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When the Kondratieff winter comes: an exploration of the recent economic crisis from a long wave theory perspective

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Abstract

The paper contributes to the incipient discussion on how the recent economic crisis should be located in the framework of long cycles (50 ± 10 years) of economic activity, known as 'Kondratieff waves'. The time series of ca 350–500 years (including 7–10 cycles) are necessary for rigorous statistical test of hypothesis. As only some 200–250 years passed since the industrial revolution, this condition is still not satisfied. The growing body of research includes two broad streams. The first stream goes back to Joseph A. Schumpeter's general business cycles theory. Neo-Schumpeterians are focusing on the mechanisms of the emergence of radical technological innovation and their diffusion in the capitalist economy. The second (neo-Marxist) stream goes back to Immanuel Wallerstein's application of the Kondratieff hypothesis in the capitalist world system analysis and to Ernest Mandel's explanation of how the tendency of the rate of profit to fall, famously asserted by Karl Marx as a *law* of capitalist mode of production, can be temporarily reversed with the upswing of a new Kondratieff wave. Contributing to the first stream, the paper focuses on the question whether the recent crisis can be considered as the downturn point in the current fifth Kondratieff wave, driven by the rise of digital techno-capitalism in the early 1990s. While some analysts consider the recent international economic crisis (since 2008) as a marker of the onset of the downswing of the fifth Kondratieff wave, other experts expect it to occur by the end of the current decade. The view the fifth Kondratieff winter is already with us can be accepted only assuming the acceleration of the technological and social change, with long waves becoming shorter with each Kondratieff cycle. This assumption can be criticised as ad hoc, because it immunises the long cycles hypothesis against refutation by statistical testing. Another evi-

dence against this view is the lack of 'Neo-Marxist' symptoms of the peaking upswing (the surge of the anti-systemic movements), and not truly global scale of the recent crisis, which has spared newly industrialising countries. So the author opts for second diagnosis, which implies the forecast of the bio-capitalist age of synthetic biology and nanotechnology coming only after some two or more decades. Due to their cultural distinctiveness, non-Western countries may present a more accommodating cultural environment for radical biological engineering which often goes against accepted Western values.

Keywords: Kondratieff waves, economic crisis since 2008, synthetic biology and nanotechnology, acceleration of social change

1. Introduction

The goal of this paper is to explore the diagnostic and prognostic value of the long-wave theory of economic activity, known as Kondratieff waves (or K-waves), for the analysis of the recent (since 2008) international economic slump. Kondratieff waves are hypothetical long-term cyclical fluctuations in economic activity (50 ± 10 years) – (Kondratieff 1999). From the statistical point of view, the problem of detecting the cyclical fluctuations in data of economic statistics is equivalent to that of the extraction of the signal from the noise in physics. However, available time series are not long enough for conclusive results of statistical analysis, because the size of the signal-to-noise ratio is inversely related to the assumed length of the signal's period. There is no agreement how many cycles are necessary to test the long wave hypothesis. Jacob van Duijn asks for seven to ten (Duijn 1999: 207) and Michael Beenstock for eight to ten (Beenstock 1983: 139). According to Solomos Solomou (1987: 16), at least seven cycles are required. Both J. van Duijn and S. Solomou refer to an authoritative statement by Clive Granger and Michio Hatanaka who suggested seven cycles as minimal condition for the applicability of spectral analysis (Granger, Hatanaka, 1972: 26).

So if one counts Kondratieff waves from the industrial revolution in the late eighteenth century, one should wait some 100 more years before one would have sufficient data to test the long wave hypothesis. Therefore, mainstream economists remain sceptical about the existence of K-waves, although Joseph Alois Schumpeter used them in his monumental theory of business cycles (Schumpeter 1939). However, like N. Kondratieff's hypothesis, J. Schumpeter's general theory of the business cycles

is not generally accepted, either, in mainstream economics. It is expected, however, that it should be possible to determine the cycles mathematically explainable. However, J. Schumpeter's ideas even now can only be partially formalised, using non-linear systems. This is another reason why contemporary neoclassical economists consider them as unorthodox. In contrast, sociologists often refer to long-term dynamics in their studies which is the reason for this paper.

In claiming the relevancy of K-waves in economic sociology, no pioneering contribution is made herein. Outside the confines of mainstream neoclassical economics, a large body of the historical economic and sociological work on the K-waves exists. In the first section of the paper, contributions in economic sociology on research on long waves are being reviewed. In the second section, it is investigated how the incipient controversy of the present economic crisis should be understood in terms of the framework of the K-waves theory. A question arises whether or not the crisis of 2008 be considered as downturn point in the fifth Kondratieff wave, heralding the start of a long downswing or *Kondratieff winter*. The concluding third section is reserved not only for future speculations about the coming sixth Kondratieff wave, but also for the discussion of the cultural obstacles that the capitalist economic system will face in turning it around.

2. The contribution of economic sociology to the research on the long waves: two traditions

In sociological contributions to the literature on long waves, one can distinguish two broad traditions: neo-Schumpeterian and neo-Marxist. The neo-Schumpeterian tradition continues J. Schumpeter's analysis of the *Business Cycles* by J. Schumpeter himself, enriched by ideas borrowed from other approaches, and extending it behind the year 1929, which was when J. Schumpeter presented his own analysis. Contributions in this field of research include many pieces of literature (Mensch 1979; Freeman 2008; Tylecote 1992; Modelski 2006; Modelski, Thompson, 1996; Ayres 2006a, 2006b; Dator 2006; Papenhausen 2008; Gore 2010; Devezas 2010; Linstone, Devezas, 2012. The most prominent work in this field is a book by Christopher Freeman and Francisco Louçã (2001). It extends J. Schumpeter's interpretation

of the capitalist world economic history up to the year 2000. This paper aims at continuing this endeavour.

In J. Schumpeter's monumental treatise, three main cycles, i.e. J. Kitchin (ca 40 months), C. Juglar (ca 8–9 years), and N. Kondratieff (ca 50 years), were added to account for the dynamics of capitalist economy as it was observed since the late eighteenth century. 'Barring very few cases in which difficulties arise, it is possible to count off, historically as well as statistically, six Juglars to a Kondratieff and three Kitchins to a Juglar – not as an average but in every individual case' (Schumpeter 1939: 174). Importantly, J. Schumpeter not only claimed that such cycles exist, but also advanced explanatory hypotheses about the distinct sets of causes for each type of cycle. From this time, the topic of the causes of long waves remains central in the agenda of the neo-Schumpeterian tradition.

In his seminal contribution, J. Schumpeter made a distinction between innovation and invention. Innovation means commercial application of available inventions. Innovations are promoted not by inventors but by entrepreneurs, although some inventors may become entrepreneurs or vice versa. For the explanation of long waves, the distinction between incremental innovations of existing technologies and radical innovations by introducing new technologies is crucial. For example, the emergence of the automobile – a radical innovation which replaced previous transport modes – is an incremental innovation. Similarly, the construction of the personal computer (PC) – also a radical innovation that increases the speed of its predecessors – is also an incremental innovation. While Kitchin's and even Juglar's cycles reflect quantitative growth, Kondratieff's waves reflect qualitative development of the economy, changing the position of its long-term equilibrium state.

Clusters of radical innovations drive new K-waves. When all elements of a cluster are in place, new carrier branches emerge, providing spillover effects (e.g. new core inputs) for the more traditional branches of an economy. Such branches are recognisable by the rates of growth that significantly exceed those of old branches. Some of them stagnate and even disappear as victims of 'creative destruction'. Others are transformed by technological innovations coming from new branches. These branches are 'carriers', because they have spillover potential for other industries (cf.

Ayres 2006a: 59). The use of new core inputs or marked decrease in their price plays a crucial role in the success or failure of a new carrier branch.

The beginning of the upswing of a new K-wave is marked by the wide publicity of highly visible examples of technically successful and profitable innovations that become the icons in an emerging techno-economic paradigm. During the upswing phase, new transport and communication infrastructure adequate for the new paradigm is created, and managerial and organisational changes take place. The upswing phase is punctuated by sudden financial crises and recessions caused by a burst of speculation bubbles due to excessive optimism about the profitability of new industries. However, until the potential of the new technological paradigm is exhausted, these recessions last only for short time periods. New bursts of sustained growth follow. General properties of processes of diffusion explain the exhaustion of the technological paradigm (or technological mode of production). The S-shaped logistic curve visualises these properties: while diffusion accelerates approaching the middle phase, it starts to decrease due to decreasing marginal productivity or exhaustion of the spaces for application of new technology (see Mackevičius 2012: 41-52; Girdzijauskas 2008, 2011).

First railway lines brought immense economic effects and investments were very profitable. However, after the basic railway network was provided, the economic effect of the building of the new railway lines began decreasing. When mass automobilisation started (cars ceased to be an expensive luxury toy for the elite and they became a necessity for everyday life), the automobile and related industries, e.g. oil extraction and refining, for some time served as carrier branches for the growth in the economy overall. However, after most families owned a car or two, the phase of the explosive growth was over, and the automobile industry became one of the traditional industries. The traditional industries produce for saturated markets and are involved in the *positional war* of competition, where economic viability is contingent on the producer's or provider's capability to sustain the stream of incremental innovations.

Unlike neo-Schumpeterians, neo-Marxist researchers focus on the social, political (including international politics), and cultural effects of long waves. This neo-Marxist strand is represented by the work of the Belgian Trotskyite economic theorist

and historian Ernest Mandel (1980), *world system* theorists (e.g. Arrigi 1994; Wallerstein 2000), *regulation school* (Fontvieille 1999) and *social structures of accumulation* (Gordon 1999) analysts. They works demonstrate that the analysis of capitalism by Karl Marx is not only compatible with long wave of hypothesis, but can also be enriched and updated on its foundation.

In fact, Karl Marx did not write about the cyclical fluctuations of periods longer than seven to eleven years (Juglar cycles). His analysis includes the prognosis that each next recession will be increasingly severe, leading not only to the relative, but also to the absolute submersion of the working class, unemployment even during the boom phases of economic cycles, and to the world socialist revolution during one of these future disturbances of the extended reproduction of capitalism. K. Marx made exact predictions of the timing of such revolutions contingent on the political factors: first of all, on the progress in organisation of the labour class and in the awakening of the *class consciousness*. K. Marx's famous *law of the declining average profit rate* sets the absolute limit of how long the capitalist mode of production can endure.

Confronted with the economic statistics that there is no overall trend of decreasing average profit rate, some Marxist researchers argued there are long-time fluctuations in average profit rates. They identify the fluctuations with Kondratieff waves. There is no agreement amongst them concerning the sequence and causality of events. 'According to Mandel, at first the profit rate suddenly increases because of external factors, and only after that a technical revolution takes place. According to our argument, a low profit rate moves capitalism to a technical revolution, which explains a spontaneous increase of profit rate and a chain reaction of the prolonged boom that follows' (Menshikov, Klimenko, 1989: 46).

Theorists of the world system, launched by Immanuel Wallerstein in the 1970s, who blended the ideas of Rosa Luxemburg, Vladimir Lenin, and *dependence theory*, focus on the outbreaks of the struggle for hegemony in the world system that are allegedly related to K-waves. By changing the world balance of economic power, upswings may lead to the emergence of new world powers that challenge the position of the established hegemonic states in the world international system.

Analysts of the regulation school (e.g. Aglietta 1979) worked to relate each of the Kondratieff waves to a specific accumulation and regulation regime. These are types of capitalist modes of production (or simply capitalism). K. Marx was wrong about the immediate prospects of capitalism, but *his law of correspondence of productive powers and relations of production* after all is true, because each change in the productive powers leads to a transformation of the capitalist relations of production and the superstructure, described by the concepts of accumulation and regulation regimes.

The brand mark of the neo-Marxist elaboration of the long wave hypothesis is the prominence of class conflicts in their analysis. According to Ernest Mandel, the transition from one K-wave to another does not occur spontaneously. The downswing of each of them can be terminal for capitalism as an economic system. A new upswing is conditional on the victory of bourgeoisie over the working class in the battle over the change in the inherited system of work relations to increase the rate of exploitation and to accumulate capital for a new technological revolution. Therefore, E. Mandel asserts that intensification of class conflicts marks the closing phase of the downswing, as reflected by strike and lockouts statistics and other indicators. Besides these upheavals due to defensive battles of the working class during the K-waves downswings, there are offensives of the working class during the last years of upswing (just before the downturn), after (and because of) protracted strong demand for labour power which increases its bargaining power.

To sum up: according to neo-Schumpeterian and neo-Marxist insights, the recurring features of the long term fluctuations 'include the phenomenon of pervasive and interdependent constellations of innovations, and the role of core inputs, of carrier branches and new infrastructures, and of new management styles. Finally, profound structural changes can come only through a crisis of adjustment in each wave, which necessitates many changes in the institutional and social framework' (Freeman, Louçã, 2001: 151).

3. Does the recent international financial and economic crisis mark the downswing phase in the fifth Kondratieff wave?

C. Freeman and F. Louçã (2001) distinguish five Kondratieff waves:

1. (1) the water-powered mechanisation of industry wave, with an upswing phase from 1780s to 1815, and a downswing from 1815 to 1848;
2. (2) the steam-powered mechanisation wave, with an upswing phase from 1848 to 1873, and a downswing from 1873 to 1895;
3. (3) the electrification wave, with an upswing from 1895 to 1918 and a downswing from 1918 to 1940;
4. (4) the motorisation wave, with an upswing from 1941 to 1973, and a downswing until 1990;
5. (5) the computerisation wave, with an upswing since early 1990s.

Due to space limitation, the discussion is limited to the current fifth wave[1].

The structural adjustment crisis of the fourth Kondratieff wave was over by the early 1990s, when all components of the new technological-economic paradigm were ready to make a new carrier branch to carry the entire economy. This new branch was, of course, the information, telecommunication, and microelectronic industry. The onset of the new long-term upswing was accompanied and reflected in the public economic discourse by the flood of publications about the *knowledge economy*, *new economy*, *knowledge society*, etc. The unbounded optimism about prospects of new ventures in information and communication industries led to the explosion of the *dot.com* bubble that collapsed in 2001, when many new U.S. enterprises with overvalued stocks crashed before they even marketed their first products. However, the boost in the branches of *new economy* slowed down the overall rates of economic growth in the U.S. only for a while, because the computerisation of the entire economy was not yet achieved, even in the advanced countries.

Computers as emblematic products for the new technological-economic paradigm were in use since the 1940s. However, until the invention of the personal computer (PC) in the 1980s only so-called mainframe computers built out of electric tubes were used for scientific and management calculations. The invention of the PC was

[1] For more detail see e.g. Norkus (2010; 2012: 96-107).

prepared by the invention of transistors (in 1946) and, most importantly, of microprocessors (by Intel in 1970). Only after the production costs of the integrated circuits (chips) dramatically decreased in the 1980s, they could advance to the role of the new key inputs. The formation of the new technological-economic paradigm was over after the Internet connected PC's. This was the case only in 1993, although its predecessors (Arpanet and other networks) were in use for the goals of scientific and military communication since around 1970 (Devezas *et al.*, 2005).

The arrival of Internet was tantamount to the revolution in the entire communication infrastructure, leading to the emergence of the worldwide information highways. In the production itself, specialised assembly robots were developed and were widely adopted in mass production industries. However, the main economic effect of the computerisation was the decrease of transaction costs in the entire economy, and emergence of the new (networking) forms of the *post-Fordist* organisation of production, involving computer-aided design, minimal inventory, flexible manufacturing, and lean production.

Of course, the most intriguing question is how the recent financial crisis and economic recession that started in the USA in 2008, and which subsequently spread to most of the other countries of the world, can be conceptualised from the confines of the Kondratieff hypothesis. Should it be described as one of those relatively short and mild recessions that are part of Juglar cycles in the upswing phase, or does it herald the start of a downswing that some authors poetically termed *Kondratieff winter*[2]. It is important to note that the K-wave upswing phase does not exclude the possibility of short but severe recessions. Similarly, a downswing can witness periods of sustained growth.

To extend the climate analogy, some summers are cool, and some winters are mild. Even in the cold winter there can be some days with high temperatures. However, summer is summer and winter is winter because of the difference of the average temperatures for specific periods. The most important indicator of the difference between Kondratieff upswings and downswings is different average growth rates. Although for downswing (or *winter*) periods they are less, they generally are positive

[2] Since 2007, one can find in the Internet the website (Kondratieff winter) that declares as its mission 'the discussion of the impact of one certain long wave cycle theory on today's USA economy and capital markets'. Another Internet forum with similar goals is (Longwave Group).

both for upswing and downswing phases. However, recessions during the Kondratieff downswing last longer compared with those during the upswing, and the growth phases in the downswing Juglars are shorter and weaker. During the K-waves upswings, the number of prosperous years exceeds twice or even trebly the number of depressed years; during K-wave downswing, the relation of economically prosperous and depressed years is opposite[3].

The prediction that the downswing of the 5th Kondratieff wave is just about to start was published in 2006 by Russian scholars Vladimir Pantin and Vladimir Lapkin (2006: 280-332). Their start date for the fifth Kondratieff wave is 1981 and they believed that the downswing already was here underway in 2005. They substantiate their forecast by the argument that a general acceleration of social change is taking place (see Pantin, Lapkin, 2006: 288-292). Therefore, recent Kondratieff waves are somewhat shorter in comparison with those during the nineteenth and the first half of the twentieth century. However, this compression is taking place only at the cost of downswing phases, that are allegedly shorter by half (12 years), with duration of upswing phases remaining intact. Assuming the onset of the downswing in the fourth Kondratieff wave in 1969 and its compression, V. Pantin and V. Lapkin can date the start of the fifth Kondratieff in 1981, and to assert the downswing since 2005.

If one assumes the compression of Kondratieff downswings, one should predict that it would be over already by 2017. However, the next years most probably will resemble the long depression of 1873 to 1879, or its repetition from 1929 to 1939, punctuated only by the weak recovery from 1933 to 1936. Askar Akaev (2009), Andrey Korotayev and Sergey Tsirel (2010) also describe the recent crisis as the onset of a Kondratieff downswing. This diagnosis implies that current neo-Keynesian attempts of the governments of the advanced countries to lead economies out of recession most probably will fail, as the classical Keynesian attempts failed in 1971 to 1975, leading to stagflation. In the present situation, they may just complicate the recession by the fiscal crisis, leading to the maelstrom of state bankruptcies similar to that of Iceland and (avoided only by the extraordinary measures of the European Union) of Greece, Ireland, Latvia, Portugal, Spain, and Cyprus (which will be next?). However, in this case one can grant for himself the comforts of the long-time opti-

[3] See Haberler (1946: 273) who used the calculations of Arthur Spiethoff.

mism: after some five years the 'hard times' will be over, ushering into the new long era of the sustained growth.

V. Pantin's and V. Lapkin's chronology makes some sense, because 1981 was the time when stagflation came to an end, and the informatisation of the economies of the most advanced countries started to make strong progress. Nevertheless, the most probable date for the start of the present fifth Kondratieff seems to be 1993/94, when the recession – which broke out in 1992 and was very severe in Germany, Sweden, Finland, and Japan but not in the USA – was over. In terms of technological change, one can argue that one can identify the completion of the formation of new economic-technological paradigm before the Internet, and this was precisely the time when this happened. In the 1987, Robert Solow, a Nobel laureate, was quoted as saying 'you can see the computer age everywhere except in the productivity statistics' (Ayres 2006b: 1189). Only after arrival of the Internet, the coming of the new era was visible in the statistics of the total factor productivity. This event heralded the start of the era of the *dot.com economy*, which did crash in 2001. Then a new boom followed, ending with the *subprime mortgage crisis* of 2008.

There is some evidence that the present Kondratieff wave's upswing has already passed the inflection point in the logistic S-curve in the most advanced countries. The statistics of the increase of Internet use are most significant. It reveals that growth of the internet users is approaching its ceiling, as almost all adult persons in these countries (not to speak about the businesses) are in possession of a PC and are Internet users. By 30 June 2012 63,2% of European population were Internet users, this number rising from 45% in 2005 during about seven years. In some countries (Iceland with 97.1%, Norway 96.9%, Sweden 92.7%,) already reached the market saturation state, while the Baltic (Estonia 78.0%, Latvia 71.7%, Lithuania 65.1%) and Central European countries (Czech Republic 73.0%, Hungary 65.4%, Poland 64.9%, Slovakia 79.1%) are rapidly approaching it (Internet World Stats 2012)[4].

The situation resembles that of the fourth wave, when all or nearly all families in the advanced countries of Europe and the USA became the owners of one or two cars; or that of the third wave, when electrification was completed, or the second wave, when all or nearly all towns and townships in Europe were connected by rail-

[4] Cf. Modis (2005).

ways. Both railways and cars are still with us. Both railway manufacturing and the automobile industry witness important innovations. Nevertheless, they are no more the carrier branches for the growth of entire economies, because even the radical innovations (like maglev trains and electromobiles) in these now old or traditional branches barely will have the spillover effects on the scale that the introduction of railways and cars had. In the computer industry, the innovation is very rapid but the economic effect that brings the replacement of Windows XP with Windows Vista cannot be compared with the revolution by the first Windows type programmes. Nevertheless, it would be premature to conclude from the observations that the upswing phase of the fifth Kondratieff wave is already over. The characteristic feature of most Kondratieff upswings was their coincidence with the rise of the newly industrialising powers. For the old industrial powers, the start of a new Kondratieff wave means a new burst of creative destruction. For the new ones it means the entrance into the club of the technologically most advanced countries.

This was the case for Germany during the second Kondratieff wave, Russia (USSR) during the third one, and Japan, South Korea, and Taiwan during the fourth one. The peculiarity of the current Kondratieff wave is its coincidence with the industrialisation of China, India, and Brazil. While the industrialisation of Russia in 1930–1950s under conditions of a closed plan economy could not have a stabilising impact on the global capitalist system, this is the case with the rise of new industrial nations in South and Eastern Asia. The computerisation of their economies seems to be still far from the point of saturation.

Therefore, the upswing of the current K-wave may last for eight or nine years, helping the ailing economies of the old industrial and post-industrial nations to extricate themselves from the current recession and enter another Juglar cycle with strong growth during its starting phase. Complications due to the fiscal crisis of the advanced Western nations may prolong the recent recession in some of them. However, in terms of the real economy there is still no sufficient reason to maintain that the growth potential, due to technologies specific for the fifth Kondratieff wave, is already exhausted. The continuing growth of China and other emerging market economies assist in pulling the Western countries out of the recession. It may help them to keep growing until the end of the current decade. This is how neo-

Schumpeterians – Charles Gore (2009) and Tessaleno Devezas (2010) – conceive the recent crisis.

Departing from a neo-Marxist approach, one can find more evidence in favour of the traditional chronology of the current Kondratieff wave: characteristic symptoms that Marxist and neo-Marxist scholars expect from the closing phase of Kondratieff waves were absent before the recent crisis. Long sustained growth decreases unemployment and empowers the working class. So one should observe in the contemporary world the events displaying similarity (even if only very distant) to the emergence of the first International and Paris Commune during the final phase of the upswing of the second Kondratieff wave. One should be able to see something like the electoral successes and rise of the influence of the socialist parties on the eve of the First World War. Alternatively, something like the rise of the New Left in 1968 at the end of the upswing of the fourth Kondratieff wave should take place by the end of the upswing of the fifth Kondratieff wave. In fact, there was no evidence of comparable processes during closing first decade of the twenty-first century. 'There is no alternative' (TINA) to neoliberal capitalism and its globalisation remains the prevailing attitude in the public opinion despite the devastations of the recent crisis.

To recall, J. Schumpeter famously estimated that a full Kondratieff cycle includes six Juglar cycles, three of them representing upswing phases, three downswing, with the recession in the third Juglar marking the turning point from Kondratieff upswing to Kondratieff downswing. Since the early 1992–1993, the world economy went only through two Juglar cycles, so one more full Juglar cycle can be seen before the full downswing arrives. The assumption of the general acceleration of social change implies that each following Kondratieff wave will be shorter and shorter. The problem is very high price one has to pay for this assumption. It becomes much more difficult, if not impossible, to test long wave hypothesis by means of presently available statistical technique – spectral analysis of time series (e.g. Spree 1991: 41-59). Immunising the hypothesis against refutation by means of statistical test, one exposes it to the Popperian criticism to be just a metaphysical article of faith.

4. Will the sixth Kondratieff wave be the last one?

The forecast that the fifth Kondratieff winter will come only by the end of the second decade of the twenty-first century provides some ground for optimism about the success of the recent efforts of the U.S. government and those of other countries to boost the economy by pumping it with money. Assuming neo-Marxist analysis, socio-political upheavals should be expected in the newly industrialising countries between 2015 and 2018. As Tunisia, Egypt, or Syria do not belong to them, one cannot consider the recent *Arab Spring* as the case in question. Most probably, the offensive of the working class will be seen by 2017 or 2018 to coincide with the 100th anniversary of the Great October Revolution in China (probably also in India and Brazil), because masses of Asian workers presently toiling in the sweatshops will demand a fair share in the economic prosperity. This may be an Asian version of the *Solidarność* movement in Poland, which heralded the demise of the Soviet style communism. These upheavals most probably will end the (nominally) communist rule in China. Of course, one cannot exclude, either, most economically successful post-communist countries from the list of the arenas where the offensives of the working class could take place.

A question arises what comes next. Is the next, post-Information and Communication Technology economic-technological paradigm so near that its overall shape may be distinguished? Schumpeterian theory of economic development provides a strong rationale why one could believe in the Kondratieff wave theory. Therefore, the analysis of the technological substance – trends in the development of technology – should substantiate the prognostic use of the long wave hypothesis. If the Kondratieff downswing is about to enter, the outlines of the coming techno-economic paradigm should already be visible behind the curtain blocking the view through the window of future.

It is difficult to find more plausible candidates for future carrier industries of the sixth Kondratieff wave than nanotechnology and biotechnology. The latter is already being developed in developed industries[5]. Its history began in 1976 when Genentech Corporation was established. After 25 years the number of companies focusing merely on biological products and processes increased globally to more than

[4] Some authors even consider biotechnological industry on a par with ICT industries as one of the carrier branches of the present (fifth) Kondratieff wave (e.g. Freeman, Louçã, 2001: 141; Linstone 2006).

5,500 (Sager 2001: 110). Most of them, however, currently focus on human therapeutic markets. In the pharmaceutical industry, product development times are relatively long (often up to 15 years), and the relatively long payoff periods (often 10 years or more) for biotechnology investments still make ventures in the biotechnological industry less attractive in comparison to investments in the electronic commercial markets (Sager 2001: 112). The progress in agricultural biotechnological industry faces the growing public biases (if not scare) against genetically modified products. This time it is not clear how the pharmaceutical industry and agricultural biotechnology could have spillover effects for an entire economy, becoming its carrier branches. One cannot identify new core branches for the emerging techno-economic paradigm yet.

However, there are some nascent areas of biotechnology, including industrial biotechnology, material science, environmental engineering, biological computing, and others that show some promise. The promise of industrial biotechnology is to replace traditional industrial manufacturing based upon high temperature and energy using noxious chemicals, e.g. acids, alkali, silicates, and surfactants, with low-temperature, low-energy enzymatic reactions. In the material science, the promise of biotechnology is to develop biological materials for improved structure and function, e.g. materials with properties of spider silk and insect exoskeletons. Environmental engineering promises to develop biotechnologies to repair and sustain the natural environment, e.g. microbial *cleaner* organisms that are designed to clean up contaminated soil, air, groundwater, petrochemical spills, and to destroy themselves after their mission has been completed. Biological computing promises to replace silicon-based chips with living computers.

Although some of these areas display significant progress in keeping these promises, there are still few commercial products fabricated that use these technologies. The commercial products that are currently marketed do seem to have a potential to serve as carrier branches or new key inputs that will revolutionise older industries. Brian Sager speculates that this is unlikely to happen until all the areas of biotechnology will come together as 'convergent biotechnology' (Sager 2001: 113).

This coming convergence will involve nanotechnology. According to an authoritative definition by the National Nanotechnology Initiative (NNI)[6], nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometres (nm), where unique phenomena enable novel applications. To recall, a nanometre is one-billionth of a metre. A sheet of paper is about 100,000 nanometres thick; a single gold atom is about a third of a nanometre in diameter. Dimensions between approximately 1 and 100 nanometres are known as the nanoscale. Unusual physical, chemical, and biological properties can emerge in materials at the nanoscale. These properties may differ considerably from the properties of bulk materials and single atoms or molecules.

Encompassing nanoscale science, engineering and technology, nanotechnology involves imaging, measuring, modelling and manipulating matter at this length scale (Nanotechnology basics 2009). Otherwise, despite much talk and a lot of real progress, there are still relatively few commercial products besides the sphere of military application, where expensive nanoproducts do not face competition with their cheaper traditional alternatives (e.g. Kostoff *et al.*, 2007; Pilkington *et al.*, 2009). In most cases, they are only nonminal nanoproducts because real technologies used for their fabrication do not correspond to stringent definition of nanotechnology cited above.

The idea of a coming synthesis of nanotechnology and biotechnology, leading to the emergence of nano-bioengineering or synthetic biology, producing blueprints of the genomic patterns of new biological organisms and then building them *bottom up* seems to be the field that holds the most potential as a future carrier branch for the next Kondratieff wave. However, turning this into reality does not seem to lie just around the corner. Importantly, the coming new techno-economic paradigm faces much more cultural obstacles than those met by the entrepreneurs who promoted steam power, automobiles or computers. In fact, the barrages of the anti-technology criticism and pessimism accompanied each breakthrough in technological progress, including prophesies of the demise or degeneration of *real culture* or *real humanity* under the impact of new technology. The list of famous thinkers who voiced such criticisms includes Martin Heidegger, Lewis Mumford, Herbert Marcuse, Jean

[6] This is the programme established by U.S. government in 2001 to coordinate Federal nanotechnology research and development.

Jacques Rousseau, and Henry David Thoreau. However, there were no ideological and political movements to set limits for technological progress or to outlaw some kinds of scientific research. Even the most reactionary political movements (e.g. German Nazism), were open to the most advanced technologies, even if merely for military goals.

The situation seems approaching the sixth Kondratieff wave differently. Influential opinion-makers in the mass media are working to shape public opinion that is hostile as a matter of principle to some specific discoveries related to human biology and, first of all, to those related to mechanisms of biological reproduction. With public opinion changing, some specific kinds of research and discoveries are legally prohibited, as it was the case of the restrictions on the stem cell research in the USA. The animal rights movement is on the rise, with the general prohibition of experimental research on animal organisms on the top of its agenda. It is difficult to see how, given these and coming other restrictions, the biological research will be able to develop technologies for new carrier industry in the near future. It is even more difficult to see how this industry will be able to find markets for sustained growth, given the broad bias against genetically modified traditional agricultural products. This bias will be even stronger with respect to much more innovative products of synthetic biology.

Hugo de Garis may be not far off mark when he predicts the coming conflict between *cosmists* and *terrestrials* as the main political and ideological cleavage in the technologically and economically advanced Western societies in future (Garis 2005). On the other hand, increasing ethical obstacles for biomedical research in the Western world provide unique opportunities for the newly industrialised or industrialising Asian countries. Because they remain outside the reach of animal liberationist movement, they can become a safe haven for the advanced research in life sciences. India and China are likely to develop regional clusters of biotechnology firms because lax political and cultural views on human testing provide more space for technological experimentation and development. The harvesting of human organs from the executed death convicts is usual praxis in China, so there would also be no legal or ethical obstacles for human experiments to develop biotechnologies. Of course, as the *war on terror* is becoming increasingly fierce, one can imagine that time will come

when U.S. scientists sponsored by CIA and the Pentagon will do the same with captured Islamic terrorists to close *biotechnology gap* with China, if it will open wide.

These statements are relevant for practical politics if the sixth Kondratieff wave is already achieved. A more conservative and accurate assessment of the current recession is that it still forms a part of the final upswing of the fifth Kondratieff wave. However, V. Pantin and V. Laptin (2006) are not alone with their statement of the general acceleration of the social change leading to the shorter Kondratieff waves[7]. Ray Kurzweil, a prominent scholars of contemporary future studies, makes essentially the same statement as he claims that the pattern of exponential acceleration is discernible in the technological change taking place (Kurzweil 2005). Substantiating his claim, he refers to the Moore's Law of exponential growth of computational capacity (as well as the exponential decay of computational costs). Gordon Moore predicted in 1964 that the number of transistors on a chip would double every two years (Ayres, Williams, 2004: 318). Up to now, G. Moore's prediction held firm.

R. Kurzweil uses this law to predict the coming of what he calls singularity by 2045. 'It's a future period during which the pace of a [sic!] technological change will be so rapid, its impact so deep, that human life will be irreversibly transformed. Although neither utopian nor dystopian, this epoch will transform the concepts that we rely on to give meaning to our lives, from our business models to the cycles of human life, including death itself' (Kurzweil 2005: 7). Trans-human singularity will come when human beings will *transcend the biology*, successfully using nano-bio-engineering to create computers that will be smarter than human brains. However, this will be only the starting point for the new phase in the evolution of artificial intelligence itself. Although R. Kurzweil's forecast borders on scientific fiction and enters the religion realm, it provides important insight how integrated bio- and nanotechnological industry can become the carrier branch for the entire economy – by integrating with ITC industry, and transforming in the wake, other branches of the economy.

R. Kurzweil focuses on technology and does not discuss the topic of long-term fluctuations in the economy at all. However, his prediction has two important (if not paradoxical) implications: (1) the approaching sixth Kondratieff wave will be the last

[7] There is a fledgling field of *Acceleration studies* promoted by the Acceleration Studies Foundation (Acceleration Watch).

one (cf. Dator 2006); (2) by econometric or quantitative standards, nobody will ever know whether there were K-waves. It may be recalled for cycles with durations of 50 to 60 years experts in econometric time series analysis ask for at least seven such cycles and time series of approximately 350 to 400 years.

Years ago Immanuel Wallerstein observed: 'a long-standing witticism has it that the credibility of the existence of long economic cycles is a function of whether or not the discussion on this topic takes place during the A-phase of expansion or the B-phase of economic stagnation' (Wallerstein 1984: 579). Although Kondratieff's hypothesis is considered as obsolete at times, the recent renewed attention to Kondratieff hypothesis, serves as a confirmation of the relevancy of I. Wallerstein's hypothesis about N. Kondratieff's hypothesis. Indirectly, it confirms the N. Kondratieff hypothesis but it is a different kind of confirmation than those that econometricians would have preferred.

5. Conclusions

(1) Because of its mathematical intractability, the problematic of the long-term economic dynamic is a domain that is not given prominence in mainstream (neoclassical) economics.

(2) There are two main traditions in the reception of N. Kondratieff's idea of long cycles of economic up- and down swings. The neo-Schumpeterian tradition focuses on the causal mechanisms of the long-time dynamics, and the neo-Marxist one is concentrated on its social, political, and cultural repercussions.

(3) While some (mainly Russian) analysts consider the recent international economic crisis (since 2008) as a marker of the onset of the downswing of the fifth Kondratieff wave, other experts expect it to occur by the end of the current decade.

(4) The evidence against the *Russian view* is the lack of *Marxist* symptoms of the peaking upswing, and not truly global scale of the recent crisis, which has spared newly industrialising countries. The *Russian view* assumes the acceleration of technological and social change, while this assumption may be criticised as *ad hoc* one.

(5) Most probably, the rise of the new carrier branches of economy, grounded in nano-bio-engineering, will drive the upswing of the coming sixth Kondratieff wave.

(6) Like in the former Kondratieff cycles, the formation of the new technical-economic paradigm will take place during the downswing phase of the present fifth Kondratieff wave: during the current decade according the *Russian view*, or between 2020 and 2040 according to the conservative view.

(7) Non-Western countries may provide more hospitable cultural environment for radical biological engineering involved in the making of the sixth Kondratieff.

6. References

Acceleration Watch, n.d., http://www.accelerationwatch.com/.

Aglietta M., 1979: *A theory of capitalist regulation: the US experience.* London: NLB.

Akaev A. A., 2009: Акаев А. А.: *Современный финансово-экономический кризис в свете теории инновационно-технологического развития экономики и управления инновационным процессом*; в: Д. А. Халтурина, А. В. Коротаев (ред.): *Системный мониторинг. Глобальное и региональное развитие*. Москва: Либроком/URSS, 141-162.

Arrighi G., 1994: *The long twentieth century: money, power, and the origins of our times*. London: Verso.

Ayres R. U., 2006a: *Did the fifth K-wave begin in 1990–92? Has it been aborted by globalization?*; in: T. Devezas (ed.): *Kondratieff waves, warfare and world security*. Amsterdam: IOS Press; 57–71.

Ayres R. U., 2006b: *Turning point: the end of exponential growth?.* "Technological Forecasting and Social Change", 73, 1188–1203.

Ayres R. U., Williams E., 2004: *The digital economy: where do we stand?* "Technological Forecasting and Social Change", 71, 315–339.

Beenstock M., 1983: *The world economy in transition*. London: Allen and Unwin.

Dator J., 2006: *Alternative futures for K-Waves*; in: T. Devezas (ed.): *Kondratieff waves, warfare and world security.* Amsterdam: IOS Press, 311- 317.

Devezas T., Linstone H., Santos H., 2005: *The growth dynamics of the Internet and the long wave theory*. "Technological Forecasting and Social Change", 72, 913–935.

Devezas T., 2010: *Crises, depressions, and expansions: global analysis and secular trends*. "Technological Forecasting & Social Change", 77, 739–761.

Duijn J. van, 1999: *Long waves in economic life*; in: F. Louçã, J. Reijnders (eds): *The foundations of long wave methodology*; vol.1. Cheltenham: Edward Elgar; 185-212.

Fontvieille L., 1999: *Long cycle theory. Dialectical and historical analysis*; in: F. Louçã, J. Reijnders (eds): *The foundations of long wave methodology*; vol.2. Cheltenham: Edward Elgar; 314-342.

Freeman Ch., 2008: *Systems of innovation: selected essays in evolutionary economics*. Cheltenham: Edward Elgar.

Freeman Ch., Louçã F., 2001: *As time goes by. From the industrial revolution to the information revolution*. Oxford: Oxford UP.

Garis H. de, 2005: *The artilect war: cosmists vs. terrans. A bitter controversy concerning whether humanity should build godlike massively intelligent machines.* Palm Springs: ETC Publications.

Girdzijauskas S., 2008: *The logistic theory of capital management: deterministic methods*. "Transformations in Business and Economics", 7, 2, 14, Monograph No 1, Supplement, Vilnius: Vilnius UP.

Girdzijauskas S., 2011: *Sovereign debt crisis: Logistic analysis*. Vilnius: Vilnius UP.

Gordon D. M., 1999: *Inside and outside the long swing: The endogeneity/exogeneity debate and the social structures of accumulation aapproach*; in: F. Louçã, J. Reijnders (eds): *The foundations of long wave methodology*; vol.1. Cheltenham: Edward Elgar; 224-273.

Gore Ch., 2010: The *global recession of 2009 in a long-term development perspective*. "Journal of International Development", 22, 714-738.

Granger C. W. J., Hatanaka M., 1972: *Спектральный анализ временных рядов и экономике*. Москва: Статистика.

Haberler G., 1946: *Prosperity and depression. A theoretical analysis of cyclical movements*. Lake Success, New York: United Nations.

Internet world stat., 2012, http://www.internetworldstats.com/stats4.htm.

Kondratieff N., 1999: *The long cycle wave*; in: F. Louçã, J. Reijnders (eds): *The foundations of long wave methodology*; vol.1. Cheltenham: Edward Elgar; 45-126.

Kondratieffwinter, n.d., http://www.kondratieffwinter.com

Korotayev A. V., Tsirel S. V., 2010: *A spectral analysis of world GDP dynamics: Kondratieff waves, Kuznets swings, Juglar and Kitchin cycles in global economic development, and the 2008 – 2009 economic crisis.* "Structure and Dynamics", 4, 1. http://www.escholar-ship.org/uc/item/9jv108xp

Kostoff R. N., Koytcheff R. G., Lau C. G. Y., 2007: *Global nanotechnology research literature overview*, "Technological Forecasting and Social Change", 74, 1733–1747.

Kurzweil R., 2005: *The singularity is near: when humans transcend biology*. New York: Viking Penguin.

Linstone H. A., Devezas T., 2012: *Technological innovation and the long wave theory revisited*. "Technological Forecasting & Social Change", 79, 414-416.

Longawave Group, n.d., http://www.longwavegroup.com/.

Mandel E., 1980: *Long waves of capitalist development. The Marxist explanation*. Cambridge: Cambridge UP.

Mackevičius R., 2012: *Ekonominių ciklų logistinė analizė [Logistical analysis of economic cycles*]. Doctoral dissertation, Social Sciences, Economics (04 S). Vilnius: Vilnius university.

Mensch G.., 1979: *Stalemate in technology – innovations overcome the depression*. New York, NY: Ballinger.

Menshikov S. M., Klimenko L A., 1989: Меньшиков С. М., Клименко Л. А.: *Длинные волны в экономике. Когда общество меняет кожу*. М: Международные отношения.

Modelski G., 2006: *Global political evolution, long cycles, and K-waves*; in: T. Devezas (ed.): *Kondratieff waves, warfare and world security*. Amsterdam: IOS Press; 293–302.

Modis Th., 2005: *The end of the internet rush*. "Technological Forecasting and Social Change", 72, 938–943.

Norkus Z., 2010: *Kondratjevo bangos ir kapitalizmo tipai* [*Kondratieff waves and types of capitalism*], "Sociologija. Mintis ir veiksmas", 2, 27, 13-33.

Norkus Z., 2012: *On Baltic Slovenia and Adriatic Lithuania. A qualitative comparative analysis of patterns in post-communist transformation*. Vilnius: Apostrofa/CEU Press.

Pantin V. I., Lapkin V. V., 2006: Пантин В. И., Лапкин В. В. *Философия исторического прогнозирования: ритмы истории и перспективы мирового развития в первой половине XXI века*. Дубна: Феникс+.

Papenhausen Ch., 2008: *Causal mechanisms of long waves*. "Futures", 40, 788-794.

Pilkington A., Lee L. L., Chan C. B., Ramakrishna S., 2009: *Defining key inventors: A comparison of fuel cell and nanotechnology industries*. "Technological Forecasting and Social Change", 76, 118–127.

Schumpeter J. A., 1939: *Business cycles: a theoretical, historical and statistical analysis of the capitalist process*; vol. 1-2. New York: McGraw-Hill.

Solomou S., 1987: *Phases of economic growth 1850-1973*: *Kondratieff waves and Kuznets' swings*. Cambridge: Cambridge UP.

Spree, R. 1991: *Lange Wellen wirtschaftlicher Entwicklung in der Neuzeit. Historische Befunde, Erklärungen und Untersuchungsmethoden.* "Historische Sozialforschung", 4, Supplement.

Tylecote A., 1992: *The long wave in the world economy*. London: Routledge.

Wallerstein I., 1984: *Economic cycles and socialist policies*. "Futures", 16, 6, 579-585.

Wallerstein I. 2000: *Globalization or the age of transition?: A long-term view of the trajectory of the world-system*. "International Sociology", 15, 2, 249-265.

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