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Abstract – The research article presents the highly innovative theoretical research results: 1) the new quantum microeconomics theory in the quantum econophysics science is formulated; the idea on the existence of the discrete-time induced quantum transitions of firm’s earnings (the firm’s value) in the quantum microeconomics theory in the quantum econophysics science is proposed; 2) the formulas (1, 2) to compute the firm’s discrete-time EBITDA (the firm’s value) changes at the different time moments in the quantum microeconomics theory in the quantum econophysics science is derived; 3) the formulas (3, 4) to calculate the distribution of a number of the firms’ excited business processes of certain value at the selected firm’s state in the economy of scale and scope in terms of the quantum microeconomics theory in the quantum econophysics science is presented; 4) the notion on the wave function in the quantum microeconomics theories in the quantum econophysics science is introduced; 5) the formulas (5, 6) to predict the firm’s discrete-time EBITDA (the firm’s value) state changes in the national/global economies at the certain time moment, using the wave functions in the quantum econophysical time-dependent/time independent wave equations in the quantum microeconomics theory in the quantum econophysics science, are derived; 6) the evolutionary shifts from the classic economic theories to the quantum economic theories, from the analogue economic signal processing to the digital economic signal processing, from the continuous-time signal filtering economic prediction techniques to the wave functions computing economic prediction techniques in application to the quantum econophysics science are described; 7) the perspectives of application of the quantum microeconomics theory in the quantum econophysics science with the aim to solve the various economic problems in the real- and speculative- sectors of economic markets are discussed.

JEL: C0, D0, G21, G24, G30, G32, G34, G38, G39, L1, L4, L11, L25, L60, M2, M16, D0, E32, E43, E44, E53, E58, E61, G18, G21, G28

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Keywords: theory of firm, quantum theory of firm, firm’s performance state prediction problem at the certain time moment, wave function in quantum econophysical wave equation in quantum microeconomics theory in quantum econophysics science, wave function in Schrödinger quantum mechanical wave equation in quantum mechanics science, quantum econophysics, econometrics, nonlinear dynamic economic system, economy of scale and scope, quantum microeconomics.
Introduction

The *modern human civilization* has been established on the basis of the poly-scientific poly-technical creative innovative discoveries in a number of natural and social sciences, including the *economics science*, which studies the production, distribution and consumption of commodities / products / services at the national and global scales in the time domain.

Going from the scale and scope of the considered scientific problems, the economics science can be conditionally divided on the *fundamental economics* and the *applied economics* in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Menger (1871), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), Bachelier (1900), Schumpeter (1906, 1911, 1933, 1939, 1961, 1939, 1947), Slutsky (1910, 1915 1923), von Mises (1912), Hayek (1931, 1935, 2008; 1948, 1980), Keynes (1936, 1992), Ellis, Metzler (1949), Friedman (1953), Baumol (1957), Debreu (1959), Krugman, Wells (2005), Stiglitz (2005):

1. **Fundamental economics** – a science on the fundamental scientific problems in the economics, including the *fundamental economic problems formulation, theories creation, laws writing, equations derivation, etc*;

2. **Applied economics** – a science on the applied scientific problems in the economics, including the *macroeconomic performance forecasts for the national/global economies, microeconomic performance forecasts for the firms and corporations, firm’s business indicators forecast, firm’s economic performance variables computing, financial indexes forecasts in the national / international money markets, etc*.

Going from the scale of researched scientific problems, the economics science can be conditionally separated into the *macroeconomics, microeconomics* and *nanoeconomics* in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Menger (1871), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), Bachelier (1900), Schumpeter (1906, 1911, 1933, 1939, 1961, 1939, 1947), Slutsky (1910, 1915 1923), von Mises (1912), Hayek (1931, 1935, 2008; 1948, 1980), Keynes (1936, 1992), Ellis, Metzler (1949), Friedman (1953), Baumol (1957), Debreu (1959), Krugman, Wells (2005), Stiglitz (2005):

1. **Macroeconomics** – a science on the *macro-economic processes in the national/global economies, which are characterized by the economic variables such as the national economic input/output, employment level, inflation level, interrelationships between various economic sectors, and macro-credits for the states, etc*;
2. **Microeconomics** – a science on the micro-economic processes in the national/global economies, which are characterized by the economic variables such as the firm’s earnings, taxes, investments, performance, and micro-credits for the firms, etc.

3. **Nanoeconomics** – a science on the nano-economic processes in the national/global economies, which are characterized by the economic variables such as the time of the ultra high frequency trading in the foreign exchange markets, volume of the ultra high frequency trading in the foreign exchange markets, and value of nano-credits for the firms, etc. The nanoeconomics term is introduced and defined by the authors for the first time in Ledenyov D O, Ledenyov V O (2015h, 2015i).

Taking to an account all the expressed historical scientific views and the existing scientific schools of thinking, the modern macroeconomics science can be conditionally divided on, but not limited to: the Hayek macroeconomics school of thinking, the Chicago macroeconomics school of thinking, the Keynes macroeconomics school of thinking, the George macroeconomics school of thinking and the Marx macroeconomics school of thinking in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Menger (1871), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), Bachelier (1900), Schumpeter (1906, 1911, 1933, 1939, 1961, 1939, 1947), Slutsky (1910, 1915 1923), von Mises (1912), Hayek (1931, 1935, 2008; 1948, 1980), Keynes (1936, 1992), Ellis, Metzler (1949), Friedman (1953), Baumol (1957), Debreu (1959), Krugman, Wells (2005), Stiglitz (2005):

1. **Hayek macroeconomics school of thinking** – a scientific school of thinking in the economics by Friedrich August von Hayek, Austrian born English economist, creating the monetary theory that the credit cycles drives the business cycle and stating his vision that the economic market is a self-regulating self-adjusting economic system in Hayek (1931, 1935, 2008; 1948, 1980);


3. **Keynes macroeconomics school of thinking** – a scientific school of thinking in the economics by John Maynard Keynes, English economist, expressing an opinion that the state must regulate the economic market by the different economic regulatory means (monetary and
financial policies) to a certain extent, because the economic market is a partly self-regulating self-adjusting economic system in Keynes (1936, 1992);

4. **George macroeconomics school of thinking** – a scientific school of thinking in the economics by Henry George, American philosopher and economist, proposing an idea that the state must regulate the economic market by the single tax on the land value to a certain extent, because the economic market is a partly self-regulating self-adjusting economic system in George (1879, 1881, 2009), Gerstein (May, 1996, 1999);

5. **Marx macroeconomics school of thinking** – a scientific school of thinking in the economics by Karl Marx, German political philosopher and economist, advocating a position that the progress is due to the class struggle, creating the labour theory of value, and promoting the basic idea that the state must regulate the economic market by means of the planned economy, because the economic market is not a self-regulating self-adjusting economic system in Marx (1867, 1885, 1894).


1. **Babbage microeconomics school of thinking** – a scientific school of thinking in the microeconomics by Babbage, economist, who created the theory of firm in Babbage (1832);

2. **Ueda microeconomics school of thinking** – a scientific school of thinking in the microeconomics by Ueda, economist, who contributed to the creation of the theory of firm in Ueda (1904, 1937);


4. **Fama microeconomics school of thinking** – a scientific school of thinking in the microeconomics by Fama, economist, who significantly contributed to the modern theory of firm in Fama (1980), Fama, Jensen (1983, 1985);


Going from the existing approaches to research the scientific problems, the economics science can be conditionally treated as the **classic economics** and the **quantum economics** in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Menger (1871), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), Bachelier (1900), Schumpeter (1906, 1911, 1933, 1939, 1961, 1939, 1947), Slutsky (1910, 1915 1923), von Mises (1912), Hayek (1931, 1935, 2008; 1948, 1980), Keynes (1936, 1992), Ellis, Metzler (1949), Friedman (1953), Baumol (1957), Debreu (1959), Krugman, Wells (2005), Stiglitz (2005):

1. **Classic economics** – a science, which uses a big number of the classic macroeconomics, microeconomics and nanoeconomics theories, based on the continuous-time
wave representations, attempting to explain and predict the observed economic phenomena in the real- and speculative- sectors of economic markets in the national and global economies of the scales and scopes in Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Menger (1871);

2. **Quantum economics** – a science, which uses the quantum macroeconomics, quantum microeconomics and quantum nanoeconomics theories, based on the discrete-time wave representations, with the purpose to explain and predict the observed economic phenomena essence in the real- and speculative- sectors of economic markets in the national and global economies of the scales and scopes in Ledenyov D O, Ledenyov V O (2015h, 2015i).

Moving forward with our scientific discussion, let us explain that there is a scientific opinion that the classic scientific representations within the classic economic theories proved to be outdated, illogical, incomplete and inaccurate from the scientific point of view, resulting in the frequent forecasting errors as far as the economic variables change dynamics in the macroeconomics, microeconomics and nanoeconomics is concerned. Speaking clearly, the classic economic theories have the derived mathematical equations, which cannot be used to accurately model the economic variables change dynamics in the macroeconomics, microeconomics and nanoeconomics in the time, frequency and scale domains.

Therefore, thinking about the quantum economics, it is logically to assume that the foundational principles of quantum economics will help to achieve the following research goals:

1. to create the new innovative quantum economics theories to logically describe the macroeconomics, microeconomics and nanoeconomics processes in the real- and speculative- sectors of economic markets;

2. to generate the new innovative quantum economics theoretical approaches to solve the economic forecasting problems in the real- and speculative- sectors of economic markets; and

3. to accurately model the macroeconomics, microeconomics and nanoeconomics processes in the real- and speculative- sectors of economic markets.

Let us emphasis again that, aiming to achieve the outlined research goals, we will use the quantum econophysics science, mainly based on the quantum physics science, with the purpose to formulate the theoretical postulates of the quantum microeconomics theory in the beginning, then we will create the theory of the Ledenyov wave function and derive the Ledenyov quantum mechanical wave equation in the quantum microeconomics theories in the quantum econophysics science with the ultimate goal to attempt to create the new theoretical modeling.
approaches and to accurately predict the firm systemic state changes in the national/global economies at the specific time moment or over the certain time period.


Speaking clearly about the foundations of the quantum physics science, it is necessary to explain that it was shown in quantum physics science that the discrete nature of microscopic physical world manifests in the quantization of energy spectrum of electronic excitations, which can be mathematically described by the quantum mechanics science in Planck (1900a, b, c, d, 1901, 1903, 1906, 1914, 1915, 1943), Einstein (1905, 1917, 1924, 1935), Einstein, Podolsky, Rosen (1935), Bohr (1922, 1924), de Broglie L (1924, 1925, 1926, 1927, 1928), Compton (1926), Compton A, Allison S K (1935), Schrödinger (1926), Schiff (1949), Akhiezer, Berestetsky (1953, 1964, 1980), Berestetsky, Lifshits, Pitaevsky (1980), Dirac (1958),

Discussing the numerous applications of the quantum physics, it is necessary to say that the nuclear reactors at the nuclear power plants as well as the quantum electronic devices have been developed due to the ongoing considerable progress in the quantum physics:

1. The nuclear energy generation with the various types of nuclear reactors is achieved in Fermi (1934), Fermi, Amaldi, d'Agostino, Rasetti, Segre (1934), Blokhintsev (1954);

2. The new quantum electronics devices are successfully developed:


   c) the various types of semiconductor / superconductor / metal heterostructures transistors, including the single electron transistor, single electron quantum dot transistor, in which the discrete charge carriers quantum tunneling effects are present in Bardeen (1956), Fulton, Dolan (1987), Grabert, Devoret (1992), Mygind (1997);

   d) the Josephson junctions in Josephson (1962, 1964, 1965) and the dc/rf superconducting quantum interference devices (SQUIDs) in Tesche, Clarke (1977), Clarke (1989), Muck (1998), Bardeen (1972, 1990);


Moving ahead to the discussion on the main scientific problems of our interest, the authors would like to say that we intend to consider the following five research problems in this research article in details:

1. The quantum microeconomics theory formulation in the quantum econophysics science;

2. The formula derivation to describe the discrete-time EBITDA changes during the firm’s economic performance variations in terms of the quantum microeconomics theory in the quantum econophysics science;

3. The formula derivation to explain the 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 in the quantum econophysics science;

4. The formula derivation to predict the firm’s possible economic performance state changes in the national/global economies at the certain time moment, using the wave function in the quantum econophysical wave equation in the quantum microeconomic theory in the quantum econophysics science;
5. The concluding remarks summary on the perspectives of application of the quantum microeconomics theory in the quantum econophysics science with the aim to solve the various economic challenges in the real- and speculative- sectors of economic markets.

Quantum microeconomics theory and its applications

“Microeconomics is a branch of economics that studies the behaviour of individuals and firms in making decisions regarding the allocation of limited resources,” as it is explained in Wikipedia (2015k).


1) Barriers to entry creation,
2) Strategic boundaries definition,
3) Limits to growth evaluation.”

The theory of firm studies the firm’s organizational structure, the firm’s functional performance, and the firm’s economic variables change forecast. A number of the possible theories of the firm, including the information theory of the firm in Ledenyov D O, Ledenyov V

1. The neo-classical theory of the firm describes the various market structures, regulation issues, strategic pricing, barriers to entry, economies of scale and scope and even optimum portfolio selection of risky assets, and establishes the principle of profit maximisation, according to which profit is maximised, when marginal revenue is equal to marginal cost in the conditions of complete information. The theory does not allow for firm evolution in Berle, Means (1932a, b), Kantarelis (2007).

2. The transaction cost theory of the firm states that the people begin to organise their production in the firms, when the transaction cost of coordinating production through the market exchange in the conditions of the imperfect information, is greater than within the firm in Coase (1937). It does not take into consideration agency costs or firm evolution, neither does it explain how vertical integration should take place in the face of investments in human assets, with unobservable value, that cannot be transferred in Kantarelis (2007).

3. The managerial theory of the firm suggests that the managers would seek to maximise their own utility and consider the implications of this for firm behaviour in contrast to the profit-maximising case in Baumol (1959, 1962), Marris (1964) and Williamson (1966).

4. The principal–agent theory of the firm extends the neo-classical theory of the firm and managerial theory of the firm by adding agents to the firm, and it considers the friction due to asymmetric information between owners of firms and their stakeholders or managers and employees; the friction between agent and principal requires precise measurement of agent performance and the engineering of incentive mechanisms. The weaknesses of the theory are
many: it is difficult to engineer incentive mechanisms, it relies on complicated incomplete contracts (borderline unenforceable), it ignores transaction costs (both external and internal), and it does not allow for firm evolution in Spence and Zeckhauser (1971), Ross (1973), Kantarelis (2007).

5. The **behavioural theory of the firm** assumes that the groups of people participate in setting goals and making decisions on the production; inventory; market share; sales and profits in the firm, potentially creating conflicts. The theory proposes that the real firms aim to satisfy rather than maximize their results in agreement with the bounded rationality concept in Simon (1950), Cyert, March (1963).

6. The **evolutionary theory of the firm** states that the firm possesses unique resources (the resource based view of the firm): financial, physical, human and organizational. It sees the firm as a reactor to change and a creator of change for competitive advantage. The firm, as a creator of change, may cause creative destruction, which in turn may give birth to new industries and enable sectors of, or entire, economies to grow. The theory does not take to the account that the creative innovation process cannot be easily programmed within a firm or a nation in Penrose (1959), Wernerfelt (1984), Barney (1991), Kantarelis (2007).


8. The **information theory of firm** describes the firm in terms of the information computing and processing processes Ledenyov D O, Ledenyov VO (2015c). The main distinction of the information theory of firm from the knowledge theory of firm is in the fact that the information theory of firm characterizes the firm by means of the dynamic information flow and processing processes. In other words, the information theory of firm is a truly dynamic theory of the firm, but not a static theory of the firm as in the case of all other theories.

Discussing the firm’s earnings forecast problem, it makes sense to highlight an interesting fact that the firm’s value (the firm’s earnings: EBITDA) is usually computed and forecasted, using the continuous-time wave models in the classic microeconomics theory in the classic economics science. However, there is a scientific opinion that the functional nature of the
modern firm is discrete, because the main parameters of the firm tend to change discretely in the time domain. Therefore, the authors proposed that the firm can be better characterized by the discrete-time wave models in the quantum microeconomics in the quantum economics science in Ledenyov D O, Ledenyov V O (2015i).

As we know the quantum microeconomics theory has been formulated in Ledenyov D O, Ledenyov V O (2015i) for the first time: “Let us formulate the quantum microeconomics theory for the first time: The quantum microeconomics theory 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 systems at the time moment, when:

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

   \[ l_{\text{micro}} \omega_{m,n} = \Delta EBITDA(t) = EBITDA(t)_m - EBITDA(t)_n \]  

   \[ l_{\text{micro}} \omega_{m,n} = \Delta \text{firm's value}(t) = \text{firm's value}(t)_m - \text{firm's value}(t)_n \]  

where: \( l_{\text{micro}} \) – 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.

4. 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
\[
\frac{N_m}{N_n} = \exp^{-\left(EBIDTA(t)_m - EBIDTA(t)_n\right) / \lambda_{\text{micro}} T}, \\
\frac{N_m}{N_n} = \exp^{-\left(firm's\ value(t)_m - firm's\ value(t)_n\right) / \lambda_{\text{micro}} T},
\]

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 and Amortization,

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

In other words, let us emphasis that the quantum microeconomics theory 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:

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 firms’ business processes population inversion mechanism, which occurs at the following condition: \(N_2/N_1 > 1.\)”

The authors would like to add that there are many possible disruptive scientific/technological/financial/social/political innovations in Ledenyov D O, Ledenyov V O
“Let us give the possible examples of the above discussed disruptive scientific/technological/financial/social/political innovation(s):

1. **Scientific innovation**: the discovery of new scientific phenomena and laws such as the relativity law in the physics in Landes (1998);

2. **Technological innovation**: the creation of new materials/devices such as the new metals/steam engines, new metals/combustion engines, semiconductors/transistors, semiconductors/lasers, superconductors/electric motors, superconductors/single electron transistors, superconductors/Josephson junctions, superconductors/quantum random number generators, superconductors/quantum processors in Ledenyov D O, Ledenyov V O (2015a);

3. **Financial innovation**: the creation of new financial products and services such as the derivatives and mobile banking;

4. **Social innovation**: the introduction of new socioeconomic models, for instance: the shared-value initiative, which can be defined as: “the policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates” in Porter, Kramer (2006, 2011);

5. **Political innovation**: the establishment of the new effective governmental system.”

The quantum microeconomics theory opens a number of new opportunities to tackle the economic and financial forecasts problems, hence the formula to predict the firm’s economic performance state changes in the national/global economies at the certain time moment can be derived, using the wave function in the quantum econophysical wave equation in the quantum microeconomic theory in the quantum econophysics science as it was shown in Ledenyov D O, Ledenyov V O (2015i).

Therefore, let us derive a set of the complete formulas to predict the firm’s economic performance state changes in the national/global economies at the certain time moment, using the wave function in the quantum econophysical wave equation in the quantum microeconomic theory in the quantum econophysics science as in Ledenyov D O, Ledenyov V O (2015i), making some additional clarifications:

“Let us write the time dependent Ledenyov quantum econophysical wave equation in the quantum microeconomics theory in the quantum econophysics science

\[ i \hbar \frac{\partial}{\partial t} \psi_{\text{micro}} = \hat{L}_{\text{micro}} \psi_{\text{micro}}, \]

where: \( i \) – the imaginary unit,

\( \psi_{\text{micro}} \) – the wave function of a quantum system, which is a mathematical function in the quantum mechanics to accurately characterize a specified state of a quantum system. The
square of the amplitude of the wave function at a given point being representative of the probability of the system being found in that state at that point.

\( I_{\text{micro}} \) – the Ledenyov constant,

\( t \) – the time,

\( \frac{\partial}{\partial t} \) – the partial derivative with respect to the time,

\( \hat{L}_{\text{micro}} \) – the Ledenyov operator to characterize the total energy of the wave function.

The time independent Ledenyov quantum econophysical wave equation in the quantum microeconomics theory in the quantum econophysics science is

\[
E_{\text{micro}} w_{\text{micro}} = \hat{L}_{\text{micro}} w_{\text{micro}},
\]

where: \( w_{\text{micro}} \) – the wave function of a quantum system, which is a mathematical function in the quantum mechanics to accurately characterize a specified state of a quantum system. The square of the amplitude of the wave function at a given point being representative of the probability of the system being found in that state at that point,

\( \hat{L}_{\text{micro}} \) – the Ledenyov operator to characterize the total energy of the wave function,

\( E_{\text{micro}} \) – the energy of the state \( w_{\text{micro}} \).

Continuing the scientific discussion, the authors would like to comment that we know that: “the wave function is considered as a natural attribute of quantum mechanics” in Rylov (2015).


In general, the authors believe that the Ledenyov wave function in the Ledenyov quantum econophysical wave equation represents a most complete accurate characterization that can be given to the firm’s economic performance state in the microeconomic system in agreement with the quantum microeconomic theory in the quantum econophysics science.

Conclusion

This research article presents a number of the highly innovative theoretical research results:

1. the new quantum microeconomics theory in the quantum econophysics science is formulated;
2. the idea on the existence of the discrete-time induced quantum transitions of firm’s earnings (the firm’s value) in the quantum microeconomics theory in the quantum econophysics science is proposed;
3. the formulas (1, 2) to compute the firm’s discrete-time EBITDA (the firm’s value) changes at the different time moments in the quantum microeconomics theory in the quantum econophysics science is derived;
4. the formula, (3, 4) to calculate the distribution of a number of the firms’ excited business processes of certain value at the selected firm’s state in the economy of scale and scope in terms of the quantum microeconomics theory in the quantum econophysics science is presented;
5. the notion on the wave function in the quantum microeconomics theories in the quantum econophysics science is introduced;
6. the formulas (5) and (6) to predict the firm’s discrete-time EBITDA (the firm’s value) state changes in the national/global economies at the certain time moment, using the wave functions in the quantum econophysical time-dependent/time independent wave equations in the quantum microeconomic theory in the quantum econophysics science, are derived;
7. the evolutionary shifts from the classic economic theories to the quantum economic theories, from the analogue economic signal processing to the digital economic signal processing, from the continuous-time signal filtering economic prediction techniques to the wave
functions computing economic prediction techniques in application to the quantum econophysics science are established;

8. the perspectives of software program development to solve the various economic problems in the real- and speculative- sectors of economic markets, using the new quantum microeconomics theory in the quantum econophysics science, are discussed.

Acknowledgement

The first author started his scientific work on the information processing in Kharkiv, Ukraine, researching the microwave filters, making the discovery that the quantum knot of the magnetic vortex is in an extreme quantum limit, focusing on the research and development toward the ultra dense memory on the quantum knots of the magnetic vortices, and presenting his innovative research results at the international conferences, including the Marconi seminar at Birmingham University in the UK in 1999.

The advanced research on the analog and digital signals processing in the electronics and physics has been conducted by the first author under Prof. Janina E. Mazierska at James Cook University in Townsville in Australia in 2000 – 2015.

The idea to perform the econophysical research on the discrete time digital signals and the continuous-time signals toward the oscillating economic variables spectrum analysis in the macroeconomics attracted the first author’s research interest in recent years.

The first author would like to tell an interesting story that he decided to fly from James Cook University in the City of Townsville in the State of Australia to University of Czernowitz in the City of Czernowitz in the State of Ukraine to pay his respect to Prof. Joseph Alois Schumpeter’s scientific achievements in March, 2015, because Prof. Joseph Alois Schumpeter started to think on the business cycles and economic development in the economics science at University of Czernowitz in the City of Czernowitz in the State of Ukraine in 1909 – 1911, completing the writing of his well known book on the business cycles in Schumpeter (1939).

It may worth to note that the first and second authors were graduated from V. N. Karazin Kharkiv National University in the City of Kharkiv in the State of Ukraine in 1999 and 1993, hence we would like to comment that our research interest in the economic cycles in the economics science is quite natural, because Prof. Simon Kuznets conducted his scientific work on the cyclical fluctuations in the economic systems in the City of Kharkiv in the State of Ukraine in 1915 - 1922, being influenced by the Prof. Joseph Alois Schumpeter research ideas and coming up with the remarkable research results in Kuznets (1930, 1973).
It is a notable historical fact that the first and second authors were strongly influenced by the remarkable scientific papers and books by Lev Davydovich Landau, who had a considerable interest in the physics and, at the later stage of his life, in the econophysics, working in the City of Kharkiv in the State of Ukraine in 1930s.

The second author began his research work on the information processing, specifically focusing on the information processing and coding by various electronic computing devices in Ukraine in the later 1980s and early 1990s. The second author made his significant research contributions to establish the scientific field on the information processing by the quantum computing devices, researching and developing the 1024 Quantum Random Number Generator on the Magnetic Flux Qubits, based on the Superconducting Quantum Interference Device (SQUID) arrays, for the space applications at a number of leading research institutions and elite universities in Europe and in North America since mid 1990s. The second author is frequently regarded and commonly recognized as a founder of the research field on the information processing by the superconducting quantum computing devices, which was established in Europe almost 30 years ago.

The second author’s scientific views were mainly influenced by Prof. Lev Landau research papers on the quantum physics, which have been absorbed during his research work in the City of Kharkiv in the State of Ukraine in 1990s; and by Prof. Niels Bohr research articles on the quantum physics, which have been studied during his scientific work at Technical University of Denmark in the City of Lyngby near the City of Copenhagen in the State of Denmark in Scandinavia in 1995, 1997-1998.

Discussing the scientific problems on the signal generation, it is necessary to comment that the second author completed his research on the Gunn diode microwave generators in 1991-1992 at V. N. Karazin Kharkiv National University in Kharkiv, Ukraine, and then continued his innovative scientific work on the various scientific programs towards the continuous-time waves generators such as the Yttrium Iron Garnet (YIG) microwave generators, tuned by the magnetic field, as well as the discrete-time digital signal generators such as the 1024 Quantum Random Number Generator on the Magnetic Flux Qubits, based on the Superconducting Quantum Interference Device (SQUID) arrays, the superconducting microwave resonators, among other research programs during the last three decades. In addition, the second author has developed a plenty of experience in the discrete-time digital signal generators, using the digital modulation techniques such as the Pulse Amplitude Modulation (PAM), Quadrature Amplitude Modulation (QAM), Phase Shift Keying (BPSK, QPSK, MPSK), Frequency Shift Keying (FSK), Gaussian Minimum Shift Keying (GMSK), etc.
The second author has been greatly influenced by the Henry George’s scientific ideas, articles and books in the economics since the beginning of 1990s. The second author has had the numerous opportunities to discuss a wide range of research problems in the economics during his frequent visits to the international conferences and his intensive research work at leading universities in Europe and North America during last four decades.

Let us repeat that this innovative research uses the knowledge on the analogue and digital signals processing in the physics and the electronics engineering, which is described in our scientific book on the nonlinearities in the microwave superconductivity in Ledenyov D O, Ledenyov V O (2015a).

The final writing, editing and reading of our research article have been made by the authors during our travel to the Prof. Viktor Yakovlevich Bunyakovsky motherland in the Town of Bar in Vinnytsia Region in the State of Ukraine in the beginning of May, 2015 and August, 2015.

The additional research changes have been added by the authors during the visits to the City of Kharkiv in the State of Ukraine in June / July / September, 2015. The obtained research results have been extensively discussed with a number of prominent scientists at the VII International Economic Forum: Innovations, Investments, Kharkiv initiatives at Kharkiv Palace hotel in Kharkiv, Ukraine on September 4, 2015.

Let us make a final comment by saying that, in the case of the unlimited presence of the information, knowledge and creative integrative thinking around the Globe, we do believe that the new innovative discoveries in the science and technology could be generated by the talented scientists and inventors at any place in our global multi-polar World at any time.

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