Cyclicality of innovative development in entrepreneurship

La ciclicidad del desarrollo innovador en el emprendimiento
Ciclicidade do desenvolvimento inovador no empreendedorismo

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Abstract

Research of innovative processes development is one of the most important and popular areas in modern economics. According to neoclassical economics, the innovative development cyclicality, which is manifested in the periodic change of economic ups and downs, is the basis to explain the dynamics in many processes in the modern world economy. Scientific and practical research problem is the multiplicity and often the contradictory explanation of cyclical nature in innovative development. The purpose of the research is to analyze the innovative development cyclicality in entrepreneurship, its identification. The main hypothesis of the research is the thesis that the cyclicality presence is related to technological development of production and also to innovation life cycle. To confirm the point of view, the authors define the connection between the innovation process and the production process by means of technological cycles that can be graphically represented as S-shaped curves and the corresponding curves of average cost. The connection between the innovative development cyclicality and the innovation life cycle is clearly reflected in the dynamics of entrepreneur's efficiency

Resumen

La investigación del desarrollo de procesos innovadores es una de las áreas más importantes y populares en la economía moderna. De acuerdo con la economía neoclásica, la innovación cíclica del desarrollo, que se manifiesta en el cambio periódico de los altibajos económicos, es la base para explicar la dinámica de muchos procesos en la economía mundial moderna. El problema de la investigación científica y práctica es la multiplicidad y, a menudo, la explicación contradictoria de la naturaleza cíclica en el desarrollo innovador. El propósito de la investigación es analizar el desarrollo innovador de la ciclicidad en el emprendimiento, su identificación. La principal hipótesis de la investigación es la tesis de que la presencia de ciclismo está relacionada con el desarrollo tecnológico de la producción y también con el ciclo de vida de la innovación. Para confirmar el punto de vista, los autores definen la conexión entre el proceso de innovación y el proceso de producción mediante ciclos tecnológicos que se pueden representar gráficamente como curvas en forma de S y las curvas correspondientes del costo promedio. La conexión entre el ciclo de desarrollo innovador y el ciclo de vida de la innovación se refleja

(profitability) at each stage in the innovation life cycle.

Keywords: Innovative development cyclicality, entrepreneurship, technological cycles, innovation life cycle, S-shaped curves, average cost, technological gap, production efficiency, profit dynamics.

claramente en la dinámica de la eficiencia (rentabilidad) del empresario en cada etapa del ciclo de vida de la innovación.

Palabras claves: Ciclo de desarrollo innovador, emprendimiento, ciclos tecnológicos, ciclo de vida de la innovación, curvas en forma de S, costo promedio, brecha tecnológica, eficiencia de producción, dinámica de ganancias.

Resumo

A pesquisa de desenvolvimento de processos inovadores é uma das áreas mais importantes e populares da economia moderna. De acordo com a economia neoclássica, a ciclicidade do desenvolvimento inovador, que se manifesta na mudança periódica dos altos e baixos econômicos, é a base para explicar a dinâmica em muitos processos na economia mundial moderna. Problema de pesquisa científica e prática é a multiplicidade e muitas vezes a explicação contraditória da natureza cíclica no desenvolvimento inovador. O objetivo da pesquisa é analisar a ciclicidade do desenvolvimento inovador no empreendedorismo, sua identificação. A hipótese principal da pesquisa é a tese de que a presença da ciclicidade está relacionada ao desenvolvimento tecnológico da produção e também ao ciclo de vida da inovação. Para confirmar o ponto de vista, os autores definem a conexão entre o processo de inovação e o processo de produção por meio de ciclos tecnológicos que podem ser representados graficamente como curvas em forma de S e as correspondentes curvas de custo médio. A conexão entre a ciclicidade do desenvolvimento inovador e o ciclo de vida da inovação está claramente refletida na dinâmica da eficiência do empreendedor (rentabilidade) em cada estágio do ciclo de vida da inovação.

Palavras-chave: Ciclicidade de desenvolvimento inovadora, empreendedorismo, ciclos tecnológicos, ciclo de vida da inovação, curvas em forman de S, custo médio, gap tecnológico, eficiência de produção, dinâmica de lucro.

Introduction

Modern science has vast research experience related to innovative development, the economic growth sustainability and prediction of its dynamics. Any economic process development or phenomenon is characterized by unevenness, cycles, including periods of recovery and recession. Economic fluctuations are expressed by quantitative and qualitative changes and form a positive or negative trend. Financial and political crises, migration problems, social tensions that we have in our life indicate the uneven development and dynamics uncertainty of the modern world economy. Because of this, the foundation for further growth and national economies interaction are seen in the only right direction – the development of scientific and technological progress that underlies the innovation policy in countries.

At the beginning of the twentieth century the Russian economist Nikolai Kondratyev (1892-

1938) explained that the scientific and technical inventions and discoveries are based on the development cyclicality of the world capitalist economic system (the economic large cycles) (Kondratyev, 2015). Innovative development in economics, as well as any qualitative change over time is a contradictory and difficult-to-measure process, subjected to the influence of various exogenous and endogenous factors, which in turn determine the economy movement non-linearity.

The purpose of the research is to analyze the innovative development cycle in entrepreneurship, its natural and internal analysis. The main hypothesis of the research is the thesis that innovative development is inherently cyclical, not straightforward, e.g. it has at least two phases - rise and fall. The presence of such cyclicality is associated with the technological development in production process and with the innovation life cycle. At the

same time the effeciency of innovation and, consequently, the profits volume depend on how the entrepreneur handles this cyclicality.

It is necessary to define the main economic categories that are used in this article. Innovation is the result of research and development, presented as a new or improved product (or a new or improved production technology of a traditional product or service). Innovation is a process, aimed on the scientific research results and development into a new product or technology. Innovative development is a gradual and continuous innovation implementation in order to commercialize innovations, i.e. transforming innovation into a real market product and making a profit from its implementation (Twiss, 1989; Postalyuk, 2006; Terentieva, Korneyko, 2018). The entrepreneurship is the subject-object integrity with a clear hierarchy and clearly defined relations. In this article for the authors there is no significant difference between the levels of economic systems: the innovative development cyclicality is considered regardless of the system scale and the specific conditions for the implementation of its activities. Innovation cycles phases, technological transitions and etc. are typical for a separate enterprise, and for the region, and for the country as a whole.

In this research the authors are based on the concept that the object of innovative management is the innovation activity (the innovation process), and the subject of management is management in entrepreneurship that implements its regulatory process by means of innovation policy. In relation to innovative processes any entrepreneurship system (whether it is an enterprise, a region, or a national economy) is an external environment in which the potential of their development is formed.

Methods

The methodological basis of the article is the general provisions in modern economics, in particular: modern economic theory, the theory of economic cycles, the innovative development concept, the production organization theory, the general adaptation theory. The provisions of these theories are applied in the article by means of system analysis. In terms of methodology the research is based on methods of economic and institutional analysis, average cost analysis, traditional methods of calculating efficiency and profit on the basis of discounting, and also on the

approaches, that are used in world practice to make management decisions.

The systematic approach use considers the research object specifics. The research is based on the classical conceptual apparatus developed by world science, which allows to objectively and reasonably define the problem of the innovative development cyclicality.

Scientific backgrounds of the research

Scientific interest in the problems of innovative development is enormous due to the large impact in scientific and technological progress on the world economy growth, but also due to the lack of an unified view on the cyclicality problem. Nobel laureate in economics Joseph E. Stiglitz published the paper "Unemployment and Innovation", in which he predicts the economic inequality growth due to technological progress and labor automation. Despite the productivity growth acceleration in most areas of management over the last century, the key problems of modern economies are the inequality growth and lower incomes of many workers categories (RIA News, 2018).

Numerous papers explore the innovation development cyclicality in the following contexts.

1) Research of innovative development nature. Scientists analyze innovation cycles, the impact of technological cycles on economic development (Beketov, 2008; Dziallas, Blind, 2018; Roshchin, 2012; Tabas, Beranová, 2016). Modern innovative development trends through the "technological leaps" prism, opportunities and development prospects of different countries from the standpoint of the post-industrial economy theory are also under consideration, various scenarios of the cyclical development of innovative economies are given (Kabanov, 2018; Savina, 2010; Tsvetkov, Zoidov, Gubin & Zoidov, 2012).

2) Innovation management methods improvement. The authors consider the practical issues of real entrepreneurship, which are associated with the optimization of innovative development management in terms of risk and uncertainty, inevitably arising in

the research activities implementation (Kotov, 2009; Markard, 2018; Fagerberg, 2018). Issues of implementation in innovation policy and innovative products commercialization are still highly topical (Huarng, Mas-Tur & Moreno, 2018; Sabri, Micheli & Nuur, 2018; Vasilenko, Linkov & Potachev, 2015).

3) Territorial and branch aspects in innovative development periodization. The main subject of these researches is the cluster approach, program-targeted programming and the specificity of cyclicality manifestations at the meso-level (Berkovich, Komarova, 2014; Domnina, Savoskina & Shekhova, 2016; Tavassoli, 2015).

A comprehensive research on the innovation development cyclicality, the comparison of various views enriches the basis for further research. However, in the scientists' works there is still no consensus about the cyclicality nature and proper management of these processes from the standpoint of the interests in entrepreneurship. All this makes it necessary to continue the work in this area.

Results and discussion

In the framework of the post-industrial economy, the innovation process is an integral part of the production process, although it begins before it and continues after its completion. Let us consider a meaningful connection between innovation and production processes, their interconnection and interdependence.

From an economic point of view, production is the transformation of resource costs into the final product that have to be sold on the market. According to economic theory, under normal conditions these investment costs are converted into production expenses and profits. However, when research and development becomes the main productive force, the process of cost transformation into the final product becomes more difficult. Instead of the standard scheme, which includes procurement production, processing production and the assembly stage, it is necessary to consider research, design, development, marketing and other types of work, which accompany the innovative production process. Social production is inherently continuous, so the innovation process is also continuous, but not straightforward. Strictly speaking, rectilinear development is almost impossible due to the rapid exhaustion of the resource potential in society (Beketov, 2008; Roshchin, 2012).

The innovative development cyclicality, which was integrated into production by means of new technologies, can be graphically displayed using a repeated inclined S-shaped curve (Figure 1). The graph reflects the productivity of entrepreneurship growth as a result of transitions from one level of technological development to another. S-shaped curve shows the technological cycle, i.e. dynamics of product volume growth per unit of resources expended.

Each S-curve has two inflections and is characterized by a transition from accelerating growth to uniform (concavity) and from uniform growth to slowing (bulge) (Gorobets, Mayakova & Osipov, 2014). Every second inflection point on the S-curve means the achievement of maximum production efficiency within a specific technological cycle, which corresponds to the minimum average costs at this technological development stage (ACmin).
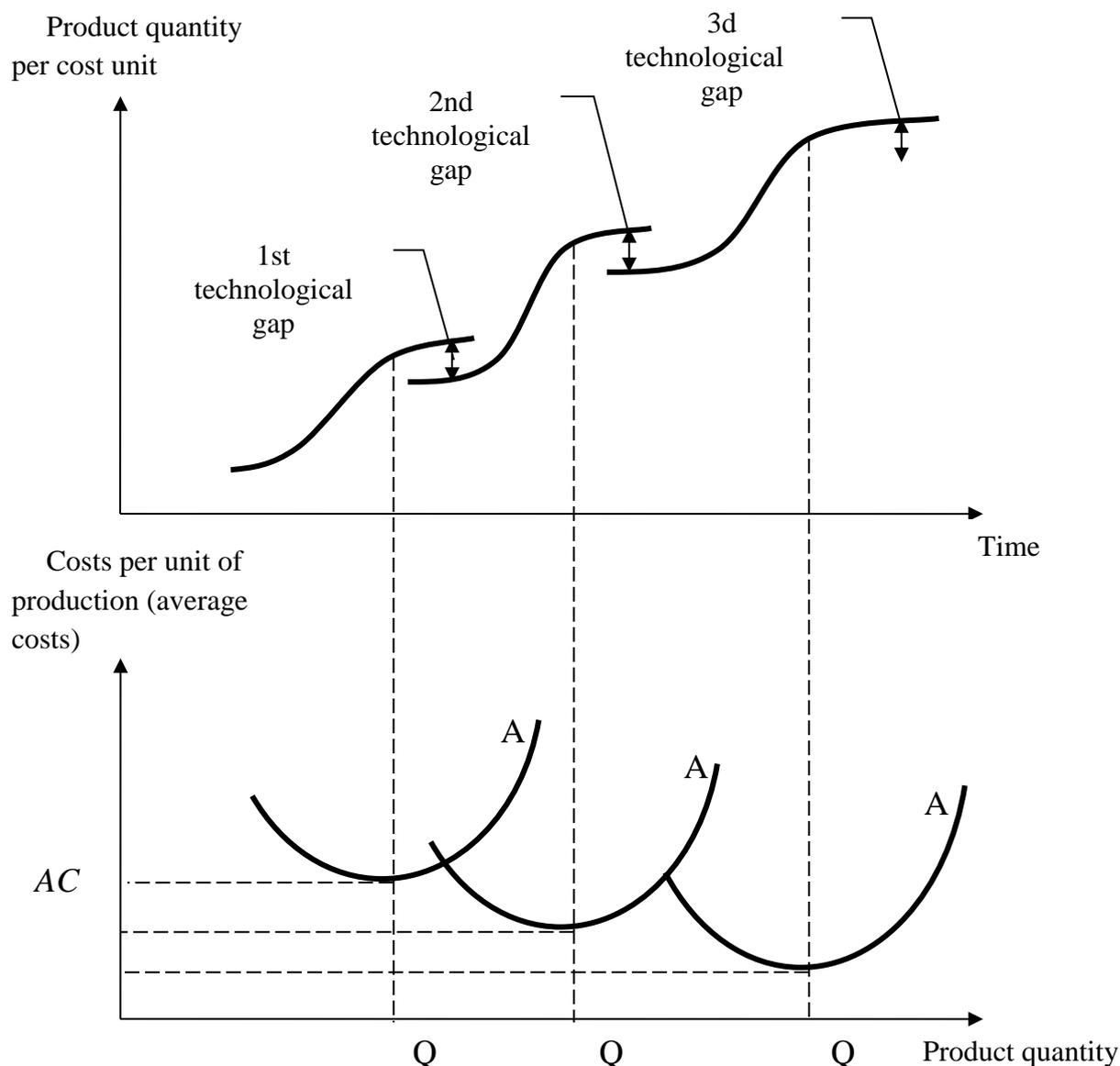
Figure 1. Technological cycles in the production process development

Continued use of technology after reaching the second inflection point in each case leads to the increase in average costs, which means a reduction in production efficiency and a decrease in profits. To change the situation for the better, it is necessary to use a new technology, which requires additional costs for research and development (R&D). Due to the cost increase for R&D, the production efficiency drops noticeably at the beginning of each technological cycle, forming a technological gap. However, the next increase in production efficiency reduces the average social costs to a new level: ACmin2 < ACmin1; ACmin3 < ACmin2 and so on. It allows producing much more products per unit of resources in each subsequent technological cycle: Q2 > Q1; Q3 > Q2. The positive

dynamics of production volume and the negative dynamics of minimum average costs reflect the general technological progress in society.

Understanding the inevitability of cyclicality in technological development allows managing the business activities effectively. If management can trace the dynamics of changes in production efficiency and foresee the approach to the technological gap, a basis for making competent and timely management decisions is arised, in particular: how to change the cost structure, and what efforts are required to achieve a higher technological level.

The reason for the technological development cyclicality, which causes the alternate growth and

productivity decline in entrepreneurship, is associated with the innovative production cycle and with the methods, which are used to control the technological process. The innovation production cycle is known as the time from the beginning of the scientific idea design (technological concept of production) to the end in sales of the product's last copy. Modern scientists identify the following main stages of the innovation production cycle (Gorobets, Mayakova & Osipov, 2014; Vasilenko, Linkov & Potachev, 2015):

1) Marketing research of people's needs;
2) The scientific ideas generation, their filtration and the selection to find the best ones;
3) Technical and economic examination of the innovative project;
4) Research works;
5) Development works;
6) Experimental implementation of the innovative product;
7) Preparation for serial (or mass) product manufacture;
8) Serial (or mass) production and the product sale;
9) Using the product to meet the people' needs;
10) Disposal of the product either physically or morally obsolete.

Marketing research (1)-(2) is necessary for effective adaptation of the enterprise production potential to market conditions and consumers' requirements. Marketing research includes two main elements: study of the current market characteristics and the identification of opportunities for companies' innovative activities so that to capture new market niches. Based on marketing research, business leaders tend to make correct and timely management decisions in the field of innovative entrepreneurship, which are likely to reduce the level of uncertainty in the market and thus hedge business risks.

Stages (4)-(7) represent the innovative component of the general production and technological process: they can be considered as scientific research and development. Stage (4) includes scientific preparation for production; stages (5)-(6) include experimental design and partially technological preparation for production. Stage (7) includes the completion of the experimental design preparation, realization the main mass of the technological equipment for production and also the implementation of the organizational and economic preparation for production.

Stages (4)-(7) are costly, and the dynamics of total costs are upward. However, while the production activates (stage (8)), the resource intensity of the innovative product decreases, forming the downward part of the average social cost curve (Figure 2).

Figure 2. Average costs dynamics in the period of the innovative product production beginning
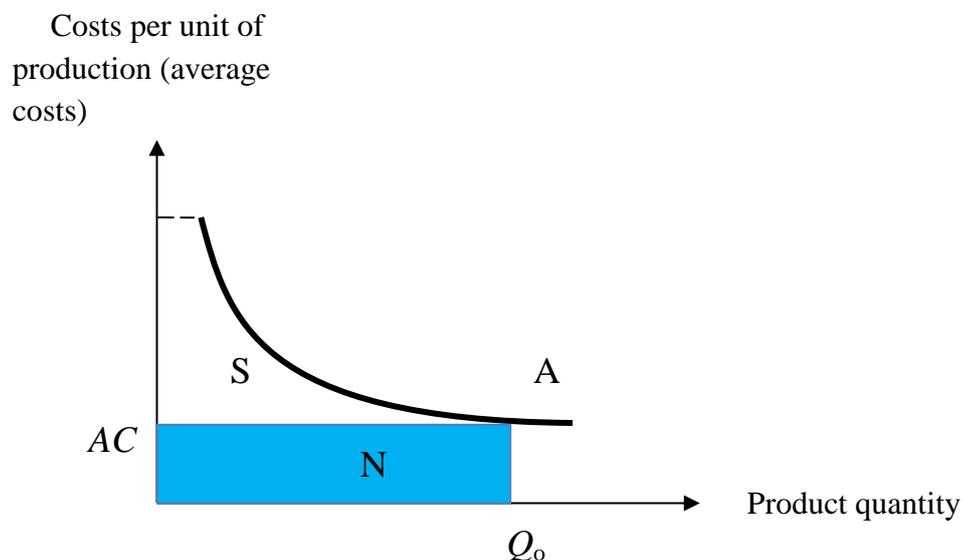
During the period of the innovative product production beginning the total cost is equal to the sum of socially necessary costs (NC, or Necessary Costs) and additional costs for science and technology (STC, or Science and Technology Cost). While the product output grows, the return on science and technology costs increases, and the average cost drops to its minimum ACmin. If the market is competitive and the average costs minimum is reached, the optimum production volume Qopt is formed in terms of the distribution of the society resources. Production volume at the level Qopt will provide normal profit to the product's manufacturer.

If the market is noncompetitive, making profit process by the manufacturer of innovative product can be shown as a combination of the product price movement, which is formed by market demand D, and the dynamics cyclicality of the individual average manufacturer costs (Figure 3).

Price;
Costs per unit of production
(average costs)

D

AC

Los

AC

Pr

AC

Product quantity
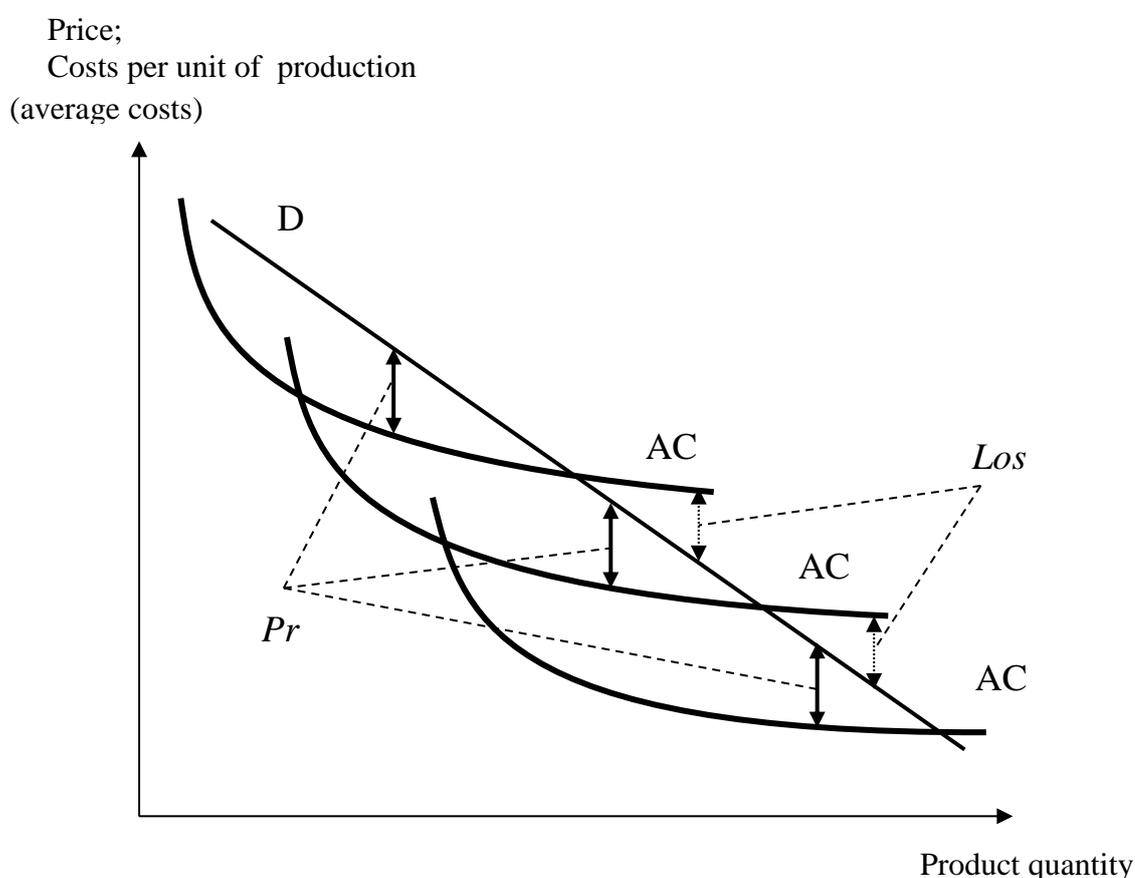
Figure 3. The general model of the cyclical formation profits for the innovative product's manufacturer, operating in a noncompetitive market

Profit is determined by the difference between the price that consumers of the product are willing to pay and the average cost. The market is noncompetitive, that is why within each technological cycle, which reflected by a specific average cost curve (AC1, AC2 и AC3), the point of profit maximization is achieved long before minimizing average costs, i.e. the average costs level achieved by the manufacturer is obviously higher than the minimum. The rate of decrease in average costs is essentially less than the rate of price reduction. That is why a producer can get a loss before its technological equilibrium. In order to prevent losses, the producer in a timely manner and while still in the profit zone, has additional research and development costs in order to shift the average cost curve down to the right and ensure profit in the next long-term

period. The producer works ahead, reducing his average costs in advance compared to the average social ones. At the same time, both individual and social production efficiency increases due to the shift of average cost curves down.

This model reflects the idea of Austrian economist Joseph Schumpeter (1883-1950), according to which the real profit of an entrepreneur is a temporary profit, obtained by the reduction of individual costs in advance relative to the social costs of product manufacture. The earlier new equipment and technology are applied, the greater the difference will be between social and individual average costs, the greater the production volume, the longer the lead-over period and the greater the potential profit of manufacturer will be (Gorobets, Mayakova & Osipov, 2014; Likhosherst, Mazelis, Gresko & Lavrenyuk, 2017).

Such potential profit can be calculated using the formulas below:

$$Pr = (P - AC) \cdot Q \cdot T \tag{1}$$

or

$$Pr = \sum_{j=1}^{T} (P_j - AC_j) \cdot Q_j, \tag{2}$$

Pr – profit that the producer will receive as a result of innovative product implementation at the j-th time interval;

P_j – actual price of the product on the market at the j-th time interval;

AC_j – individual average costs of innovative product production at the j-th time interval;

Q_j – manufactured product quantity at the j-th time interval;

T – period of advanced reduction of the individual average costs level relative to the market price on goods (or average social costs).

In this way, the main factor of innovation development is the saving time for the resources passing through the whole economic system. All costs in one technological cycle must be connected with production stages or procedures time. The example of the Japanese system "Just in time", its wide distribution in the world shows that it is quite possible and technically achievable. The technological procedures duration is the time when mechanical, chemical, physical and other effects on resources take place. As a result, there is a change in shape, size, physicochemical properties of resources, i.e. a new product is created.

Conclusions

This research leads to the following conclusions.

1. The research on the innovative development cyclicality in entrepreneurship is a topical issue, which has various views, theories, and positions. The authors adhere to the concept that such cyclicality is associated with the technological cycles of production. At the same time, the innovation use effectiveness and, accordingly, the amount of profit depend on how well and timely the entrepreneur takes into consideration this cyclicality.

2. Technological cycles can be represented graphically by means of repetitive S-shaped curves, each of them reflects the production efficiency dynamics within one technological development level. The productivity dynamics is closely connected with the average cost curves configuration: the maximum productivity (average product) corresponds to the minimum average costs. Expressed in a decrease of production efficiency at each technological cycle beginning, a technological gap inevitably appears between the S-shaped curves.

3. The innovation development cyclicality in entrepreneurship is influenced by the

innovation life cycle. In contrast to the traditional product, innovative production periodically requires additional costs, which is expressed in the cyclicality of the efficiency dynamics (profitability) in entrepreneurship. If the market is competitive, the optimal output is formed when a minimum of average social costs is achieved. If the market is noncompetitive, the manufacturer is forced to work ahead, reducing his average costs in advance compared to the social average cost.

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