Digital DNA of economy of scale and scope

Dimitri O. Ledenyov and Viktor O. Ledenyov

James Cook University, Townsville, Australia

20 January 2016

Online at https://mpra.ub.uni-muenchen.de/68929/
MPRA Paper No. 68929, posted 24 January 2016 11:37 UTC
Digital DNA of economy of scale and scope

Dimitri O. Ledenyov and Viktor O. Ledenyov

Abstract – The research article aims to create a general fundamental theory on the Digital DNA of the modern digital creative economy of the scale and scope. In the frames of our theory, we define the Digital DNA of the modern digital creative economy of the scale and scope, making the following theoretical assumptions: 1) Digital DNA exists in the modern digital creative economy of the scale and scope; 2) Digital DNA consists of a chain of the knowledge with all the information on the modern digital creative economy of the scale and scope; 3) the Digital DNA uniquely identifies and accurately characterizes the modern digital creative economy of the scale and scope in the time, scale, frequency domains; 4) the Digital DNA represents a genetic key, which may help us to better understand the generation of the discrete-time digital business cycles with the different amplitudes, frequencies, shapes and powers in the modern digital creative economy of the scale and scope in the time, scale, frequency domains. In this innovative advanced research, we investigate the following research problems: 1) the existing damaging mechanisms of the Digital DNA’s complex knowledge base structure in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains; 2) the possible repairing mechanisms of the Digital DNA’s complex knowledge base structure in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains; 3) the specific influences by the damaged/repaired Digital DNA on the discrete-time digital business cycles generation/propagation in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains. In addition, the innovative advanced research aims: 1) to perform the computer modeling on the Digital DNA’s complex knowledge base structure in the modern digital creative economy of the scale and scope; 2) to decode the Digital DNA’s complex knowledge base structure in the modern digital creative economy of the scale and scope.

JEL: E32, E43, E44, E53, E58, E61, G18, G21, G28

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

Keywords: Digital DNA, chain of knowledge, Ledenyov discrete-time digital waves, spectrum analysis of discrete-time digital signals, amplitude / frequency / wavelength / period / phase of discrete-time digital signal, continuous time signals, Juglar fixed investment cycle, Kitchin inventory cycle, Kondratieff long wave cycle, Kuznets infrastructural investment cycle, modern digital creative economy, macroeconomics, econometrics, econophysics, macroeconomics.
Introduction


evolutionary development of both the empirical methods in the social sciences and the technical methods in the natural sciences, led to both the better understanding of the fundamental economics science principles and the groundbreaking discovery of the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles) with the different amplitudes, frequencies, shapes and powers in the modern digital creative economy of the scale and scope in the time, scale, frequency domains in Ledenyov D O, Ledenyov V O (2015e, f). Therefore, presently, we know that the Ledenyov discrete-time digital waves can be generated by and propagated in the modern digital creative economy of the scale and scope in the time, scale, frequency domains in Ledenyov D O, Ledenyov V O (2015e, f).

In this connection, the following empirical question may arise: Can we formulate the general fundamental theory on the Digital DNA of the modern digital creative economy of the scale and scope with the purpose to accurately characterize the modern digital creative economy of the scale and scope and predict the generation of the Ledenyov discrete-time digital waves in the modern digital creative economy of the scale and scope? Therefore, this innovative research article aims to create the general fundamental theory on the Digital DNA of the modern digital creative economy of the scale and scope, changing in the time, scale, frequency domains. In the frames of our general fundamental theory, we would like to define the Digital DNA structure in the modern digital creative economy of the scale and scope, making the following theoretical assumptions:

1. the Digital DNA exists in the modern digital creative economy of the scale and scope;
2. the Digital DNA consists of a chain of knowledge on the modern digital creative economy of the scale and scope;
3. the Digital DNA uniquely identifies and accurately characterizes the modern digital creative economy of the scale and scope in the time, scale, frequency domains;
4. the Digital DNA represents a genetic key, which may help us to better understand the generation/propagation of the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles) with the different amplitudes, frequencies, shapes and powers in the modern digital creative economy of the scale and scope in the time, scale, frequency domains.

Moreover, in this innovative advanced research, we aim to investigate the following research problems:

1. the existing damaging mechanisms of the Digital DNA’s complex knowledge base structure in the economies of the scales and scopes in the time, scale, frequency domains;
2. the possible repairing mechanisms of the Digital DNA’s complex knowledge base structure in the economies of the scales and scopes in the time, scale, frequency domains;

3. the specific influences by the damaged/repaired Digital DNA with the complex knowledge base structures on the generation/propagation of the Ledenyov discrete time digital waves of \(GIP(t)/GDP(t)/GNP(t)/PPP(t)\) (the discrete-time digital business cycles) with the different amplitudes, frequencies, shapes and powers in the modern digital creative economy of the scale and scope in the time, scale, frequency domains.

In addition, the innovative advanced research aims to do the following things:

1. to perform the computer modeling the Digital DNA’s complex knowledge base structure of the modern digital creative economy of the scale and scope in the time, scale, frequency domains;

2. to decode the Digital DNA’s complex knowledge base structure of the modern digital creative economy of the scale and scope in the time, scale, frequency domains.

Following the above written introduction, let us begin a more detailed insightful scientific thinking and discussion on the general fundamental theory of the Digital DNA of the modern digital creative economy of the scale and scope, presenting our original research thoughts and ideas on the subject of our scientific interest in this research article.

Digital DNA of modern digital creative economy of scale and scope

We would like to start our empirical philosophical research toward the creation of the general fundamental theory on the Digital DNA of the modern digital creative economy of the scale and scope in the macroeconomics, using the following research plan:

1. Presentation on the overview of available research information on Deoxyribonucleic acid (DNA);

2. Presentation on the original research proposal on the Digital DNA of the modern digital creative economy of the scale and scope;

3. Presentation on the concluding remarks on the Digital DNA of the modern digital creative economy of the scale and scope.

Beginning the discussion on the Deoxyribonucleic acid (DNA) in the biology science, let us explain that the Deoxyribonucleic Acid (DNA) is a molecule, with the complex double helix structure made of the two biopolymer strands in the living cell nuclei, that contains all the biological information in the form of the genetic instructions on how it is possible to develop, function and reproduce the existing living organisms in Miescher (1871), Kol'tsov (December
The Deoxyribonucleic Acid (DNA) in the form of the nuclein substance was discovered by Friedrich Miescher, Swiss physician, University of Tübingen in 1869 in Miescher (1871). The double helix structure of DNA was first discovered by Watson and Crick, University of Cambridge, UK in 1953 in Watson, Crick (1953). The coding scheme for the Deoxyribonucleic Acid (DNA) was proposed in Gamow (July 2 1954a, b, Library of Congress (2015).

Going to the discussion on our original research proposal on the Digital DNA of the modern digital creative economy of the scale and scope, we would like to propose a concise definition of the Digital DNA of the modern digital creative economy of the scale and scope and formulate the general fundamental theory on the Digital DNA of the modern digital creative economy of the scale and scope.

Thus, performing a comparative analogy between the Deoxyribonucleic Acid (DNA) in the biology science and the Digital DNA in the macroeconomics science, let us define the Digital DNA in this empirical philosophical research for the first time: The Digital DNA of the modern digital creative economy of the scale and scope represents an accumulated chain of knowledge, which stores all the information in the form of the “genetic instructions” on how it is possible to develop, function and reproduce the modern digital creative economy of the scale and scope in the time, scale, frequency domains.

Continuing the research on the Digital DNA in the macroeconomics science, let us clarify that, in our opinion, a chain of accumulated knowledge may include all the spectrum of information, which has been created, exchanged, transmitted and stored by the humans in the natural sciences databases, the social sciences databases, the numerous encyclopedia databases, the intellectual properties databases, the technological standards databases at the governments, universities, institutions, colleges, schools, firms, governmental organizations, non-governmental organizations, cultural organizations, religious organizations within the particular modern digital creative economy of the scale and scope in the time, scale, frequency domains.

Let us consider the possible damaging mechanisms of the Digital DNA’s complex knowledge base structure in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains. In our research opinion, the Digital DNA’s complex knowledge base structure can be severely damaged by the bad governance practices at the governments, universities, institutions, colleges, schools, firms, governmental organizations, non-governmental organizations, cultural organizations, religious organizations at the
state/province/city/district/organization levels, resulting in a possible disappearance of the
certain knowledge in various sectors of the modern digital creative economies of the scales
and scopes in the time, scale, frequency domains. For example, the bad governance practices
may include the failing strategies creation and execution by the presidents/prime
ministers/ministers/governors/chairmen/directors/managers at the governments, universities,
institutions, colleges, schools, firms, governmental organizations, non-governmental
organizations, cultural organizations, religious organizations at the
state/province/city/district/organization levels, resulting in a possible disappearance of the
certain knowledge in various sectors of the modern digital creative economies of the scales and
scopes in the time, scale, frequency domains.

Let us describe the possible repairing mechanisms of the Digital DNA’s complex
knowledge base structure in the modern digital creative economies of the scales and scopes in
the time, scale, frequency domains. In our view, the Digital DNA’s complex knowledge base
structure can be partly/completely repaired by the good governance practices at the
governments, universities, institutions, colleges, schools, firms, governmental organizations,
non-governmental organizations, cultural organizations, religious organizations at the
state/province/city/district/organization levels, resulting in a possible appearance of the certain
knowledge in various sectors of the modern digital creative economies of the scales and scopes
in the time, scale, frequency domains. For instance, the good governance practices may include
the winning virtuous strategies creation and execution by the presidents/prime
ministers/ministers/governors/chairmen/directors/managers at the governments, universities,
institutions, colleges, schools, firms, governmental organizations, non-governmental
organizations, cultural organizations, religious organizations at the
state/province/city/district/organization levels, resulting in a possible appearance of the certain
knowledge in various sectors of the modern digital creative economies of the scales and scopes
in the time, scale, frequency domains.

Let us comment that a number of insightful discussions on the existing distinctions
between the failing strategies and the winning virtuous successful strategies, which can be
created and implemented in the governance/management practices can be found in Chandler
(2004), Anand, Bradley, Ghemawat, Khanna, Montgomery, Porter, Rivkin, Rukstad, Wells,

Going to the next problem, let us identify the specific influences by the damaged/repaired Digital DNA on the discrete-time digital business cycles generation/propagation in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains. The authors’ strategic vision is that the damaged/repaired Digital DNA may have the specific influences on the generation/propagation of the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles of GIP(t)/GDP(t)/GNP(t)/PPP(t)) in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains. For example, the damaged/repaired Digital DNA may result in the generation and propagation of the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles of GIP(t)/GDP(t)/GNP(t)/PPP(t)) with the small/big amplitudes, low/high frequencies, different phases in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains. The main reason for the above mentioned facts existence is that the damaged/repaired Digital DNA can decrease/increase the outputs by the real sector and by the speculative sectors of the modern digital creative economies of the scales and scopes in the time, scale, frequency domains. The more comprehensive description of the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles of GIP(t)/GDP(t)/GNP(t)/PPP(t)) is presented in Ledenyov D O, Ledenyov V O (2015e, f).
Presently, the authors’ research efforts are mainly focused on the following two research problems in the macroeconomics science:

1. the computer modeling the Digital DNA’s complex knowledge base structure of the modern digital creative economy of the scale and scope in the time, scale, frequency domains;
2. the understanding of the coding/decoding schemes for the Digital DNA’s complex knowledge base structure in the modern digital creative economy of the scale and scope in the time, scale, frequency domains.

We report a successful development of the complex software program, **DNACode**, to model the existing Digital DNAs of the G20 economies of the scales and scopes for the first time. The complex software program can code/decode the Digital DNA’s complex knowledge base structure, researching any selected economy of the scale and scope in the case of the G20 nations. It may worth to note that the complex software program can accurately forecast the generation/propagation of the Ledenyov discrete time digital waves of \(GIP(t)/GDP(t)/GNP(t)/PPP(t)\) (the discrete-time digital business cycles of \(GIP(t)/GDP(t)/GNP(t)/PPP(t)\)) in the G20 economies of the scales and scopes.

**Conclusion**

The research article had a goal to create a general fundamental theory on the Digital DNA of the modern digital creative economy of the scale and scope. In the frames of our theory, we defined the Digital DNA of the modern digital creative economy of the scale and scope, making the following theoretical assumptions:

1. Digital DNA exists in the modern digital creative economy of the scale and scope;
2. Digital DNA consists of a chain of knowledge with all the information on the modern digital creative economy of the scale and scope;
3. Digital DNA uniquely identifies and accurately characterizes the modern digital creative economy of the scale and scope in the time, scale, frequency domains;
4. Digital DNA represents a genetic key, which may help us to better understand the generation of the discrete-time digital business cycles with the different amplitudes, frequencies, shapes and powers in the modern digital creative economy of the scale and scope in the time, scale, frequency domains.

In this innovative advanced research, we investigated the following research problems:
1. the existing damaging mechanisms of the Digital DNA’s complex knowledge base structure in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains;

2. the possible repairing mechanisms of the Digital DNA’s complex knowledge base structure in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains;

3. the specific influences by the damaged/repaired Digital DNA on the discrete-time digital business cycles generation/propagation in the modern digital creative economies of the scales and scopes in the time, scale, frequency domains.

In addition, the innovative advanced research aimed:

1. to perform the computer modeling on the Digital DNA’s complex knowledge base structure in the modern digital creative economy of the scale and scope;

2. to decode the Digital DNA’s complex knowledge base structure in the modern digital creative economy of the scale and scope.

Finally, the present research article had an ultimate goal to continue our scientific exploration on the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles of GIP(t)/GDP(t)/GNP(t)/PPP(t)), which constitute a new class of the discrete-time digital waves in the economies of scale and scope in the macroeconomics science.

Particularly, the present research article aimed to continue to study the following early outlined research topics:

1. the re-thinking of the foundations of macroeconomic theory, introducing the scientific proposition about the digital nature of the business cycles, which can be originated by the discrete-time fluctuations such as the creative disruptive innovations in the economies of the scales and scopes;

2. the creation of the Ledenyov discrete time digital signals theory to precisely characterize the discrete time digital signals (the business cycles) in the macroeconomics;

3. the modeling of new types of the discrete-time digital signals generators for the business cycles origination in the macroeconomics;

4. the analysis the spectrum of discrete-time digital signals in the economies of scale and scope;

5. the demonstration of the technical differences between the new model of the discrete-time digital signals generator and the existing models of the continuous-time (continuous wave) signals generators in the macroeconomics; and
6. The development of the complex software program DNACode to forecast the business cycles, going from the spectral analysis of the discrete time digital signals and the continuous time signals in the nonlinear dynamic economic system over the selected time period.

Acknowledgement

The scientific thinking school in Bunyakovsky (1825a, b, c, 1846) influenced the authors’ strategic scientific vision creation and helped to develop the authors’ tactical approaches to the scientific problems solutions search. The authors acknowledge the multiple scientific discussions on the Digital DNA with Oleg P. Ledenyov in Kharkiv, Ukraine in 1988 – 2016. The first author appreciates many hours of the research discussions on the computing modeling techniques for the accurate characterization of the scientific phenomena with Janina E. Mazierska at James Cook University in Townsville, Australia in 2000 - 2016.

*E-mails: dimitri.ledenyov@my.jcu.edu.au, ledenyov@univer.kharkov.ua.
References:

Economics Science, Finance Science, Economic History Science:


5. Bagehot W 1873, 1897 Lombard Street: A description of the money market Charles Scribner's Sons New York USA.


10. Schumpeter J A 1933 The common sense of econometrics Econometrica.


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

17. von Mises L 1912 The theory of money and credit *Ludwig von Mises Institute* Auburn Alabama USA


22. Ellis H, Metzler L (editors) 1949 Readings in the theory of international trade *Blakiston Philadelphia* USA.

23. Friedman M (editor) 1953 Essays in positive economics *Chicago University Press* Chicago USA.


    http://www.bard.edu/library/archive/minsky/.


31. Stiglitz J E 2015 The great divide *Public Lecture on 19.05.2015* London School of Economics and Political Science London UK


**Juglar Economic Cycle:**


**Kondratiev Economic Cycle:**


37. Kondratieff N D 1925 The big cycles of conjuncture *The problems of conjuncture* 1 (1) pp 28 – 79.


41. Kondratieff N D 1984 The Long wave cycle *Richardson & Snyder* New York USA.


52. Van Duijn J J 1979 The long wave in economic life *De Economist* 125 (4) pp 544 – 576.
54. Van Duijn J J 1983 The long wave in economic life *Allen and Unwin* Boston MA USA.
58. Tinbergen J 1981 Kondratiev cycles and so-called long waves: The early research *Futures* 13 (4) pp 258 – 263.

63. Wallerstein I 1984 Economic cycles and socialist policies *Futures* 16 (6) pp 579 – 585.


67. Freeman C, Louçã F 2001 As time goes by: From the industrial revolutions to the information revolution *Oxford University Press* Oxford UK.

68. Goldstein J 1988 Long cycles: Prosperity and war in the modern age *Yale University Press* New Haven CT USA.


70. Berry B J L 1991 Long wave rhythms in economic development and political behavior *Johns Hopkins University Press* Baltimore MD USA.


74. Tylecote A 1992 The long wave in the world economy *Routledge* London UK.


76. Modelski G, Thompson W R 1996 Leading sectors and world politics: The co-evolution of global politics and economics *University of South Carolina Press* Columbia SC USA.


79. Perez C 2002 Technological revolutions and financial capital – The dynamics of bubbles and golden ages *Edward Elgar* Cheltenhem UK.


**Kitchin Economic Cycle:**


**Kuznets Economic Cycle:**

89. Kuznets S 1924 Economic system of Dr. Schumpeter *M. Sc. Thesis under Prof. Wesley Clair Mitchell* Columbia University NY USA.

90. Kuznets S 1930 Secular movements in production and prices *Ph. D. Thesis under Prof. Wesley Clair Mitchell* Columbia University NY USA.
91. Kuznets S 1930 Secular movements in production and prices. Their nature and their bearing upon cyclical fluctuations *Houghton Mifflin* Boston USA.


96. Kuznets S 1966 Modern economic growth: Rate, structure, and spread.

97. Kuznets S 1968 Toward a theory of economic growth, with reflections on the economic growth of modern nations.

98. Kuznets S 1971 Economic growth of nations: Total output and production structure.


Accurate Characterization of Properties of Economic Cycles:


118. Hicks J R 1950 A contribution to the theory of the trade cycle Oxford University Press Oxford UK.


120. Inada K, Uzawa H 1972 Economical development and fluctuations Iwanami Tokyo Japan.


137. Sussmuth B 2003 Business cycles in the contemporary World *Springer* Berlin Heidelberg Germany.


143. Jourdon Ph 2008 La monnaie unique Europeenne et son lien au developpement economique et social coordonne: une analyse cliometrique *Thèse Universite Montpellier* France.

144. Taniguchi M, Bando M, Nakayama A 2008 Business cycle and conserved quantity in economics *Journal of the Physical Society of Japan* vol 77 no 11.


**Disruptive Innovation in Technology, Economics and Finances:**

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


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

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


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


195. Shah Ch D, Brennan T A, Christensen C M April 2003 Interventional radiology: Disrupting invasive medicine.
196. Christensen C M March April 2003 Beyond the innovator's dilemma *Strategy & Innovation* 1 no 1.


207. Dyer J H, Gregersen H B, Christensen C M 2011 The innovator's DNA: Mastering the five skills of disruptive innovators *Harvard Business Press* Boston MA USA.


211. Christensen C M, Denning St December 2015 Disruptive innovation *Forbes* New York USA


1243. Dobbs R, Woetzel J, Flanders St 2015 No ordinary disruption: The four global forces breaking all the trends *Public Lecture on 08.06.2015* London School of Economics and Political Science London UK


**Strategy Science, Strategic Governance Science, Management Science:**


222. Andrews K R 1971a The concept of corporate strategy Richard D Irwin Homewood USA.


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


240. Porter M E May 1987a The state of strategic thinking Economist London UK.


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


Huff A S, Reger R K 1987 A review of strategic process research *Journal of Management* vol **13** no 2 p 211.


284. Yip G 1992 Total global strategy: Managing for worldwide competitive advantage *Prentice Hall* NY USA.


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

298. Martin R L 2004 Strategic choice structuring: A set of good choices positions a firm for competitive advantage *Rotman School of Management* University of Toronto Canada pp 1 – 14


301. Martin R L 2008 The opposable mind *Harvard Business Press* Cambridge Massachusetts USA.


304. Martin R L 2013 Strategy award *Thinkers50* London UK
www.thinkers50.org.


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

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


www.blueoceanstrategy.com ,


323. Murphy T, Galunic Ch 2007 Leading in the age of talent wars INSEAD Leader-casts INSEAD France.


328. Sull D 2007d Closing the gap between strategy and execution: The strategy loop in action Public Lecture London School of Economics and Political Science London UK.

329. Sull D 2008 An iterative approach to the strategy Public Lecture London School of Economics and Political Science London UK.


332. Chamberlain G P 2010 Understanding strategy Create Space Charleston South Carolina USA.


337. Ledenyov D O, Ledenyov V O 2015n Quantum strategy creation by interlocking interconnecting directors in boards of directors in modern organizations at time of globalization MPRA Paper no 68404 Munich University Munich Germany, SSRN Paper no SSRN-id2704447 Social Sciences Research Network New York USA pp 1 – 104 http://mpra.ub.uni-muenchen.de/68404/ ,
338. Ledenyov D O, Ledenyov V O 2015 Multivector strategy vs quantum strategy by Apple
Inc MPRA Paper no 68730 Munich University Munich Germany, SSRN Paper no SSRN-
id2707662 Social Sciences Research Network New York USA pp 1 – 109

http://mpra.ub.uni-muenchen.de/68730/

**Probability Theory, Statistics Theory, Spectrum Analysis Theory, Brownian Movement**

**Theory, Diffusion Theory, Chaos Theory, Information Communication Theory in**

**Econometrics and Econophysics Sciences:**


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

341. Bernoulli D 1738, 1954 Specimen theoria novae de mensura sortis Commentarii

Academiae Scientiarum Imperialis Petropolitanae Petropoli vol 5 pp 175 – 192; Exposition

of a new theory on the measurements of risk Sommer L (translator) Econometrica vol 22 pp

23 – 36.

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

343. Fourier J-B J 1807-1822, 1878, 2009 Théorie Analytique de la Chaleur Firmin Didot,


344. Fourier J-B J 1824 Mémoires de l'Académie Royale des Sciences de l'Institut de France

VII pp 570 – 604

http://www.academie-

sciences.fr/activite/archive/dossiers/Fourier/Fourier_pdf/Mem1827_p569_604.pdf.


346. Bunyakovsky V Ya 1825a Rotary motion in a resistant medium of a set of plates of

constant thickness and defined contour around an axis inclined with respect to the horizon

Ph D Thesis no 1 under Prof. Augustin - Louis Cauchy supervision École Polytechnique

Paris France.

347. Bunyakovsky V Ya 1825b Determination of the radius-vector in elliptical motion of

planets Ph D Thesis no 2 under Prof. Augustin - Louis Cauchy supervision École Polytechnique

Paris France.


349. Bunyakovsky V Ya 1846 Foundations of the mathematical theory of probability

St. Petersburg Russian Federation.
Connor J J, Robertson E F July 2000 Viktor Yakovlevich Bunyakovsky (December 16, 1804 - December 12, 1889) School of Mathematics and Statistics University of St Andrews Scotland UK
http://www-history.mcs.st-andrews.ac.uk/Biographies/Bunyakovsky.html.

V Ya Bunyakovsky International Conference (August 20 - 21) 2004 Private communications with conference participants on V Ya Bunyakovsky’s mathematical theory of probability and its applications in econophysics and econometrics during a tour to Town of Bar Vinnytsia Region Ukraine V Ya Bunyakovsky International Conference Institute of Mathematics of National Academy of Sciences of Ukraine (NASU) Kyiv Ukraine www.imath.kiev.ua/~syta/bunya.

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


Markov A A 1900, 1912, 1913 Calculation of probabilities St Petersburg Russian Federation; Wahrscheinlichkeits-Rechnung Teubner Leipzig-Berlin Germany; 3rd edition St Petersburg Russian Federation.

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


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


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


376. Slutsky E E 1922b To the question of logical foundations of probability calculation *Statistics Bulletin* 9 - 12 pp 13 – 21.


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


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


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


414. Mandelbrot B B 1967a The variation of some other speculative prices Joural of Business vol 40 pp 393 – 413.
424. Mandelbrot B B 1977 Fractals: Form, chance and dimension *W H Freeman* San Francisco USA.

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


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


41


469. Lamperti J 1966 Probability Benjamin New York USA.


475. Breiman L 1968 Probability Addison-Wesley Reading MA USA.


482. Box G E P, Jenkins G M 1970 Time series analysis: Forecasting and control Holden Day San Francisco California USA.
Irwin Homewood USA.
503. Taylor S 1986 Modeling financial time series *John Willey and Sons Inc* New York USA.
504. Tong H 1986 Nonlinear time series *Oxford University Press* Oxford UK.
505. Tornqvist L, Vartia P, Vartia Y February 1985 How should relative change be measured?
506. Sharkovsky A N, Maistrenko Yu L, Romanenko E Yu 1986 Differential equations and
their applications *Naukova Dumka* Kiev Ukraine pp 1 – 280.
507. Newey W, West K 1987 A simple positive semi-definite, heteroskedasticity and
autoregressive models *Biometrika* 75 pp 491 – 499.
practice of econometrics 2nd edition *John Wiley and Sons Inc* New York USA.
510. Hardle W 1990 Applied nonparametric regression *Econometric Society Monograph*
*Cambridge University Press* Cambridge UK.
511. Lancaster T 1990 The econometric analysis of transition data *Cambridge University Press*
Cambridge UK.
512. Tong H 1990 Nonlinear time series: A dynamical system approach *Clarendon Press*
Oxford UK.
513. Johansen S 1992 Cointegration in partial systems and the efficiency of single equation
514. Banerjee A, Dolado J J, Galbraith J W, Hendry D F 1993 Cointegration, error correction,
and the econometric analysis of nonstationary data *Oxford University Press* Oxford UK.
515. Cleveland W S 1993 Visualizing data *Hobart Press* Summit New Jersey USA.
516. Pesaran M H, Potter S M (editors) 1993 Nonlinear dynamics, chaos and econometrics
*John Willey and Sons Inc* New York USA.
518. Peters E E 1994 Fractal market analysis: Applying chaos theory to investment and
economics *John Wiley and Sons Inc* New York USA.
USA.


523. Moore G E 2003 No exponential is forever – but we can delay forever ISSCC.


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


534. Teolis A 1998 Computational signal processing with wavelets Birkhauser Switzerland.


541. Hayashi F 2000 Econometrics *Princeton University Press* Princeton NJ USA.
547. Tufte E R 2001 The visual display of quantitative information 2nd edition *Graphics Press* Cheshire CT USA.
554. Cameron A C, Trivedi P K 2005 Microeconometrics: Methods and applications *Cambridge University Press* Cambridge UK.

**Selected Research Papers in Macroeconomics, Microeconomics & Nanoeconomics Sciences:**

562. Ledenyov V O, Ledenyov D O 2012a Shaping the international financial system in century of globalization *Cornell University* NY USA pp 1 – 20
563. Ledenyov V O, Ledenyov D O 2012b Designing the new architecture of international financial system in era of great changes by globalization *Cornell University* NY USA pp 1 – 18
565. Ledenyov D O, Ledenyov V O 2012b On the risk management with application of econophysics analysis in central banks and financial institutions *Cornell University* NY USA pp 1 – 10
566. Ledenyov D O, Ledenyov V O 2013a On the optimal allocation of assets in investment portfolio with application of modern portfolio management and nonlinear dynamic chaos
theories in investment, commercial and central banks *Cornell University* NY USA pp 1 – 34


568. Ledenyov D O, Ledenyov V O 2013c On the accurate characterization of business cycles in nonlinear dynamic financial and economic systems *Cornell University* NY USA pp 1 – 26

569. Ledenyov D O, Ledenyov V O 2013d To the problem of turbulence in quantitative easing transmission channels and transactions network channels at quantitative easing policy implementation by central banks *Cornell University* NY USA pp 1 – 40

570. Ledenyov D O, Ledenyov V O 2013e To the problem of evaluation of market risk of global equity index portfolio in global capital markets *MPRA Paper no 47708* Munich University Munich Germany pp 1 – 25
http://mpra.ub.uni-muenchen.de/47708/ .

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

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

http://mpra.ub.uni-muenchen.de/51176/ ,


579. Ledenyov D O, Ledenyov V O 2014e MicroFX foreign currencies ultra high frequencies trading software platform with embedded optimized Stratonovich – Kalman - Bucy filtering
algorithm, particle filtering algorithm, macroeconomic analysis algorithm, market microstructure analysis algorithm, order flow analysis algorithm, comparative analysis algorithm, and artificial intelligence algorithm for near-real-time decision making / instant switching on / between optimal trading strategies. 

ECE James Cook University Townsville Australia, Kharkov Ukraine.

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

ECE James Cook University Townsville Australia, Kharkov Ukraine.


http://mpra.ub.uni-muenchen.de/61681/ ,


http://mpra.ub.uni-muenchen.de/63380/ ,


http://mpra.ub.uni-muenchen.de/63565/ ,
585. Ledenyov D O, Ledenyov V O 2015e On the spectrum of oscillations in economics
http://mpra.ub.uni-muenchen.de/64368/,

http://mpra.ub.uni-muenchen.de/64755/,

http://mpra.ub.uni-muenchen.de/64991/,

http://mpra.ub.uni-muenchen.de/65566/,

http://mpra.ub.uni-muenchen.de/66577/,

http://mpra.ub.uni-muenchen.de/67010/,

http://mpra.ub.uni-muenchen.de/67162/,
http://mpra.ub.uni-muenchen.de/67470/ ,

593. Ledenyov D O, Ledenyov V O 2015m Quantum money MPRA Paper no 67982 Munich University Munich Germany, SSRN Paper no SSRN-id2693128 Social Sciences Research Network New York USA pp 1 – 70
http://mpra.ub.uni-muenchen.de/67982/ ,

http://mpra.ub.uni-muenchen.de/68404/ ,

http://mpra.ub.uni-muenchen.de/68730/ ,

596. Ledenyov D O, Ledenyov V O 2015p MicroID software program with the embedded optimized near-real-time artificial intelligence algorithm to create the winning virtuous business strategies and to predict the director’s election / appointment in the boards of directors in the firms, taking to the consideration both the director’s technical characteristics and the interconnecting interlocking director’s network parameters in conditions of the resonant absorption of discrete information in diffusion - type financial economic system with induced nonlinearities ECE James Cook University Townsville Australia, Kharkov Ukraine.

597. Ledenyov D O, Ledenyov V O 2015t MicroITF operation system and software programs: 1) the operation system to control the firm operation by means of the information resources near-real-time processing in the modern firms in the case of the diffusion - type financial
economic system with the induced nonlinearities; 2) the software program to accurately characterize the director’s performance by means of a) the filtering of the generated/transmitted/received information by the director into the separate virtual channels, depending on the information content, and b) the measurement of the levels of signals in every virtual channel with the generated/transmitted/received information by the director, in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms during the Quality of Service (QoS) measurements process; and 3) the software program to create the winning virtuous business strategies by the interlocking interconnecting directors in the boards of directors in the modern firms in the case of the diffusion - type financial economic system with the induced nonlinearities, using the patented recursive artificial intelligence algorithm ECE James Cook University Townsville Australia, Kharkov Ukraine.

598. Ledenyov D O, Ledenyov V O 2015s MicroIMF software program: the MicroIMF software program to make the computer modeling of 1) the interactions between the information money fields of one cyclic oscillation and the information money fields of other cyclic oscillation(s) in the nonlinear dynamic economic system, 2) the interactions between the information money fields of cyclic oscillation and the nonlinear dynamic economic system itself, and 3) the density distributions of the information money fields by different cyclic oscillations (the economic continuous waves) in the nonlinear dynamic economic system ECE James Cook University Townsville Australia, Kharkov Ukraine.

599. Ledenyov D O, Ledenyov V O 2015t MicroSA software program 1) to perform the spectrum analysis of the cyclic oscillations of the economic variables in the nonlinear dynamic economic system, including the discrete-time signals and the continuous-time signals; 2) to make the computer modeling and to forecast the business cycles for a) the central banks with the purpose to make the strategic decisions on the monetary policies, financial stability policies, and b) the commercial/investment banks with the aim to make the business decisions on the minimum capital allocation, countercyclical capital buffer creation, and capital investments ECE James Cook University Townsville Australia, Kharkov Ukraine.

600. Ledenyov D O, Ledenyov V O 2015i DNACode software program 1) to model the Digital DNA’s complex knowledge base structure for the selected economy of the scale and scope in the case of the G20 nations; 2) to accurately forecast the generation/propagation of the Ledenyov discrete time digital waves of GIP(t)/GDP(t)/GNP(t)/PPP(t) (the discrete-time digital business cycles of GIP(t)/GDP(t)/GNP(t)/PPP(t)) in the G20 economies of the scales and scopes ECE James Cook University Townsville Australia, Kharkov Ukraine.
Deoxyribonucleic acid (DNA):


602. Kol'tsov N K December 12, 1927 The physical-chemical basis of morphology 3rd All-Union Meeting of Zoologist, Anatomists, and Histologists Leningrad USSR.


Continuous Time Signal, Analog Signals, Discrete Time Signal, Digital Signals, Spectrum of Signals, Electromagnetic Field, Gravitation Field, Calibrating Field, Information Field Theories in Physics and Engineering Sciences:
612. Maxwell J C 1890 Introductory lecture on experimental physics in Scientific papers of J C Maxwell Niven W D (editor) vols 1, 2 Cambridge UK.


614. Walsh J L 1923b A property of Haar’s system of orthogonal functions Math Ann 90 p 3845.


   http://cm.bell-labs.com/cm/ms/what/shannonday/paper.html.

   CiteSeerX: 10.1.1.154.2879
   http://dx.doi.org/10.1016%2FS0019-9958%2859%2990376-6


   http://dx.doi.org/10.1109%2FT-C.1972.223524.


625. Fountain T 1987 Processor arrays, architecture and applications Academic Press London UK.

626. Chen C H (editor) 1988 Signal processing handbook Marcel Dekker New York USA.
643. Wikipedia 2015h Hadamard code Wikipedia USA