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THE LONG WAVES IN THE POST-INDUSTRIAL ECONOMY

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ABSTRACT

Possibility of preservation of Kondratiev cycles in the conditions of post-industrial economy is considered. The reasons of emergence of doubts in such opportunity are explained. The role of complexity of innovations in preservation of recurrence of development of economy during a post-industrial era is shown. The special attention is paid to not monotony of accumulation of knowledge. The relationship between changes in the financing of basic research in the United States industry and the phases of the long wave of economic development is explained.

KEYWORDS: *Kondratiev cycles, post-industrial economy, network effects, long waves in economy, innovation.*

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1.INTRODUCTION: THE FEATURES OF POST-INDUSTRIAL ECONOMY AS A SOURCE OF DOUBTS IN PRESERVATION OF LONG WAVES

The post-industrial economy is related to the accumulation of human capital. The pace of its renewal presents to be a key factor shaping the dynamics of production. If the human society faces the process of transition to lifelong learning, then the absence of significant pulsations in accumulating this factor looks as the expression of a new nature of economic development.

Such a concept as 'the innovative conveyer' sometimes is featured in the discussions of the modern innovative problematics. According to one of the treatments, it represents a 'technological' line, where the inputs are the knowledge and competencies and the output is the production (products and services - Derbeneva 2003). Another treatment of this conveyer implies the interminable process of realizing the innovative projects just one after another without any delays. The renewal of the technological economy basis presents not as massive investments in the fixed assets of large corporations but as the investment conveyer from which new productions having much less sizes come from.

The beginning of postindustrial economy sometimes is viewed as the time of replacement of easily reorganized network structures with relatively small participants for the large corporations. It is argued that under the information and network economy physical size of an enterprise loses its significance because of virtualising many stages of the production cycle, that the intellectual companies cannot have any tangible assets at all (or almost at all - Diatlov et al. 2008, pp. 117-118). Under the prevalence of such companies in the post-industrial economy the necessity of accumulating large amounts of resources for the renewal of technological basis of production remains a disputable point. Such necessity is one of the cyclicity factors in the concept of N.D. Kondratiev (2002). One should take notice of the fact that in the picture of cyclic waves in the economy of the United States presented by Klepach and Kuranov (Klepach and Kuranov 2003) the amplitude of regular cycles is decreasing gradually.

What factors are capable to lead to keeping of long waves in the post-industrial economy?

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2. POSTINDUSTRIAL DEMAND AND MASS PRODUCTION

The postindustrial epoch is related reasonably to the multiplying of human needs and their individualization. Though the individualization of needs as well as the growth of uncertainty because of increasing the rate of technological development don't exclude the necessity of realizing the large projects, in particular, in the energy area. According to the assessment of Makarov and Kleiner, one should expect that in future the era of individualization and that of standartization will alternate with each other (Makarov, Kleiner, 2007, p. 50).

A personal computer became the symbol of the postindustrialization of some kind which has begun. Such computer has provided huge opportunities for repairing the individual nature of the very process of working destroyed by the industrial capitalism. The individual configuration of personal computers is made of the elements manufactured in the mass order. The development of modern information technologies provides increasingly more opportunities to combine conveyer manufacturing with executing the individual orders.

Significant niches for the large business remain in the post-industrial economy, despite the e individualization of demand and supply. The competition induces its representatives to make forced investments into new General Purpose Technologies (GPTs), when somebody of the rivals behaves so. Being late in such sectors causes the loose of market positions. The competition pressure becomes the factor of a certain synchronization of investments into the radical innovations, which results in disturbing the uniformity of the innovation process and contributes to this process being performed in separate efforts.

3. THE INEQUALITY OF TECHNOLOGICAL DEVELOPMENT BECAUSE OF INNOVATIONS COMPLEXITY

The synergetic effects determined by the linkages between the technological innovations remain the factor of inequality of innovation process in the post-industrial economy. So far, J. Shumpeter and S. Kuznets took notice of this fact. The cyclic fluctuations in the level of those stocks of technological inventions and R&Ds which are addressed by entrepreneurs seeking new effective combinations of production factors, emerge as a cause of the wave nature of economic development (Kuznets, 1940, p. 263). According to the estimation of S. Kuznets, such explanation is trustworthy as 'there may be pauses when there is no large potential available to make changes to incentivize and motivate the leading force of the entrepreneurial genius' (Kuznets, 1940, p. 264). He notes that the pulsation of such kind can be adopted only for the most important innovations, such as the energy of steam, electricity and so on, that is the innovations connected with the Kondratiev cycles (Ibid.). Indeed, S. Kuznetz has specified the innovations that began to feature as the GPTs further.

The Helpman and Thachtenberg model enables to present the influence of synergetic effects on the development of such technologies. The model implies deriving two stages in forming the GPT. The components of a new technology are developed at the first stage. The transition to a new production technology happens when the amount of this components reaches some critical level. That is a synergetic effect. The critical level can be consistent with such amount of components, which can be a starting point of profitability of a new technology (Helpman, Trajtenberg, 1998).

4. THE INFLUENCE OF NETWORK EFFECTS ON THE PRODUCTION AND TECHNOLOGY RENEWAL

Many markets of information products and services are featured by the network effects. The specific feature of the markets with such effects is the existence of a threshold level of the amount of purchasers (of their critical mass). The offered product (or a service) becomes attractive for a wide mass of consumers and the demand is increasing fast after exceeding this threshold level.

For the markets with network effects one may talk about the critical mass of innovative investments. The ability of innovator to mobilize in a short period of time such amount of invest-

ments that will enable to act ahead in forming a critical mass of acquirers, and, as a consequence, to capture leading positions in the relative market is meant.

It's not surprising that the leading role in the world sector of information and communication technologies belongs to the large transnational business which accounts for about 90% of the world output of this sector. Whereas each of the leading 250 companies has the return exceeding 5 billion dollars a year, mergers and acquisitions are still going on. The amount of cross-border transactions of such kind in the ICT sector for the recent years remains at the level of 1500 per year with total cost accounting for 180 billion dollars (Brodsky, 2009).

The network effects enforce the motivation to fill the markets intensely. The open innovations of different kinds serve as one of the tools of this acceleration. When it is analyzed, the central attention is usually paid to the mutual development of new products and technologies, when a rather flexible policy for the intellectual property is conducted for sake of uniting such efforts. (Chesbrough, 2012). The treatment of open innovations as a readiness for sharing the developments to promote successfully the innovative ideas and products appears to be very relevant for the markets with network effects (West, Gallagher, 2006). It can be evidenced by the actions of the US company connected with manufacturing electromobiles Tesla in this respect[2]. It removed the restrictions imposed on using its patents. The actions of such kind enhance the paces of innovation diffusion, which can lead to the waveability of economic development even under the uniform innovation flow (Polterovich, Khenkin, 1988).

5. THE PROBLEM OF COORDINATION OF INNOVATION PROCESSES AS A FACTOR OF THEIR NOT MONOTONY

As S. Kuznets (1940, p. 263) noticed, the large-scale innovations are connected with the change of existing economic relations and as long as their reorganisation is going on, it prevents the next large innovation from being implemented successfully. Despite the sceptical attitude of Kuznets to such explanation, it is close to a later treatment of the role of institutional circumstancies in the process if renewal of the technological basis of production (Freeman and Perez 1988; Van Duijn 1983). It concerns the fact that this renewal is being braked until the institutional innovations open the scope for new technological trends, to concentrate the entrepreneurial activity along these trends.

Though the effective selection of institutional innovations implies the preceding experience accumulation and the selection of new prospective technologies, the removal of barriers for which is ensured is ensured by such innovations. Hence, a certain move along the technological trends of a new long wave is going on within the economic relations of the preceding long wave. The necessity of institutional preparation for the next moving along these trends can be viewed as one of the reasons of interim break during the rise period of the long wave.

At the same time, the issue, what obstacles the institutional innovations in the development of new technologies help to overcome, if the implementation of these innovations starts even without such innovations remains open. Addressing the problem of coordination of such innovations, which are not limited to the fragmentary improvement of the technological base of production but ensure its principal renewal, helps to find a solution for such problem.

Some researchers (Teece 1986; Stieglitz and Heine 2007; Rayna and Striukova 2009) point to the importance of additional assets to ensure the success of innovations. Such assets can involve the network of suppliers or business partners, manufacturing machinery, customers base and reputation. The thesis about the necessity of additional assets to ensure the successful competition at the innovation markets is very close to the idea about a special set of resources to realize the potential of such technologies inherent to the Shumpeterian models focused on the GPTs. The larger the range of such resources is, the more complex is the task of ensuring the coordinated formation of capacities for the production of these resources.

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2 Fashion for Tesla: the Russian businessmen leave their cars for electromobiles(http://top.rbc.ru/retail/17/06/2014/930722.shtml).

When the potential of a GPT gets to its exhaustion stage, the resistance of institutions ensuring the coordination of activity based on this technology is able to impede the timely renewal of the institutional system and the radical renewal of technological base of production together with it. In the opinion of Bresnahan and Trajtenberg, the institutions which are designed to solve the problems of coordination, happen to be more inertial than the leading technologies. It results in the fact that institutional changes and the technological development incentivized by them have a non-monotony nature.

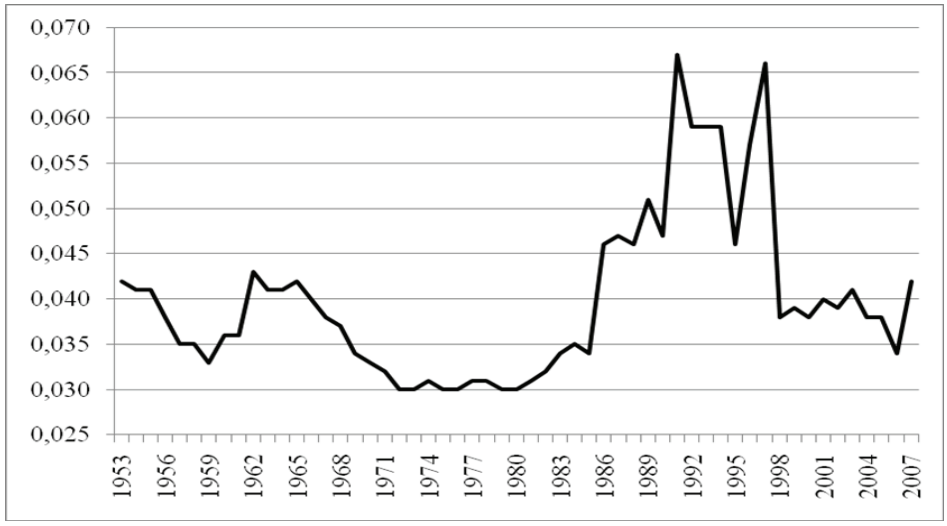
6. NON-MONOTONY NATURE OF KNOWLEDGE ACCUMULATION

One of explanations of the pauses in the innovative activity of entrepreneurs relates these pauses to the exhaustion of the stock of inventions which are able to serve as a basis for new directed technical changes. As S. Kuznets (1940, p. 264) notes, such situation can be determined, in particular, by the functioning of economic system. For example, the electricity had to wait until the economic opportunities of the steam are exhausted by the economic system and until the attention of inventors and engineers is not addressed towards the problems of using electricity. If it is so, then the proposition on the disruptions in the development of technological opportunities should be analyzed based on the historical evidence.

This recommendation of Kuznets began to be realized in 1970th, when the discussion of the long waves became active again. The attention was paid to find the thickenings in the historical sequence of the basic innovations, as well as to define the stages of the long wave during which such thickenings happen. The studies of G. Mensch played a key role in the revival of discussions on these points. G. Mensch linked the cyclic activation of basic innovations with the depression stages of the long waves. The analysis of Mensch was continued and underpinned by the studies of Kleinknecht (1981, 1987) based on a much wider data set. Though the groundlessness of criteria of selecting the innovations remains the weak feature of statistical innovation clasterization studies of such kind. As a result, both, a steam-engine and a pen, appear in the same row of basic innovations.

Under the current conditions the fundamental studies play a major role in forming new directed technical changes. In this connection deriving the regularities of development of such studies during the period of emerged formation of the knowledge economy can shed light on the likelihood of the innovative pauses emergence and wave phenomena appearance during the growth of such economy.

Fig. 1: The share of financing basic research in the expenditures on R&D in the US industry



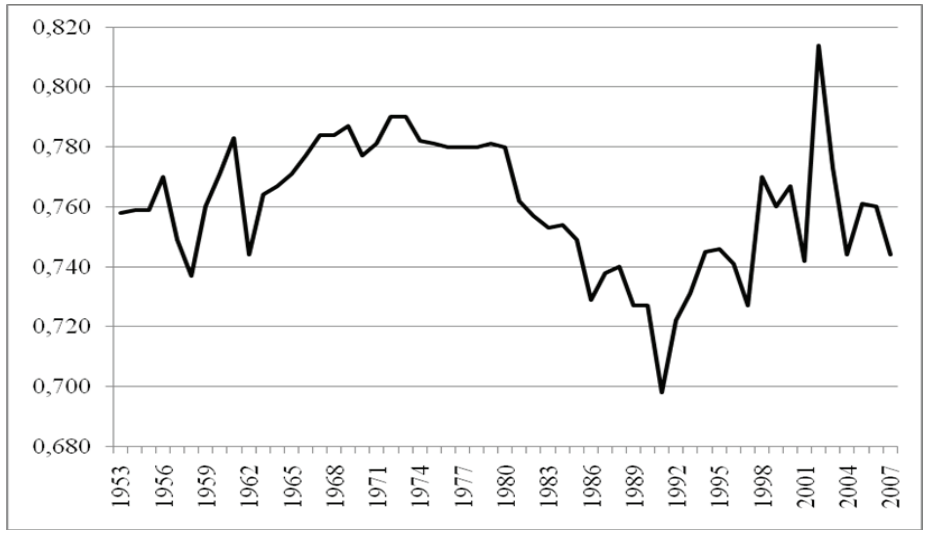
Source: Calculated using the data of the National Science Foundation

The changing attention to the fundamental studies can be evidenced by the dynamics of the share of expenditures connected with them in the US industry (Figure 1). It can be seen that the scientific activity shifted to the area of basic research in 1960th and 1980th. In terms of dating the long waves, these periods happen at the stages of maturity and depression of the fourth long wave. Simultaneously, the years since the mid-80th to the first middle of 1990th should be viewed as a transition period of some kind in the US economy from the aggression stage to the synergy stage of the fifth long wave (Dementiev 2012).

How can the presented evolution of financing fundamental studies be explained? The maturity stage of the long wave is featured by the gradual exhaustion of potential of improvements of technological basis of this wave. The decreasing return from the investments in such improvements follows the next decline of the long wave. The diminishing share of funds to support the improving research in 1970th and 1980th (Fig. 2) is admissible to be interpreted as a reaction to such situation connected with technologies of the fourth long wave.

The aim to enlarge the scientific base for a new large step in technological development leads to the increase of the share of financing basic research at the maturity stage of the long wave. The applied research designed to seek the abilities of commercialization of scientific inventions and using elements of new technologies to prolong the lifecycle of existing production processes become active, when improving the technologies that are at this stage doesn't provide any significant competitive advantages (Fig. 3). Though such way of improving them has its own limits which influence the share of financing the applied research in 1970th.

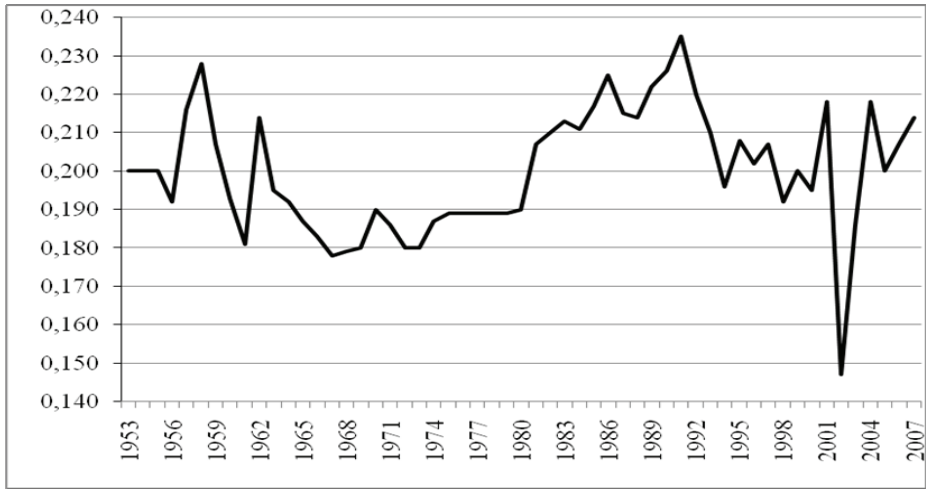
Fig. 2: The share of financing the improving research in the expenditures on R&D in the US industry



Source: Calculated using the data of the National Science Foundation

Approaching these limits means that the prospects of the further development are connected with forming new sectors. Though, what will be the image of a new technological base of production is found during the process of forming and testing different directed technical changes under the transition period. Such research is supported by fundamental and applied studies having quite a high share of financing (Figs 1 and 3). The accumulation of knowledge complex ensuring its effective commercialization comes to the front. In addition, the attention to specific directed technical changes has been growing not only in applied research but in the fundamental ones as well. When new prospective sectors have already emerged, the share connected with these research in the structure of financing R&Ds is decreasing and the share of improving research is growing (Fig. 2).

Fig. 3: The share of financing applied research in the expenditures on R&D in the US industry



Source: Calculated using the data of the National Science Foundation

The presented sequence of changes in distributing investments in R&Ds has its own economic sense. On the other side, it is these changes that influence the economic situation. The cyclic shifting of emphases in the studies being determined by the change of demands for the nature of their results presents to be an important component of the inner mechanism of forming long waves of economic development. The rhythm of big cycles, emergence of breaks as innovative pauses in them, the service terms of basic capital goods depend, in most part, on this component. There is no reason to suggest that the logics of knowledge accumulation won't keep further in the post-industrial economy.

7. CONCLUSION

The factors which can add long-wave fluctuations to the innovative development, will act under the post-industrial epoch as well. A special issue is connected with the amplitude of fluctuations of innovative activity of entrepreneurs and the impact of such fluctuations on the dynamics of economic development.

The analysis of regularities of technological development suggests that initially the role of a new GPT is reduced to the change of some constituents of technologies which already exist. The effect of such changes determined mainly by the synergy coming from the implementation of separate parts of the next technological paradigm into the existing one. The synergy of mutually additive inventions and innovations that belong to a new GPT comes to the front further either. Such synergy leads to the emergence of principally new technologies and products.

The modern economy provides numerous examples of the high absorbing capacity of the preceding sectors in relation to new technologies. As can be evidenced by the investments of different sectors in computers, peripheral equipment and software, the basic demand for these technologies was demonstrated by the mature industrial sectors (Dementiev 2013, p. 42).

The effective adaptation to new technologies enables several sectors to develop successfully during the period encompassing several long waves, forming so-called infra-trajectories (Hirooka, 2006). Several sectors of the preceding technological paradigms can become the supporting sectors of a new paradigm (Glaziev 2010, p. 89).

Such development of some sectors can't eliminate the cyclicity connected with new GPTs. However the more diversified the economy is, the stronger is the damping impact of infra-trajectories on its innovative development. Moving along this trajectory doesn't allow the sector to get rid of creative destruction, as it implies the partial substitution of its technologies. At the

same time the partial nature of the renewal adds some smoothness to the production development.

The public economic policy remains as one of the factors determining the amplitude of long waves of innovative development. The state support is crucial to decrease the likelihood of the innovative pauses emergence, which are connected with the deficit of the new GPT knowledge ready for effective commercialization. Active financing the structures specializing in knowledge commercialization by the state doesn't ensure the success of economic policy. Such financing can enhance the inequality of economic development, when the lack of knowledge stock is aggravated by the weakness of demand for innovations by the sectors that already exist.

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