the general problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

* Solves the problem on the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods, using a number of the investment products, investment vehicles and investment mediums.

* Explains the theoretical fundamentals of the modern investment products, investment vehicles and investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

* Debates the practical applications of the modern investment products, investment vehicles and investment mediums for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

* Considers the modern financial risk calculation techniques during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

* Outlines the problem on the quantum winning virtuous investment strategies creation and execution during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

* Presents the algorithm for the quantum winning virtuous investment strategies creation and execution during the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.

* Discusses the practical perspectives on the limitless opportunities for the financial capital investment in the capital markets with the aim to get an increased return premium in the short and long time periods.