

The Techno-Economic Paradigms Conception and the Cyclical Vulnerabilities of Economic Development (focusing on European transitive countries)

Iurii Bazhal

National University of "Kyiv-Mohyla Academy"

vul. Skovorody, 2

Kyiv 04070

Ukraine

Tel/ Fax: +(38 044) 425-6042, 425-7377

E-mail: bazhal@ukma.kiev.ua

Abstract

The paper develops the Neo-Schumpeterian conception about Techno-Economic Paradigms with its leading role of technological innovation. This approach gives fruitful methodological base to explain the patterns of contemporary economic crisis in case of the European transitive countries, and in particular of Ukraine. The technological determinism shapes the nature and the results of the "civilizing" competition between national economies for their position in global development rating and for the corresponding social and economic prosperity. Important result is conclusion that we must consider existing of the R&D and technological innovation sphere of a country not only as consequence, but rather as the reason for economic growth. Some transition countries, especially Ukraine, need to recognize the objective nature of these processes. It can help create more effective economic policy implementation to overcome crisis and to not allow it to arise in the future.

JEL Classification numbers: O14, O33, O38, O57.

Keywords: Schumpeterian economy, Tugan-Baranovsky's theory of economic crises, Kondratiev's "long waves", techno-economic paradigms, innovation policy, factors of country competitiveness, transitive economy.

1. Introduction

The current world financial and economic crisis raises questions about fundamental nature of such macroeconomic vulnerabilities. The answers have a crucial meaning to elaborate not only the appropriate policy response but to evolve new economic approaches to ensure the economic growth in the future. The theoretical field of such discussions is very broad and characterized by diversity of views. In this paper, we will try to develop arguments for the standpoint that ideas of the Neo-Schumpeterian theory of Techno-Economic Paradigms with its leading role of technological innovation are very fruitful for explanation of the patterns of contemporary economic cycles in case of the European post-socialist countries in general and in particular for Ukraine. It can help these transitive countries to elaborate more effective economic policy based on implementation of the innovation theory of economic development approach in order to overcome crisis and to reduce its threats in future.

The international experts recognized many factors of current crisis. But the meaning of innovation theories lies first of all in their proving of the fact that the state of the R&D and technological innovation sphere of a country is not the result, but the reason for a lot of macroeconomic changes, especially on a way of the long-run economic growth with regular economic and financial crisis. In many ways, the technological determinism shapes the economic background for the cyclical growth with its periodical crisis phases and following by the recovering and expansions. As a result of such transformations is arising the new global competition between national economies for a position in the world development rating and for the corresponding well-being and social and economic prosperity of these countries. It is very important for the national experts and policy makers to recognize the objective nature of these processes. Today's crisis situation and the international competition increasing will push them to implement a policy mobilizing the national potential to ensure an efficient integration into global technological trends.

The growth of national wealth depends, in the first instance, on the tempo and quality of economic growth, whose principal factor is effective investment in the innovation process which guarantees permanent structural re-organization of the national economy on a new technological basis, and reaching of the purpose of a constant increase in the productivity of the aggregate labor forces in the national economy. Therefore, the central point in the policy of economic development must be creation of stimuli and legal institutional conditions to promote an augmentation in the general factor of productivity.

It is essential that the transitive countries like Ukraine and its policy makers will be to consider the mentioned technological determinism as, without exaggeration, a fatal factor that crucially influence on the successful economic growth in long-run perspective. The last means that in reality we have generally no other choice for Ukraine in terms of model of dynamic economic development apart from mobilization of our possibilities for the effective inclusion of Ukrainian economy in the technological path of human civilization development. Practical realization of this task will require considerable management efforts and first of all we need an objective economic assessment of the technological structural development of Ukrainian economy in the context of the global development of techno-economic paradigms in order to develop and implement those institutional, regulatory and economic motivational measures to ensure accelerated development of the branches of 5th and 6th techno-economic paradigms.

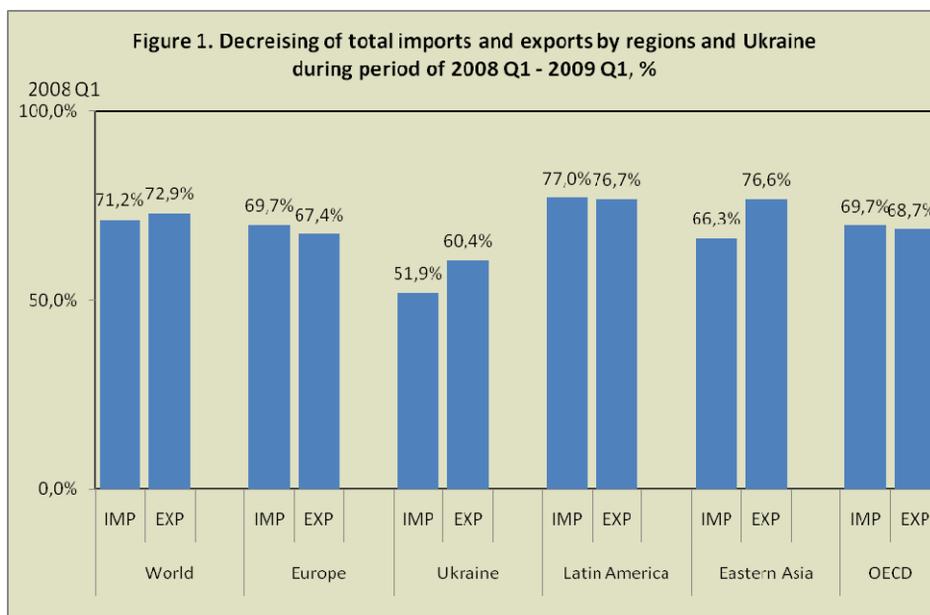
2. Puzzles of current financial and economic crisis

Overview of prescriptions to cure the actual crisis showed that much more attention is attracted to the theories which explain economic cycles by the impact of different from innovation factors, more traditional and understandable: weaknesses of global financial markets, uncontrolled "hot" foreign investments, currency exchange rate problems, peculiarities of money circulation and banks system etc. (Eichengreen B., and R. Baldwin (eds), 2008), (London Summit, 2009), (The Group of Twenty (G-20), 2009), (Filippov and Kalotay, 2009), (Burakovsky I., and V. Movchan (eds), 2009).

The similar reasons of the current crisis are called for the transitive countries. For example, on the International conference "Economies of Central and Eastern Europe: Convergence, Opportunities and Challenges", 14 – 16 June 2009, Tallinn

(Estonia), among the main factors were named following: consumption credits, government debt, foreign assets in banking systems, foreign investments and credits, speculative economy, intermediary economy, bad government (International conference 2009). Majority of participant considered the overfinancing of national economies as a combined central shortcoming of mentioned reasons of crisis in European transitive countries. But now we have a paradox when the overfinancing has been treated by the huge governmental financial interventions and the unprecedented refinancing of banking system by Central Banks of different countries. In crisis we obtain a total shortage of money. We have a puzzle.

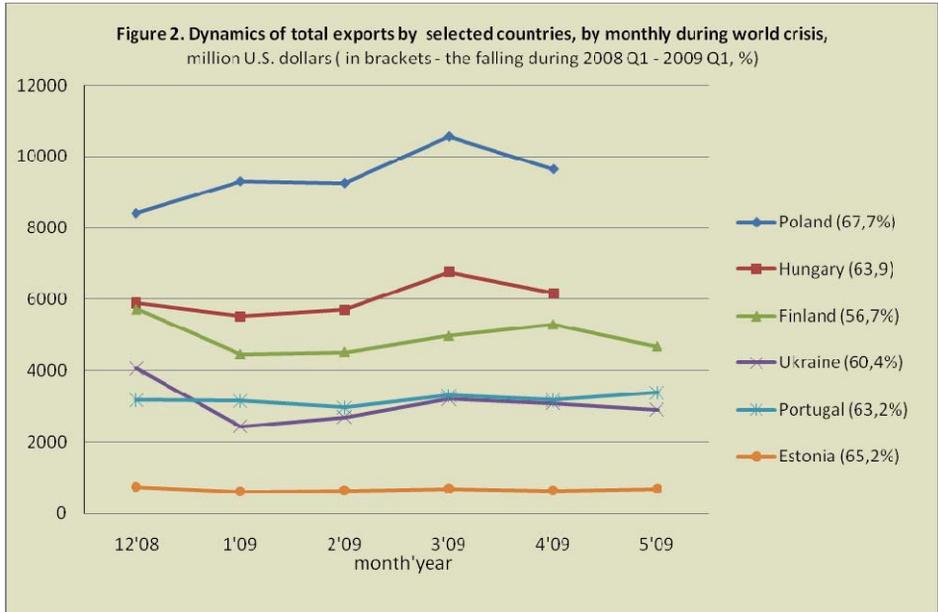
Another broad supported explanation of crisis has considered the subjective factors. These matters are mistakes of financial analytics and managers. But how could it happen? More than the one third of total imports and exports of the world (36% and 34% accordingly) were lost during 4th quarter of 2008 and 1st quarter of 2009. The financial crisis broke out in many countries simultaneously. Whether the pandemic of wrong decisions was among financiers? It is incredible that all financial managers over the world appeared as unskilled professionals. The regional structure of the global synchronic slowdowns of the international trade volumes for the one year is presented by the Figure 1, where we can see enormous vast falling. It would seem that explanation of this situation could be done by statement of fact of the world financial web existence. But the world crisis of XIX century had the same character.



Source: *Monthly Bulletin of Statistics : UN Comtrade publications, August 2009. - Table 34.*

These facts lead to recognize the existent of more fundamental reasons of current crisis. This conclusion is developed also by facts of identical trends in the international trade crisis phenomena both in the transitive European countries and in the old European countries being on the different poles of economic development. The data of the monthly exports volumes for period of December 2008 – May 2009 are presented on Figure 2. We have compared: two successful transitive countries - Poland and

Hungary, Ukraine as transitional outsider, European leader of competitiveness ranking – Finland, outsider of old European Unit – Portugal.



Source: *Monthly Bulletin of Statistics : UN Comtrade publications, August 2009. - Table 34.*

We can see the crisis trends of the exports volumes of such economically different countries are similar in general. It is also indicate that there is a more fundamental basis of current crisis than short-term disturbances due to the subjective incorrect decisions, criminal behaviour, and bad government. Actually all mentioned types of occurrences take place in any times. But the mass character of such mistakes emerges when the one socio-technological paradigm of human civilization come to be over and new paradigm starts to mature.

The basic reason of such matters concerns a situation when the traditional markets are reaching to the saturation and they have no demand potential to following development. Crisis starts when credit money for the future development of traditional markets change into financial bubbles. This kind of money disappears if they cannot find new objects to investing. New investment goals are as a rule the technological innovations. Such conceptual explanation of the economic crisis elaborates Schumpeterian and then Neo-Schumpeterian approaches of economic theory (Tugan-Baranovsky M., 1894:1901), (Schumpeter, 1934, 1939), (Mensch G., 1979), (Freeman C., Clark J., and Soete L., 1982), (Dosi G., 1982), (Arthur W. B., 1989), (Freeman C. and Louca F., 2001), (Perez C., 2002). In our opinion this theoretical and practical vision may be very fruitful to form effective anticrisis economic policy for contemporary situation.

3. Neo-Schumpeterian concept of economic development

Introduction of a characteristic of technological change into the economic analysis serving as a separate key endogenic factor of economic growth, not as a “black box” of the general productivity factor, was mainly done within the framework of a theoretical

trend which is known today under a general name “Schumpeterian economy”. This block of theories regards scientific and technical innovations as the main stimulus for economic growth. Fundamental theoretical grounds for this theory were laid as far back as the beginning of the XX century; one of its main founders was the world-famous outstanding Ukrainian economist and politician of the times of Ukrainian People’s Republic M. I. Tugan-Baranovsky (Tugan-Baranowsky, 1901). Besides him, among the luminaries of this theoretical trend we can name his student and the conceptual successor M. Kondratiev (Kondratiev, 1925), a German scientist A. Spiethhoff (Spiethhoff, 1903), and the classic of economic theory J. Schumpeter (Schumpeter, 1911:1934, 1939).

Schumpeter showed the influence of technological revolutions on the economic development. He established a tight connection between putting into operation of basic R&D and technological innovations and long-term cyclical fluctuations of economic development. One of the main categories in this theory is “destructive creation”, when basic technological innovations simultaneously ruin old branches of production and create new ones. In this context, it is important to make a clear distinction of “old” and “new” branches in the analysis and during the formation of the economic policy, as well as the problem of “leading sectors” and methods of their state support.

The economic theory of technological dynamics is related to latest achievements of economic science connected with the development of new paradigmatic path of Schumpeterian tradition – evolutionary technological dynamics (Nelson, 1995; Freeman and Louka, 2001; Perez, 2002; Dosi, 2001; Malerba *at al.*, 2003). Technological changes are regarded here as the main material object – the species that dynamically develops by itself and determines the ways of evolution of the modern civilization system. Waviness of this process is described by Kondratyev’s theory of “long waves” (Tylecote, 1992; Freeman, Clark, and Soete, 1982; Freeman and Louka, 2001; Rumjantzeva S., 2003) but we consider more productive the approach which concentrates less on the fixation of precise time phases of this wave, studying the essence of the process and its reasons. In this sense it is more important to recognize the technological changes which condition structural reconstruction of the economy as a main factor that have been causing the “long wave” of economic development. The cyclical periodicity depends on the frequency of appearance and putting into operation of basic innovations, leading to the creation of branches-locomotives of the general development and their further spreading in the economy. Today among such “locomotives” we see the branches that are connected with information technologies (Castells, 1996-1998: 2000-2004; Freeman and Louka, 2001).

The Development of the Neo-Schumpeterian conception created a theoretical basis for a new vision of the basic principles to ensure a countries’ economic development and set new requirements to the state economic policy (Elgar Companion to Neo-Schumpeterian Economics, 2007). This new vision is connected with perception of the national economy’s structure as a phenomenon occurring from the different waves of technological complexes. But in many cases of policy analyses we can meet domination of more traditional vision under consideration the characteristics of structural change. As a rule it is structure of enterprises according a form of property, dynamics in the context of interrelations of various economic indicators and sectors: commodity or service production, creation of added value, investments, such kinds of activity as the capital flows, final consumption, export, import, etc. Such analysis reveals connections between different parameters of the economic system, establishes certain regularities suitable for international comparisons, etc., but it is limited for the

tasks of strategic planning of the state economic policy as it does not give a clear vision of the influence of established structural processes on the future state of the economy. So a more modern instrument of analysis is the vision of structural dynamics of production through regularities of technological systems development.

Development of this Neo-Schumpeterian approach and putting the category of technological system as the basis of long-term cyclic economic development on the center of contemporary economic policy to ensure sustainable growth of national economy are connected with the names of C. Freeman (Freeman, 1982, 1987), D. Dosi (Dosi, 1982, 1984, 2001), C. Perez (Perez, 2002). By developing the ideas of J. Schumpeter and G. Mensch (Mensch, 1979) as to the influence of basic scientific and technical innovations on the long-term economic dynamics, C. Freeman, Clark, J, and L. Soete introduce the notion of a technological system, the change of which happens as a technological revolution. The latter is understood as the total of economically and technologically connected innovations which make up a new technological system (Freeman, Clark, and Soete, 1982). Technological revolution results in drastic changes in the leading trends of the state system of technological paradigms that influence all important sides of economic functioning (Perez, 2002).

Social and technological paradigms are considered to be the reasons for Kondratiev's "long waves". That's why their numeration depends on the numeration of the "long waves" above. Six paradigms of this kind may be singled out (five realized ones and the sixth one is still ahead, the year of the beginning or the end means the point of reference of the time period), where the key factors are: for the first long wave (1790-1850) – substitution of machinery for handwork in weaving; for the second long wave (1851-1895) – coal mining and the steam engine; for the third long wave (1896-1946) – iron industry; for the fourth long wave (1947-1989) - energy (oil and organic chemistry products); for the fifth long wave (1990-2040) - microelectronics; for the sixth long wave (2041- ?) - biotechnology. It should be noted that the key factor of a certain paradigm is also effective for the technologies that appeared in previous paradigms though it changes their technical quality.

The key factor concerns mass demand for corresponding technical changes. That's why the leaders of the global community master these technologies in advance. The branches that actively use the key factor and adapt its most successfully to the requirements of the corresponding production organization, are the main investors in advanced technologies and form the technological paradigm of the society. In this context, these branches play the role of priority branches. Understanding of the main peculiarities of development and change in technical and economic paradigms and their connection with institutional structure of the society is an important factor of economic policy formation. Specific features of the new technological paradigm, having been determined, show the way of looking for goals and ways of strategic support of its development in the country.

4. Determinants of cyclical vulnerabilities

The period of existence and the necessity to change the technological paradigm are conditioned by purely economic reasons. Achieving the limit of economic growth, the economic system reaches the state when the interaction of technical and economic spheres stimulates the creation of a new paradigm, which introduces a revolutionary change into the production system once again. Old social and institutional mechanisms

that were adapted to the old paradigm could not be adequate for the new structure of investments, market behavior, etc. They are ousted by the process of diffusion (spreading) of the new technical and economic system. Change of paradigm conditions brings about a radical change in the usual type of engineering and management thinking regarding the effective economic practice. Especially it can be demonstrated pointedly by evidence of OECD countries (Innovation and Economic Development, 2007).

The innovation theory of development was formed as a first scientific (objective) theory of the economic crisis and corresponding cycle. It got its completed form only in the middle of the XX century and then was drawing a rising attention to academics and politicians during crisis times. Up to that and in many cases now, the majority of experts had not regarded the scientific and technological progress as the main factor of cyclic and institutional economy development. For a long time the economic thought had seen a reason for the business activity fluctuations in the psychology of the market agents, rational and subjective behavior of whom would always break the balance between the demand and supply and lead to the rapid growths and abrupt destructive crisis in the development of trade and industry.

One among the first to see the reasons of economic crisis in peculiarities of fixed capital reproduction was M. I. Tugan-Baranovsky (1901). His work: "Industrial crisis in modern England, their reasons and impact on the life of people", which was published in Russia in 1984, and later translated into German (1901) and French (1913) became classical in the world science. He analyzed different approaches to the explanation of cyclic character of production development and drew a conclusion that the obstacle to the continuous accumulative production development is created mostly not by the external restriction factors, but by the inner characteristics of the economic system, which mould the cyclic character of its development. Such characteristics include cyclic regularities in the reproduction of the fixed capital of the country.

This conclusion was made on the basis of both theoretical analysis and scrupulous statistical research of the peculiarities of the industrial development in England. He showed that the industrial cycle is wholly represented in the price of iron: as the trading brightens up, the price of the iron rises – crisis and reaction are expressed by the drop of price. This dependence is explained by the fact, that iron was the most important material, which was used to produce machines, instruments, rails, ships and, in general, means of production and transportation.

Advanced character of these conclusions was defined by the fact that they were forming a new market theory, which differed from the dominating classical interpretations. The market theory of Tugan-Baranovsky was unexpectedness for his contemporaries, this especially concerns the statement that periodic changes of inflows and outflows in industry are caused not by the consumption, but by the production regularities. His theory said that in the years of expansion production increases not because the consumption grows, on the contrary, consumption grows in this phase because of the increase of production. Today we can illustrate such theoretical vision on many facts that accompany current crisis. Table 1 shows dramatically dynamics of volume the iron and steel export during last period.

Table 1. Dynamics of the iron and steel exports by top-10 countries in 2001-2007, bln. Dollars USA

	2001	2004	2007	Growth 2007/2001, times
World	112,4	250,7	425,3	3,8
1. China	2,2	11,5	39,9	17,9
2. Germany	11,0	20,5	35,7	3,2
3. Japan	11,2	21,2	30,1	2,7
4. Belgium	7,1	14,3	25,9	3,7
5. Russian Federation	5,5	16,0	21,1	3,8
6. France	7,6	13,6	20,5	2,7
7. USA	5,0	8,9	17,1	3,4
8. Italy	4,2	9,1	16,9	4,0
9. Ukraine	5,0	10,8	16,7	3,4
10. Republic of Korea	5,1	10,6	16,4	3,2

Source: ITC calculations based on COMTRADE statistics.

Presented dynamics obviously specify the pre-crisis conditions as there is a threat of an "overheat" of economy and formation of a relative overproduction according to Tugan-Baranovsky concept. It is also necessary to note that these tempo rates are caused by significant rise in prices on these products. The physical volume of exports of iron and steel increased much less (an average annual growth of 6,1 % for the period 2000-2005). In parallel, the markets of oil and mortgage had beaten all price records. All mentioned are direct attributes of crisis situation origins, which the innovative theory of economic development specifies.

The given market theory hasn't lost its urgency for the transitive economy. Its efficiency can be easily observed in Ukraine, as the government constantly attempts to carry out investment policy in order to enlarge direct consumption, but yet hasn't got anything but inflation. Such results force government to restrict consumption artificially, which, consequently, destroys all the cycle of income flows and reduces economic activity and production. The cycle theory of Tugan-Baranovsky explains why there exist different periods, during which at first big masses of borrowed capital, which cannot find their appliance, are accumulated, and then these masses are impetuously invested. But the question arises: which types of fixed capital is free money capital invested in? The answer to this question leads to the creation of innovation theories of development. The theory of M.I. Tugan-Baranovsky got its direct elaboration through the works of A. Shpithoff and J. Schumpeter.

The research of Arthur Spiethoff (1903) proved that the expansion phase cannot be caused only by the pressure of the borrowed capitals. Moreover, this phase is determined mainly by the production needs in the "pulling" of innovation. The strength of "absorbing" of the borrowed capitals is expressed by the results of the scientific and technological development, which find their appliance in the production. That is why the expansion phase can be stopped not only in result of the reduction of the free

capitals supply, which are searching for the investment opportunities, but also in the result of the drop of the real capital effective demand. These two interactive reasons determine the basis of the cyclic development.

An impulse for investing arises from the need in machines and equipment production, caused by the new technological improvements, inventions and sale markets. Inventions and technological achievements broaden "the basket of the capitals formation" and create an urgent necessity of its filling up. The capacity of this "basket" is determined by the requirements of the technological progress. But as soon as this capacity is filled up, any additional creation of the new capital becomes vain; the marginal effectiveness of the capital moves to zero, the investments cease, the expansion phase goes to its end. Spiethoff supplemented the theory of Tugan-Baranovsky with the concept of the means of filling of the productive investment vacuum, which occurs in the crisis phase. This process turned out to be impulsive, and because of that creates the cyclic economic dynamics. The formation of integrated innovation theory was completed by Schumpeter (1911:1934), who became the father of the innovation paradigm of social and economic development, which got recognition also in a nowadays through the so-called endogenous theories of economic growth.

A special place in the world's economic theory was possessed by the Schumpeter's elaboration of the concept of innovation. The latter term became the recognized category in world's economic literature. Innovation, according to Schumpeter is not only new invention, but also the new production function. It's a change of technology of production, which has a historical meaning. Innovation is a vault from the old production function up to the new. The basic innovations stimulate creating of the new productions and the new equipment, but not every new invention, new production is innovation.

5. Meaning of innovation and technological structure of economy

The urgency of the given question today is explained by the fact that development of scientific and technological revolution confirms the conclusions of innovation theory about the crucial role of innovations in economy development fluctuations (Fagerberg J., D. Mowery, and R. Nelson (eds.) 2006), (Rosenberg 1982), (Rosenberg N. (Ed.) 1992). Contemporary author's carried out detailed statistical researches of innovation processes that occur in times. Many of them proved a tight connection between the production cycles and the character of appearing and spreading of scientific and technological innovations.

The described line of development of economic theory convincingly shows the role of scientific and technological innovations not only as of the factors of scientific and technological sphere development, but also as of the factors of economic growth, speaking about the whole macroeconomic system of the country. Such point of view about social and economic processes is still not much spread in Ukraine. Much more attention is attracted to the theories which explain economic cycles by the impact of different from innovation factors, more traditional and understandable: capital investment, season fluctuations of yield capacity in agriculture, peculiarities of money circulation, demographic development etc. All these factors are important and we can say about their equal level of impact on cycle. But still the meaning of innovation theories lies first of all in their proving of the fact that the state of scientific and

technological innovation sphere of the country is not the result, but the reason for a lot of macroeconomic changes, especially on the way of economic growth.

The innovative-technological structure and respective dynamics of production exports are today one of the main objects of the strategic analysis at diagnosing competitiveness of the country development prospects. It is derived from two circumstances: recognition of a main role of technological innovations among factors of long-term economic development, and a high level of the world economy globalization. Combination of these two phenomena has led to conclusion that the first, the country's innovative development cannot be successful if it is remote from the world innovation markets, and the second, international competition is spread to practically all inward markets of countries. Therefore in case of success in competitive struggle the national innovative product receives very favorable prospect of realization in scales of the world markets. The "economic prize" of these competitions is very high for the reason that the businessman-innovator and its country receive "market power" (temporal monopoly of innovator) that can bring a huge incomes and a rising of all national economy.

The estimations of given technological level of the economy may be representative by characteristics of its export because the products that are recognized by the world market already have received evaluation of its competitiveness. To make the international comparisons of the countries innovation and technological structure we used an estimations of the technological level of export production that have been calculating by OECD statistics. These figures give us opportunity to compare mentioned technological level of the transitive economies of Central and Eastern Europe. OECD statistics divide production sectors of manufacturing according to their technological level between four groups. The criterion of such dividing is rate of R&D intensities. The aggregate R&D intensities calculated after converting countries' R&D expenditures and production using GDP PPPs, and derived as value R&D divided by production. Thus classify such four groups of manufactures on a level of technologies (in brackets showed a level of R&D intensities, %):

- 1) High-technology industries (7,7 - 13,3);
- 2) Medium-high-technology industries (2,1 - 3,9);
- 3) Medium-low-technology industries (0,6 - 1,0);
- 4) Low-technology industries (0,3 – 0,5) (OECD 2008, p. 220-221).

Our researches have shown such classification actually coincides with classification on technological paradigms which are formed within the frame of Kondratiev's "long waves" (Bazhal (ed.) 2002). We can be to consider the High-technology industries as belonging to the fifth paradigm, two groups of Medium-technology to the fourth paradigm, and the Low-technological to the third paradigm.

Estimations of technological structure of the manufacturing exports, and also exports of the mining industry and agriculture, for the transitive economies of Central and Eastern Europe, which are represented in OECD statistics, we can see in Table 2. The OECD statistics does not represent data for Ukraine. That is why we will try to do such calculation below. The given unified information presents the data to compare of presented countries. It is possible to see strong backlog of Russia from other transitive countries with implementation of innovative structural reforms. We also can see a strong orientation of the developed countries and the best transitive economies in exports production to hi-tech development that confirms the conclusions of the technological paradigms conception.

Table 2. Share of technology industries in total exports of manufactured goods and primary products from agriculture and mining in selected transitive economies of Central and Eastern Europe in 2005, %

	Manufacture according to level of technology				Agri- culture	Mining and quarrying
	High	Medium- high	Medium- low	Low		
Hungary	30,2	41,1	12,4	13,8	2,3	0,3
Czech Republic	15,2	44,2	22,0	16,3	1,4	1,0
Slovak Republic	11,2	40,9	28,8	16,9	1,6	0,7
Poland	6,4	37,7	25,3	26,7	1,9	2,1
Portugal	11,6	29,3	20,0	36,3	1,8	1,0
Russia	1,5	9,2	36,3	4,8	2,4	45,8
EU19	20,6	39,6	17,3	18,3	2,0	2,2
OECD	22,6	38,8	16,2	15,6	2,2	4,5

Source: OECD 2008, Table I.7.1.

The conception of techno-economic paradigm follows from the fact that technological changes occur relatively quickly and surpass changes in the institutional structure of the country which is less reactive as it is prone to conservative interests and support of subjective belief in the "good old days". The period of time necessary for drastic changes in the social and economic structure is the period of formation of the technological paradigm which corresponds to the new principles of management in different spheres that become generally recognized for the regular phase of development. According to scientists, this formation will last for 48-68 years, which corresponds to long-term length of Kondratiev's "long wave". The change in paradigm has all the features of the general technical and management revolution that starts the formation of a more efficient social and economic system.

Reaching the limit of economic growth, the old economic system comes to the situation when the interaction of technical and economic spheres starts the creation of a new technological paradigm which drastically changes the whole production system again. Old social and institutional mechanisms that were adapted to the old paradigm could not be adequate to the new structure of investments, market behavior, etc. They are ousted by the process of diffusion (spreading) of the new technical and economic system. Change of paradigm conditions a radical change in the usual type of engineering and management thinking regarding the effective economic practice.

6. Analyzing the structural technological dynamics of Ukraine

The key approach to the processing industry sectoral unification into separate technological clusters is the product principle, that is, unification into taxons of technologies used in the main activity of enterprises to produce goods and services. However, this or that technological taxon is not always oriented to finished products. Transition to each subsequent technological level of the classification of finished products manufacturing makes it difficult to present them in different technological

groups. For example, the branch “Aircraft construction” (production, assembly, reconstruction and repair of aircraft, gliders and parts and elements for aircraft), under the technological classification of OECD, belongs to the cluster of medium technologies production, but production of electrical devices for air navigation and measurement instruments for aircraft belongs to the groups which already belong to high-tech productions. This fact makes it more difficult to compare them with the data of the State Statistics Committee of Ukraine, but in general it does not eliminate the possibility to get a notion of the structure of Ukrainian industry both in the level of technologies (using OECD methods) and by technological modes.

Using this approach, we grouped the positions of the kinds of economic activities presented in statistic bulletins of the State Statistics Committee of Ukraine, in the context of technological paradigms representation (*numbers* – groups above by the level of technologies) in the following way:

- *Fifth technological paradigm*: production of electric, electronic and optic equipment (1).
- *Fourth technological paradigm*: production of charred coal and oil products (3); chemical production (2); production of rubber and plastic products (3); production of other non-metal mineral products (3); metallurgic production and production of ready-made metal products (3); production of machines and equipment (2); production of vehicles and equipment (2).
- *Third technological paradigm*: raw materials industry (4); production of food, drinks and tobacco products (4); textile industry (4); production of clothes, fur and fur products (4); production of leather, products made of leather and other materials (4); processing of wood and manufacturing products of wood, apart from furniture (4); paper and pulp industry (4); printing industry (4); production of electrical energy, gas and water (4).

We used the above classification of the groups of branches of industry by the type of technology level to calculate the corresponding structural dynamics of Ukrainian industry in 2001-2007. This data is given in Table 3. From this you can also go to the analysis of structural dynamics by technological paradigms as stated above.

It is clear from Table 1 that the structure of Ukrainian industry evaluated by the level of technologies does not correspond to the requirements of time. In 2007 high-tech branches amounted only to 3%. It is 4-5 times less than in developed economies. We also have a considerable retardation of industrial structure regarding the group of medium-high-tech branches. Of 22.0% of the group of medium-low-technological branches, we can single out metallurgic production and production of ready-made metal products. In the group of low-technology branches, we can single out the production of food, drinks and tobacco products. But the most important thing is the picture of structural dynamics which shows the trends of future economic development of the country. The seven years analyzed were the years of fast economic development of Ukraine. Among the branches which considerably changed their position in the structure of industry during this period were: production of vehicles and equipment and production of charred coal and oil products, and production and distribution of electrical energy, gas and water. As we see, it is difficult to talk about progressive structural policy in Ukraine. From the point of view of the theory of technological paradigm, this is the biggest threat for the present-day economy of Ukraine.

Table 3. Structural dynamics of the industry of Ukraine by type of technologies in 2001-2007 (% to the all industry; in current prices)

Branches of industry	Group of branches by level of technologies	2001	2003	2005	2007
High-tech					
Production of electric, electronic and optic equipment	1	2,7	2,9	2,9	3,0
Medium-high-tech					
Chemical production	2	4,7	5,0	4,7	4,3
Production of machines and equipment	2	4,8	4,5	4,4	4,2
Production of vehicles and equipment	2	2,7	4,8	5,4	6,5
Medium-low-tech					
Production of charred coal and oil products	3	4,9	7,4	9,4	7,3
Production of rubber and plastic products	3	1,3	1,4	1,7	1,8
Production of other non-metal mineral products	3	2,7	2,6	2,9	3,8
Metallurgy & ready-made metal products	3	18,0	20,0	22,1	22,0
Low-tech					
Raw materials industry	4	9,7	7,7	8,3	7,9
Production of food, drinks and tobacco products	4	16,6	17	16,3	15,3
Light industry	4	1,4	1,3	1,1	1,0
Textile industry; production of clothes	4	1,0	0,9	0,8	0,7
Production of leather, and other materials	4	0,4	0,4	0,3	0,3
Processing of wood and its manufacturing	4	0,7	0,8	0,8	0,8
Paper and pulp industry; printing industry	4	2,4	2,5	2,5	2,4
Production of electrical energy, gas and water	4	24,8	20,4	15,9	18,2

Source: State Statistics Committee of Ukraine.

We see an even worse situation in the analysis of the structure by technological paradigms. If we perform the above grouping of branches by three paradigms, we will get the results presented in Table 4.

Table 4. Structural dynamics of Ukrainian industry by technological paradigms in 2001-2007 (in % to the all industry; in current prices)

Paradigms	2001	2003	2005	2007
5th technological paradigm	2,7	2,9	2,9	3,0
4th technological paradigm	39,1	45,7	50,6	49,9
3rd technological paradigm	57,0	51,0	46,0	46,6

Source: State Statistics Committee of Ukraine

Today, the dynamics and quality of economic growth in developed countries are determined by branches of the 5th technological paradigm. In the industry of Ukraine, its part in the XXI century did not exceed three percent. This figure is very small. As we see from Table 4, these years saw the strengthening of positions of the 4th technological paradigm, which corresponds to the philosophy and actual priorities of the current economic policy of Ukraine.

We will see the same picture as far as external economic relations are concerned. As it is known, the indicator of the share of export of high-tech branches is one of the most important evaluation criteria of the level of the country's competitive strength. In Table 5 we see the data concerning the structure of Ukrainian export based on the evaluation of groups of production by level of technologies determined with the help of methods used above. We see again a very small share of the products of high-tech branches – only 4,6%. The advanced developed countries have the indicator of 30%. The medium-low technological branches dominate in Ukrainian export – 56,1%. It means that the country is oriented to the production of traditional industrial commodities realized at competitive saturated markets. The drawback of this external economic position consists in the fact that such markets have no special prospects of development, which raises doubts as to the possibility of supporting the long-term dynamics of economic growth of the countries oriented to such markets. That's why developed countries constantly try to make expansion to new innovational markets that can ensure their stable strategic development.

Table 5. Structure of Ukrainian industrial export in 2006 by type of branches on the basis of the level of technologies

Type of branches of industry by the level of technology	Export of industrial products		Trade balance (export – import) by groups of branches, thousand \$
	Thousand \$	Structure, %	
High-tech	1763305	4,6%	-3 076 512
Medium-high-tech	6361707	16,6%	-7 589 546
Medium-low-tech	21509082	56,1%	3 999 054
Low-tech	8733513	22,8%	12 991
Total	38367610	100,0%	-6 654 012

Source: COMTRADE statistics

Looking into the future, the advanced countries are already deploying prerequisites for the expansion of productions of the 6th paradigm, where biotechnologies are predicted to be the key factor. In Ukraine, the share of such enterprises is not only meager, it is also impossible to trace the priority of investment flows for this group. Meanwhile, advanced mastering of future technologies of the sixth techno-economic paradigm may give Ukraine a chance to catch up with the "peloton" of the developed countries in XXI century. As we see, the actual priority today is given to 3rd and 4th paradigms. It may be reflected by simple reproduction of the state of technological basis formed in the past. It is clear that such policy cannot ensure long-term economic growth of the country.

The information in Table 5 shows one more worrying tendency of Ukrainian economy: huge negative trade balance in the groups of high and medium-high technologies. These figures testify to very low innovation potential of the country. Using high-tech products, the country does not create its own production base for adequate increase in the competitive production. This situation cannot be satisfactory in the context of the task (necessity) to create pretexts for future economic growth of Ukrainian economy.

7. Economic policy application

Judging by the fact that effective innovational technological changes are the main factor of long-term social and economic development, all developed countries have created the so-called "national innovational system", which is a complex of institutional, legal and economic measures related to the stimulation of innovational economic changes in the country to ensure strategic national advantages and effective international competitive advantage both on the internal and on the external markets (ed. Nelson, 2003). Considering the above, there is an urgent need to build up the national innovational system in Ukraine as well, and the problems of stimulating investments into technological changes must obtain a priority status in the activity of the legislative and executive branches of power.

The high competitive level of high-tech products, as we may see by the experience of the dynamically developing countries, is the result of successful completion of the stage of "apprenticeship" which serves as a basis of the products of companies – pioneers of innovational process, which are still mass ones on the market, but already old in comparison with the implemented newest ones. The world's leading innovational companies "go" from the traditional market and give the competitors a possibility to "enter" it with the help of improving innovations. Some time ago it was widely used by Japan and new industrial countries to conquer the international markets of high-tech products (Hirooka, 2006). As a result, they created scientific and industrial potential which allowed these countries to strive for more – to compete in the high-tech sphere with the world's leading companies.

Analysis of character of the international technological competition shows that the countries which were not traditional technological leaders but later entered their number, started conquering export markets with imitation of innovations, then found the methods of their improvement and after that became leaders in some trends. That is why the countries which first had no possibility of producing competitive products for different reasons, were first oriented to the transfer of scientific and technological innovations from other countries and their diffusion on the internal market, and then set ambitious tasks related to the presence on world markets.

Use of the methods of techno-economic paradigm during the formation of strategy of the economic development of Ukraine is important because of peculiarities of economic heritage related to command-administrative economy. Transitive countries revealed the problem of low efficiency of resources use and excessive cost of production on a micro- and macro-level in all former command economies countries. This problem is still urgent for Ukraine. Old inefficient structure of production supports stagflation processes that are an attempt to recover macroeconomic balance by reduction of effective total demand.

It is impossible to find the way out of crisis prerequisites of this kind by direct interference of the country with the economy by methods of fiscal or monetary macroeconomic policy. Recipes of quick resolution of the situation are first of all connected with institutional measures of stimulation of dynamic structural changes. Such processes may take place mostly through innovation technological change. However, there is no effective mechanism of corresponding transformational policy provision in Ukraine today.

Technological appeals to the Ukrainian society also come from the part of modern tendencies of global development. The last quarter of XX and the beginning of the new century are characterized by an unprecedented increase in the influence of science and new technologies to the socio-economic state of all the countries. It came out that inability to ensure structural reconstruction of the national economy in accordance with the requirements of the new technological paradigm or delay in performing such structural changes not only slows down its development but also leads to economic degradation. That's why the most challenging task at present consists in building up an integral national system of strategic management aimed at the provision of the said structural changes. The new important peculiarity of development is a considerable increase in the international competition not only on the external but also on the internal markets.

Transition from the development based on the import of technologies to national innovative production is not easy. It will require direct participation of the country in the provision of high level of innovations with the help of budget and private investments in the research and development, improvement of the level of education, strengthening of capital markets and regulatory system which stimulates the appearance of high-tech enterprises. Advanced training of personnel is becoming more important. It is evident today that competitive advantage largely depends on the possibilities of creation and activity of regional innovational clusters.

It is a new phenomenon at the present stage of human evolution that innovation development of technologies is going along the way of a permanent increasing of their complexity. But corresponding production management systems will require the same complication. Empiric research of evolution of organizational structures of the world's leading companies showed that long-lasting success in the sphere of complicated innovational technologies is directly dependent upon the ability of companies to reorganize their organizational structure into a more complicated management and technological complex. The natural consequence of this process is the company's interaction with other companies within the framework of a complicated multi-branch network of enterprises. That's why the evolution of the development of innovational production systems is concentrated on the search for new organization forms which allow increasing the productivity of resources involved. These are the main feature and reason of the creation of new global enterprise agglomerations, in particular those of cluster type.

8. Conclusions

As our research shows there is a more fundamental basis of current crisis than short-term disturbances due to the subjective incorrect decisions, criminal behaviour, and bad government. Actually all mentioned types of occurrences take place in any times. But the mass character of such mistakes emerges when the one socio-technological paradigm of human civilization come to be over and new paradigm starts to mature. The basic reason of such matters concerns a situation when the traditional markets are reaching to the saturation and they have no demand potential to following development. Crisis starts when credit money for the future development of traditional markets change into financial bubbles. This kind of money disappears if they cannot find new objects to investing. New investment goals are as a rule the technological innovations.

Such conceptual explanation of the economic crisis elaborates Neo-Schumpeterian approach of economic theory.

The successful of the innovation-technology sphere of the rich countries is also one of the most notable mega-trends in the evolution of human civilization. The actualization of this factor as a solution to the general problems of economic growth is a very important and controversial subject of economic policy in Ukraine. The advantages of the modern innovations that belong to the current techno-economic paradigm cause the existing economic and technological gap between rich and poor countries. But those advantages may and must be used to the overcoming of such gap. From other hand, a containment of dynamic development of the knowledge economy will determine the social and economic weakness of the country. To search for answers these challenges it could be fruitfully to use the Schumpeter's theory with its leading role of technological innovation for economic development. It may bring important economic policy implications. It can help to form more effective economic policy based on implementation of the knowledge-based new economy approaches.

Nowadays the theory of techno-economic paradigms is fully proved by practice. All developed and dynamic countries prove the correctness of the conclusions of this theory by efficiency of their economic policy which is built up on these principles. In Ukraine, it is hard to acknowledge the objective character of this theory as one can often see real negligence of its provisions, their usage only for beautiful rhetoric. However, as was shown in the article, all transitive economies have no other choice of the model of economic development apart from mobilization of all possibilities for the effective introduction of their economies into the technological trajectory of human civilization evolution. However, practical realization of this task will require considerable political and economic measures to form an effective institutional, regulatory, economic and motivating environment which will be able to ensure accelerated development of branches of 5th and 6th techno-economic paradigms.

Conclusions of this theory directly concern the problem of choosing development priorities to introduce state support for their realization. It is clear from the analysis given that technologies of current and future technological paradigms must be such priorities. Then the structural reconstruction becomes most effective from the point of view of achieving high speed of economic growth. Support of old traditional enterprises does not guarantee achievements of economic aims of structural transformation.

But non-state and private commercial structures in Ukraine have no economic motivation to engage in innovational activities today. Competitors that maximize their profit are often unable to bear additional expenses to get the monopoly profit of the innovator; they cannot undertake economic responsibility related to the risk of a new product introduction or extending to a new market, either. That is why free competition cannot quickly mobilize resources and possibilities of the transitive society to perform the required effective technological changes. The countries with market relations that do not support innovational processes by special methods quickly find themselves in the rearguard of world economic competition.

The world practice confirms that the most effective mechanism of technological changes stimulation is the market competitive environment, where the country interferes in such a way as to protect and support the market players who take the burden of innovational initiative. That is why the country must actively conduct innovational policy. In this context, the current problems for the Central and Eastern Europe transitive countries are the creation of the management structure which would

perform evaluation, planning and support of strategic technological changes in the country in accordance with general national interests. The main aim of this organization must be state support of innovational and technological activities by provision of regulatory and resources base which would condition efficient technological changes in the country as a factor of long-term economic growth.

References

- Anikin A. (2000). History of Financial Shocks. From John Law to Sergiy Kirienko. Moscow: "Olimpic-Business". (in Russian)
- Arthur W. B. (1989). Competing Technologies, Increasing Returns, and Lock-in by Historical Events. *The Economic Journal* 99: 116–31.
- Audretsch D.B. (1995). *Innovation and Industry Evolution*. MIT Press, Cambridge, MA.
- Bazhal Y. *at al.* (2002). Economic Evaluation of State Priorities for the Technological Development, Ed. by Y.Bazhal. Kiev: Institute for economic forecasting of NAS of Ukraine. (in Ukrainian)
- Breschi S., Malerba F., Orsenigo L. (2000). Technological regimes and Schumpeterian patterns of innovation. *Econ J* 110(463):388–410.
- Burakovsky I., and V. Movchan (eds). 2009. How to overcome an influence of the international finance crisis: in search of adequate economic policy / Analytical report, – Kharkov, Prava ljudy. (in Ukrainian)
- Castells M. (1996-1998: 2000-2004). *The Information Age. Economy, Society and Culture*. Oxford; Malden, MA: Blackwell.
- Dosi G. (1982). Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants of Technical Change. *Research Policy* 11: 147–62.
- Dosi G. (1984). *Technological change and industrial transformation.*- Macmillan.
- Dosi G. (2001). *Innovation, organization and economic dynamics: selected essays*. Edward Elgar, Cheltenham Northampton
- Eichengreen B., and R. Baldwin (eds). 2008. What G20 leaders must do to stabilise our economy and fix the financial system. London: Centre for Economic Policy Research (CEPR). A VoxEU.org publication. Available at: http://www.voxeu.org/reports/G20_Summit.pdf
- Elgar Companion to Neo-Schumpeterian Economics (Elgar original reference), Ed. H.Hanusch and A.Pyka. (2007). Ed. Elgar Pbl.
- European Commission. 2008. A European Economic Recovery Plan. Communication from the Commission to the European Council. COM(2008) 800 final. 26.11.2008. Brussels. Retrieved. Available at: http://ec.europa.eu/news/economy/090119_1_en.htm
- Fagerberg J., D. Mowery, and R. Nelson (eds.). 2006. *The Oxford Handbook of Innovation*. Oxford; New York: Oxford University Press.
- Filippov S. and K. Kalotay. 2009. Foreign Direct Investment in Times of Global Economic Crisis: Spotlight on New Europe. Working Paper 2009-021. UNU-MERIT. Available at: <http://www.merit.unu.edu>
- Freeman C. (1982). *The Economics of industrial innovation*. The MIT Press. Cambridge (Massachusetts).

- Freeman C. (1987). *Technology Policy and Economic Performance. Lessons from Japan.* - N.Y.
- Freeman C. and Louca F. (2001). *As Time Goes By: From the Industrial Revolution to the Information Revolution.* Oxford: Oxford University Press.
- Freeman C. and Soete L. (1997). *The Economics of Industrial Innovation*, 3rd edition. London: Pinter.
- Freeman C., Clark J., and Soete L. (1982). *Unemployment and Technical Innovation. A Study of Long Waves and Economic Development.* London: Frances Pinter.
- Hirooka M. (2006). *Innovation Dynamism and Economic Growth. A Nonlinear Perspective.* Ed. Elgar Pbl.
- Hogselius P. (2005). *The Dynamics of Innovation in Eastern Europe. Lessons from Estonia.* Ed. Elgar Pbl.
- Innovation and Economic Development*, Ed. By Lynn K. Mytelka. (2007). UNU-INTECH. Ed. Elgar Pbl.
- International conference "Economies of Central and Eastern Europe: Convergence, Opportunities and Challenges", 14 – 16 June 2009, Tallinn (Estonia). – CD edition.
- Kondratiev N. (1925). 'The Static and Dynamic View of Economics'. *Quarterly Journal of Economics*, 39: 575-83.
- London Summit. 2009. Leaders Statement 'The Global Plan for Recovery and Reform - London, 2 April 2009'. Available at: http://www.g20.org/Documents/g20_communique_020409.pdf
- Malerba F, Nelson R, Orsenigo L, Winter S. (2003). Demand, innovation and the dynamics of market structure: the role of experimental users and diverse preferences. CESPRI WP No. 135.
- Mandel E. (1980). *Long Waves of Capitalist Development.* Cambridge.
- Mensch G. (1979). *Stalemate in technology: Innovations overcome the depression.* Ballinger. Cambridge (Massachusetts).
- Nelson R. (1995) 'Recent Evolutionary Theorizing about Economic Change'. *Journal of Economic Literature*, 32/1: 48-90.
- Nelson R.R. (ed.). (1993). *National Systems of Innovation: A Comparative Study*, Oxford: Oxford University Press.
- Perez C. (2002). *Technological revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages.* Ed. Elgar Pbl.
- Rosenberg N. (Ed.). 1992. *Technology and the Wealth of Nations.* Stanford, CA: Stanford University Press.
- Rosenberg N. 1982. *Inside the Black Box: Technology and Economics.* Cambridge, MA: Cambridge University Press.
- Rumjantzeva S. Iu. 2003. *The Long Waves in Economy: Multivariate Analysis.* S.-Peterburg University. Sankt-Peterburg. (in Russian)
- Schumpeter J. (1934). *Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle.* Harvard University Press, Cambridge, MA.
- Schumpeter J. (1939). *Business cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process.* MacGraw Hill, New York.

- Spiethoff A. (1903). 'Die Krisentheorien von M.Tugan-Baranovsky und L.Pohle'. *JfGVV*.
- The Global Competitiveness Report 2007-2008 / Co-Directors: Klaus Schwab, Michael E. Porter. (2007)/ The World Economic Forum, PALGRAVE MACMILLAN.
- The Group of Twenty (G-20). 2009. Working group 1: Enhancing sound regulation and strengthening transparency; Working group 2: Reinforcing international cooperation and promoting integrity in financial markets; Working group 3: Reform of the IMF; Working Group 4: The World Bank and other multilateral development banks. London. Available at: <http://www.g20.org/366.aspx>
- The OECD Science, Technology and Industry Scoreboard 2007: Innovation and Performance in the Global Economy. (2008). OECD Publishing.
- Tugan-Baranowsky M. (1901). Theorie und Geschichte der Handelskrisen in England. Jena: Fisher.
- Tylecote A. (1992), The Long Wave in the World: The Current Crisis in Historical Perspective, London and New-York: Routledge.