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CONVERGENCE OF NBIC-TECHNOLOGIES AS A KEY FACTOR IN THE SIXTH TECHNOLOGICAL ORDER' DEVELOPMENT OF THE WORLD ECONOMY

Igor Matyushenko, PhD in Technical Sciences, Professor,
Olena Khanova, PhD in Geography, Associated Professor,

Department of Foreign Economic Relations and Touristic Business,
V.N. Karazin Kharkiv National University, Kharkiv, Ukraine

Abstract: *The article highlights the basic model of economic development; attention is focused on industrial and postindustrial types of the economy. Basic factors of catch-up and advanced development' economies are justified, i.e. copying, borrowing, cooperation, innovation and self-reliance. Authors analyze the historical preconditions of socio-economic development' relations in the world economy with the hypothesis of Kondratiev's long waves, Schumpeter's theory of innovation and dissemination of technical and economic paradigms that reflect a certain level of scientific knowledge and potential market penetration. Periodization and the main characteristics of the six waves of innovative development of the world economy are determined, including the perspectives for social and economic development for the 2030-2080. The author's vision of the structure of sixth technological order of the world economy is presented. The perspectives of the NBIC-technologies convergence are described that could lead to revolutionary changes in the industry, economy and social structure.*

Keywords: *economic development models, NBIC-technologies convergence, technological order of the world economy.*

INTRODUCTION

The aim of any technological innovation is to improve or "enrichment" conditions of human existence and the challenges facing humanity in general. There are many economic theories, which are an forecasting attempt to socio-economic development of society.

One of the first economists who proposed the historical periodization of economic life according to wavelength (cycles) approximately fifty years, was M. Kondratiev [12-13]. His ideas were developed by the Austrian-American economist J. Schumpeter, who was taking Kondratyev's approach as a base, insisted on innovative nature of long cycles [25-26]. J. Schumpeter identified five types of innovation and developed Kondratiev's hypothesis, recognizing the unique nature of each cycle and presenting economic development as a sequence of ascending pulsations caused by the spread of the corresponding clusters of interrelated innovations.

MATERIALS AND METHODS

Content analysis has been used as the main method of research, which allowed to make a meaningful analysis of classic papers and researches of modern economists-theorists and practitioners devoted to the peculiarities of the innovative component of the world economy.

RESULTS

It should be noted that the most widely used theories of Western specialists on the futurology and postindustrial society theory are researches of D. Bell, P. Drucker, J. Galbraith, F. Fukuyama, L. Thurow and M. Castells. Three main types of economy have been described in these works, i.e. pre-industrial, industrial and postindustrial.

There is a large number of economic development models according to the types of economies. They are shown in *Figure 1* [3, 10-11, 17, 20, 22]. As *Figure 1* shows, the industrial order is characterized by a catching-up model of the economy by means of copying, borrowing or self-reliance. In turn, postindustrial order is characterized by an advanced model of the economy with the help of cooperation, innovation or self-reliance.

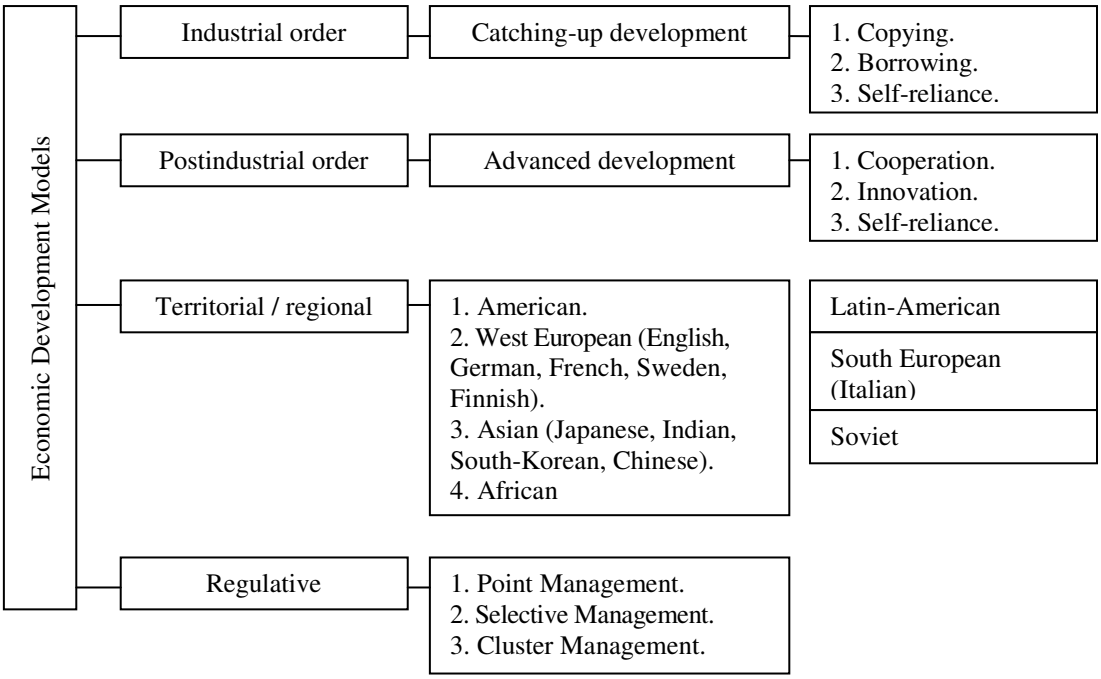

Figure 1: Main economic development models

Source: created by authors

The experience of Japan, South Korea, Taiwan, Finland and Ireland shows that the path of intensive borrowing of advanced technological expertise can be used successfully for serious breakthrough and transformation in rich countries and then a gradual transition to own innovative activity might be appropriate.

Most of the results obtained in the modern long waves theory confirms the fact that the nature of the 200-year socio-economic development in the world economy is correlated with the long waves' hypothesis [6, 7, 21]. Understanding of long waves as a change and dissemination of technical and economic paradigms was the most influential. Technological paradigm is defined as a dominant sphere of problems solving, usage of dominant procedures and methods, a set of principles derived from already achieved level of scientific knowledge, i.e. paradigm accompanied by the spread of basic technologies clusters.

Radical innovations in the middle of each new technological paradigm have a high potential of the market penetration. As J. Schumpeter showed their implementation provides an entrepreneurs' additional profit. This profit stimulates massive capital investments in new technologies that over time bring the growing mass of additional profit. It is capitalized again in the favor of new high-performance facilities expansion. At the same time there is the implementation of various innovations, as well as economies of scale and increase economic efficiency. Thus, the establishment of a new technological paradigm is a spread of new productions along with the increase of their efficiency during the next long-wave expansion.

If the duration of the fifth, as well as other cycles will be approximately 50 years, then the maturity stage of technologies that form it still ahead. At the same time, in the fifth cycle (as in the previous ones) the contours of the new sixth order are beginning to form.

The first global informational crisis took place in 2001-2002. It was at this time the technology's development of the first generation of the sixth technological order began. The authors proposed a structure of the sixth technological order (*Figure 2*), which clearly highlights the key factors, radical (basic) technologies of order core and bearing industries.

Table 1 reflects periodization and main characteristics of major waves of innovative development according to M. Kondratiev, J. Schumpeter, K. Freeman and S. Glaz'ev [4, 6-7, 12-13, 21, 25-26] and characterizes a number of point of experts' view [5, 8-9, 11, 14-16, 23-24, 27-32] and the author's view to the perspectives of the socio-economic development for 2030-2080 [18-19].

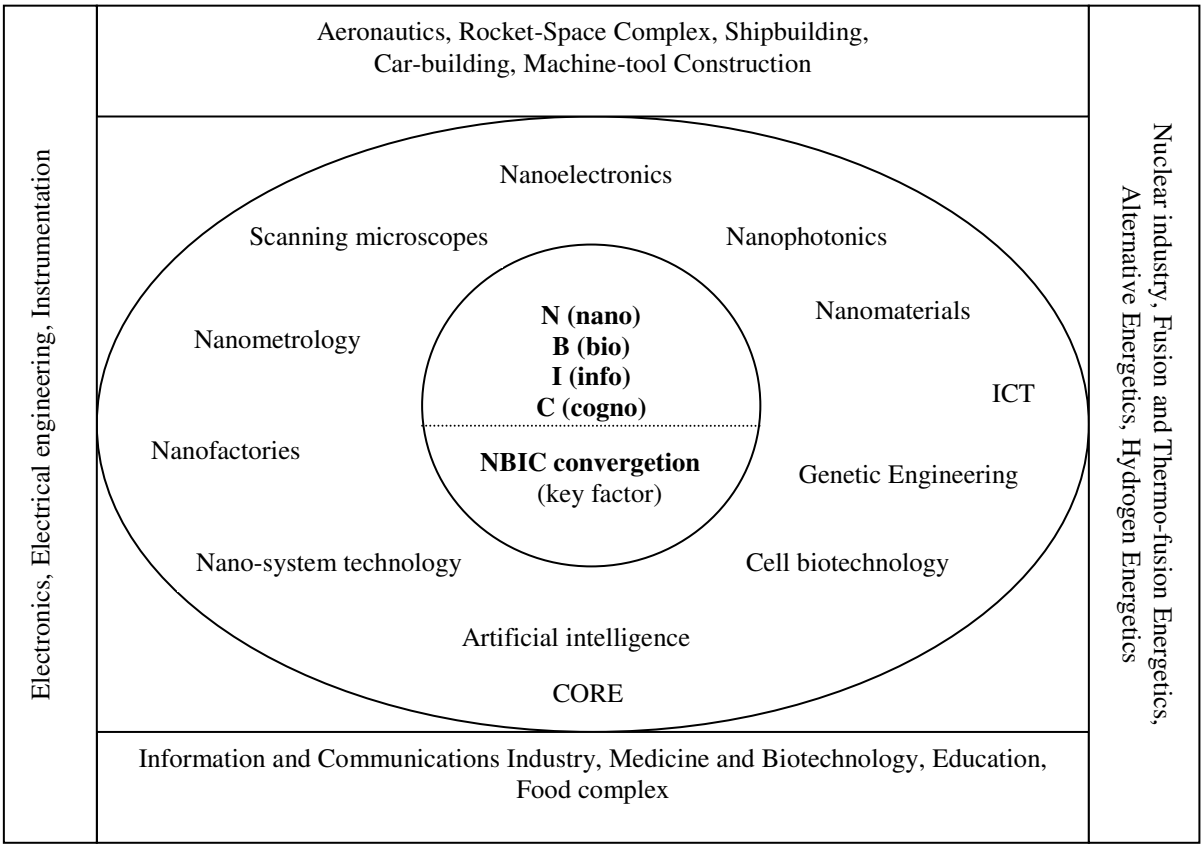

Figure 2: The structure of the sixth technological order

Source: created by authors

World leading experts believe that a core's key factor will become the convergence of NBIC-technologies (*Figure 2*).

The core of the technological order will be formed by nanomaterials, nanoelectronics, nanophotonics, scanning nanotechnique, nanometrology, nanofactories, nano-system technology, genetic engineering, cell biotechnology, ICT and artificial intelligence. The leading sectors will become aeronautics and space-rocket complex; electronics, electrical engineering and instrumentation; information and communications industry; education; nuclear industry; fusion and thermo-fusion energetics; alternative and hydrogen energetics; shipbuilding, car-building and machine-tool construction; chemical and metallurgical complex; food complex.

DISCUSSION AND CONCLUSIONS

The influence of technological innovations on the society economic development manifests itself in the fact that they provide periodic innovative renovation of goods and services productions, as well as the material base of society. As part of the fifth order (as in previous ones), the contours of the new sixth order start to develop that will be a core's key factor of the NBIC-technologies convergence. The core of the sixth technological order will be formed by nanomaterials, nano electronics, nanophotonics, scanning nanotechnique, nano-system technology, nanometrology, nanofactories, genetic engineering, cell biotechnology, ICT and artificial intelligence. The convergence of NBIC-industries will solve effectively and at a qualitatively new level the global problems of humanity.

REFERENCES

1. Antonenko, L.A. (2002), Common and specific in the national economic transformation models, in monograph; *Ekonomicheskaya teoriya na poroge XXI veka* [Economic theory on the border XXI century], Book 1, Edited by Yu. Osipov, V. Chekmarev, E. Zotova, Yurist', Moscow, Russian Federation, pp. 455-461.

Table 1

Periodization of the major waves of innovative development

Wavelength / cycles			Status of Science and Education	Infrastructure		Universal resource
Time frame	Leading countries	Cycle characteristics		Transport and communications	Energy	
First 1780-1840	Belgium, UK, France	Industrial Revolution, factory production of textiles	Learning in the workplace, universities, and scientific communities	Channels and dirt roads	Water power	Cotton
Second 1840-1890	France, Belgium, UK, USA, Germany	Cycle of steam and railways	Mass primary education, first technical colleges, engineers	Railroads, telegraph	Stream energy	Coal, iron
Third 1890-1940	France, USA, UK, Germany	Cycle electricity and steel	First scientific laboratories in corporations, technical standards	Railroads, telephone	Electricity	Steel
Fourth 1940-1980	USA, Europe, Japan	Cycle cars and synthetic materials	Rapid growth in corporations and public sector, mass access to higher education	Motorway, airlines, radio and television	Oil	Oil, plastics
Fifth 1990-2030 (forecast)	USA, Japan, EU, Southeast Asia	Information and communications (computer) revolution (I)	Global scientific researches, i.e. network, lifelong education and vocational training	Informational Networks, Internet	Gas / oil, nuclear energy	Microelectronics, semiconductors
Sixth 2030-2080 (forecast)*	USA, Japan, EU, China, Southeast Asia, Russia, India, Brazil	Nanotechnology (N) and biotechnology (B) revolution and rapid development of the cognitive science (C)	NBIC-technologies convergence, global services market, network research and innovation systems	Integrated information systems and telecommunications, mobile internet, broadband access	Hydrogen and thermonuclear energy	Nano-electromechanical systems, bioprocessor, devices with direct access to the neurons*

Source: created by authors

2. Bliznyuk, T.P. (2008), *Vpliv tsiklichnosti rozvitku ekonomiki na innovatsiynu diyalnist' pidpriemstva* [Cyclical impact of economic development on the enterprises' innovative activity], monograph, LLC Aleksandrova, Kharkov, Ukraine, 352 p.

3. Filipenko, A.S. (2006), *Ekonomichniy rozvitok suchasnoyi tsivilizatsiyi* [Economic development of modern transformation], textbook, Ed. 3, Znannya Ukrayini, Kiev, Ukraine, 316 p.

4. Freeman C., Clark J. and Soete L. (1982), Unemployment and Technical Innovation: A Study of Law, St.-Petersburg, pp. 15-20.

5. Geets, V.M. and Seminozhenko V.P. (2006), *Innovatsiyni perspektivi Ukrayini* [Innovative perspectives of Ukraine], Konstanta, Kharkov, Ukraine, 272 p.

6. Glaz'ev, S.Yu. (1998), *Genotsid* [Genocide], TERRA, Moscow, Russian Federation, 320 p.

7. Glaz'ev, S.Yu. (1993), *Teoriya dolgosrochnogo tehniko-ekonomicheskogo razvitiya* [Theory of long-term technical and economic development], Vladar, Russian Federation, 456 p.

8. Golichenko, O.G. (2006), *Natsionalnaya innovatsionnaya sistema Rossii: sostoyanie i puti razvitiya* [National innovative system of Russia: current state and developing ways], Otdelenie obschestvennyih nauk RAN, Rossiyskiy nauch.-issled. in-t ekonomiki, politiki i prava v nauch.-tehnich. sfere, Nauka, Moscow, Russian Federation, 396 p.

9. *Innovatsionnaya ekonomika* [Innovative economy] (2006), Edited by A. Dyinkin, N. Ivanova, M. Grachev and others, Nauka, Moscow, Russian Federation, 352 p.

10. Inozemtsev, V.L. (2004), Models of postindustrial society, *Ekonomika znan': vikliki globalizatsiyi ta Ukrayina*, Edited by A. Galchinskyi, S. Lovochkin and V. Seminozhenko, HF NISD, Kiev, Ukraine, pp. 105-160.

11. Ivanova, N.I. (2002), *Natsionalnyie innovatsionnyie sistemyi* [National innovative systems], Nauka, Moscow, Russian Federation, pp. 22-25.

12. Kondratev, N.D. (2002), Conjuncture's big cycles and foresight theory, *Izbrannyie trudyi*, Ekonomika, Moscow, Russian Federation, 768 p.

13. Kondratev, N.D. (1989), *Problemyi ekonomicheskoy dinamiki* [Economic dynamics problems], Edited by L.I. Abalkin, Ekonomika, Moscow, Russian Federation, 526 p.

14. Kudrov, V.M. (2011), *Mezhdunarodnyie ekonomicheskie sopostavleniya i problemyi innovatsionnogo razvitiya* [International economic comparisons and problems of innovative development], Yustitsinform, Moscow, Russian Federation, 616 p.

15. Kuzyik, B.N. (2008), *Prognozirovanie, strategicheskoe planirovanie i natsionalnoe programmirovanie* [Forecasting, strategic planning and national programming], textbook, Edited by B.N. Kuzyik, V.I. Kushlin and Yu.V. Yakovets, Ed. 2, Ekonomika, Moscow, Russia, 575 p.

16. Kuzyik, B.N. (2005), *Rossiya-2050: strategiya innovatsionnogo proryiva* [Russia-2050: Innovative breakthrough strategy], Edited by B.N. Kuzyik and Yu.V. Yakovets, Ed. 2, Ekonomika, Moscow, Russian Federation, 624 p.

17. Malitskiy, B.A., Popovich, O.S., Solovyov, V.P. and others (2005), Obgruntuvannya innovatsiynoyi modeli strukturnoyi perebudovi ekonomiki Ukrayini. Naukove vidannya [Innovative model justification of the Ukraine's economy restructuring. Scientific Edition], NAN Ukrayini. Tsentr doslidzhen naukovo-tehnichnogo potentsialu ta istoriyi nauki im. G.M. Dobrova, Kiev, Ukraine, 326 p.

18. Matyushenko, I.Yu. (2006), Direction of high-tech order development and knowledge economy creating in Ukraine, Kultura narodov Prichernomorya, Simferopol, No. 80, pp. 98-103.

19. Matyushenko, I.Yu. (2006), Perspectives of science development in Ukraine under conditions of overcoming a multi-ordered economy and a society built on knowledge, *Biznes Inform*, INZhEK, Kharkov, Ukraine, No. 1-2, pp. 9-21.

20. *Natsionalni modeli ekonomichnih sistem* [National models of economic systems] (2010), textbook, Edited by O. Belyaev, A. Bebelo, V. Kirilenko, V. Satsik and others, KNEU, Kiev, Ukraine, 319 p.

21. *Obuchenie ryinku* [Market learning] (2004), Edited by S.Yu. Glazev, Ekonomika, Moscow, Russian Federation, 639 p.

22. *Problemi ta prioriteti formuvannya innovatsiynoyi modeli rozvitku ekonomiki Ukrayini* [Problems and priorities of the innovative model of economic development forming

in Ukraine] (2006), Edited by Ya.A. Zhalilo, S.I. Arhiereev, Ya.B. Bazilyuk and others, NISD, Kiev, Ukraine, 246 p.

23. *Problemyi informatsionnoy ekonomiki* [Informative economics problems], Ed. 5 "National innovative system of Rossia: formation and development problems", (2006), collection of scientific papers, Edited by R.M. Nizhegorodtsev, LENAND, Moscow, Russia, 424 p.

24. Seminozhenko, V.P. (2005), *Ukrayina: shlyah do postindustrialnoyi tsivilizatsiyi* [Ukraine: way to the postindustrial transformation], Konstanta, Kharkov, Ukraine, 214 p.

25. Schumpeter J. (2001), *Istoriya ekonomicheskogo analiza* [Economic analysis history], Vol. 3, Translated from English by V.S. Avtonomov, Original, Moscow, Russia, 494 p.

26. Schumpeter J. (1982), *Teoriya ekonomicheskogo razvitiya* [Theory of economic development], Progress, Moscow, Russian Federation, 456 p.

27. *Strategicheskiy globalnyiy prognoz 2030. Rasshirennyiy variant* [Strategic global forecast 2030. Extended version] (2011), Edited by A.A. Dyinkin, Magistr, IMEMO RAN, Moscow, Russian Federation, 480 p.

28. *Strategichni vikliki XXI stolittya suspilstvu ta ekonomitsi Ukrayini* [Strategic challenges of XXI century to the society and economy of Ukraine], Vol. 1 "*Ekonomika znan – modernizatsiyniy proekt Ukrayini*" [Knowledge economy – modernization project of Ukraine] (2007), Edited by academicians V.M. Geyts, V.P. Seminozhenko and B.E. Kvasnyuk, Feniks, Kiev, Ukraine, 544 p.

29. *Teoreticheskie osnovyi i modeli dolgosrochnogo makroekonomicheskogo prognozirovaniya* [Theoretical basics and models of long-term macroeconomic forecasting] (2004), Edited by Yu.V. Yakovets, MFK, Moscow, Russian Federation, 296 p.

30. Tsihan, T.V. (2005), On the technological orders' concept and innovative development priorities in Ukraine, *Innovatsiyi v Kievi*, No. 1, Available at: http://innovation.com.ua/pub/imagazine/archive/1_05/article8.php.

31. Voronina, L.A. and Ratner S.V. (2010), *Nauchno-innovatsionnyie seti v Rossii: opyit, problemyi, perspektivyi* [Scientific and innovative networks in Russia: experience, problems and perspectives], INFRA-M, Moscow, Russian Federation, 254 p.

32. Yakovets, Yu.V. (2011), *Globalnyie ekonomicheskie transformatsii XXI veka* [Global economic transformation in XXI century] (2011), Ekonomika, Moscow, Russia, 382 p.