

## **Monograph**

# **INNOVATION CYCLES AND INNOVATION DEVELOPMENT FUNDING**

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### **Forward**

*In the sphere of the innovation taking place the fundamental transformations the most of general principles of economic systems functioning. Primary interest is the nature and the dynamics is transformation of economic relations, their cyclical nature and irreversibility. Business activity in economic systems is a general object of study for this work, where main subject to study is processes of reproducing the reproductive factors productivity. Values realization through plural economic processes in production forms the basis of economic systems development for different structuring levels. The development is implemented in the process of innovation activity, it's realization is the essence of reproduction innovative reproductive factors.*

*In this monograph, intention is to analyze the elements of innovative production, which already today are functionally adequate to reproduction system of future were subjected. Nowadays, their own dynamics utilizes fragments the "traditional investment model" elements and transforms them into innovative reproduction components. All investigated elements of innovation reproduction were integrated into the funding mechanism, based on finances distribution function and functional monetary model. Comprehensive analysis and economical synthesis, gives of varying degrees unified adaption macroeconomic models of development, different configuration Cobb-Douglas's production function parameters in dependency of applicable resources. The configuration and the order application of economic factors will always determine the quantitative value of the result of activity of systemic economic of entities. Development is characterized by dialectical nature the quantitative and qualitative dynamics of performance indicators of reproduction. And this is the fundamental, distinction and complexity. Such dilemma, should be objectively considered by differentiation categorical essence the economic development. It is a prerequisite for developing of general methodology, which is realizing model of*

unification reproductive factors for productiveness growth. It also aims to differentiation economic factors to "innovative" ("reproductive) and "traditional" ("provision" or "functional").

Development is a movement, interaction, synergy and realization the reproduction potentials into organized systems.

Methodology of production and exchange economics in previous their development was directed to incorporation the time factor in economic models. So, it unable to offer priori the adequate theoretical description of the functional transformation. Creating the functionally, structurally and scale adequate for innovative reproduction characteristics mechanism is only possible based on the innovative reproduction methodology in restored values distribution system. Actually, methodology for distribution will shape the next phase of social progress in the world.

In a new system, the economical efficiency is objectively focused to epicenter business processes of innovational profit circular reproduction, where knowledge elements reproduction is appearing as reproducing factors. These are fully reflected in the categories "innovation" and "innovative development" as their functional interaction form. The global economic and social transformations problem is generated by extra-productivity the innovative reproduction. Furthermore, innovative type of reproduction carries and realizes the potential of overcoming temporal discontinuity in reproduction.

In according with unify approach we may interpret innovations within comprehensive unified concept as "competitive advantages which are produced within the organization, implemented in economic turnover, embodied (concentrated) in the commercialized product in the form of technology, licenses, patents, goods, etc. " So, innovative development should be considered as continuous reproduction the competitive advantages.

Thus, to create the models of innovation development was synchronized the model innovation cycle, currency market models, the models of enterprise, industry and national economy. The general concept of innovation and finance cycles synchronization contributed to the development of some methodological approaches to support the new principles structuring innovation. These principles are to separate management of technological innovation and capital innovation that are associated with the modernization of industry permanent renewal of technological reproduction base.

So, we sure in the field of innovations there is a cyclical interdependences of dynamic development of enterprises. Capital innovation provides the capital growth of enterprises. Technological, managerial, marketing, product innovations provide the extensive growth of technologies. Innovation is the result of consistent implementation these interdependencies. Violation of these interdependencies differentiates integrated production processes and research. This makes it impossible to use the synergy of efficient production and scientific knowledge.

The innovation process has a continuous cyclical nature. It continuity was proved by value approach to evaluation the processes of formation reproduction resources based on innovation cycle. In innovative-investment model of production function the performance is consolidated to three vectors: innovation technologies, quality of personnel and the consolidation the innovation profit in the functionality of innovative investment reproduction fund. This approach allows us to calculate the numeral parameters

for funding model of innovative development due to short funding and long investments. This, in turn, allows to offer method for synchronize using the lending and investment mechanism for innovation and science development both in the enterprise and the national economy. This calculation confirms that technological innovation induces to acceleration the depreciation fund formation and "capital recycling" with following transformation them to finances. Herewith, effectiveness funding of innovation development should be assessed based on cyclical innovative factors implementation, which can be represented by a linear function. Technology factor and capital gain factor both are the primary factors of innovation development, which are directly implements its own productivity into the innovation process for economic systems any level aggregation. The sequence and frequency their implementation forms the innovation development dynamics, which is implemented by periodic establishment their close linear interaction. To solve the problem of design a common reproduction model for economic system through financial factors we should unify the technological-innovation development dynamic model to innovation cycle model. The effectiveness funding innovation models based on self-funding mechanism and investment are functionally compatible, autonomy and equally relevant. These can be considered as basic resources for economic system innovation development.

On the level of national economy we should based on general regularity of innovation factors linearity in modeling of innovation development. It manifests itself as a long term growth of innovative environment under enterprises technological development. This approach allows to build the unified mechanism for synchronous implementing funding innovations and dynamics of innovative development factors reproduction.

The reason of cyclicity the innovation dynamics is a regularity of cause interactions the innovation cycles development. More aggregated innovation cycles has decisive impact to creating boundaries their own smaller cycles implementation. This is a main characteristic of innovations cyclicity dynamics. Therefore the innovation development volume is limited by implementation the technological innovation productivity to economic turnover within each technological cycle. The technological productivity is reflected by ratio of total amount the technological innovations and innovation profit share in structure of total profit. It is a basic principle of mechanism for implementing technological innovation in capital innovations growth.

It was researched limitation relatively larger aggregation cycle dynamics in this study. This explains the uneven development. Stochasticity and uneven development in the field of innovation is manifested under arising technological gaps within innovation cycle of reproduction. In this case, technological gaps should be regarded as loss causation functional interconnections between innovation factors implementation of enterprises keeping the possibility to compensate economic losses due to total innovation dynamics in industries or national economic system. The technological gaps reason is in absence synchronization between technological reproduction cycle and capital reproduction cycle due to arising lack financial resources on the verge of launching a new technological cycle of productivity reproduction into innovative products. It leads to arising the technological gaps in industries and, consequently, the loss of opportunities for innovation development. The intensity of technological innovation outstrips product

*innovations therefore it leads to asynchronous dynamics technological cycle and capital reproduction cycle. This creates a vacuum of economic environment development. It can be methodologically compensated through involving depreciation fund to financial turnover. Depreciation fund should be connected with innovation profit which are aimed at development of innovations and science. These can be consider as basis reproduction the technological innovation and funding mechanism of capital's innovative reproduction.*

*In the whole, this work presents theoretical description of one of the vectors the economic and social progress.*

## **INTRODUCTION**

### **Innovations: Major Categories and Modern Approaches**

Nowadays, economics as a methodological basis for research innovation and innovation development comes in some contradiction with postulates of the theory of science and technology progress, theory of information, other paradigms. In essence, the modern concepts of innovation development have different interpretations of postulation obvious manifestations of innovation primarily in economic relations. No other science haven't got effective methodology to describing the phenomena of "innovations".

The theoretical basis of the innovative development were formed under influence to several areas development, on various stages establish of economics. It is fair to allocate five basic steps: Kondratyev's theory of long waves, the Theory of economy development by Schumpeter, the Neoclassical theory [B. Santo, I. Ansof, G. Less B.Tvis, K. Freeman], the Theory of acceleration from the concept of "knowledge work" to "Innovation and Entrepreneurship" [P. Drucker, 1985 ]; the Theory of competition [M. Porter, 1985]. By the general approach in these is provision about economic growth in the country is determined by the level of innovation in the economy. However, the modern knowledge about formation and development of innovative processes, must be formed according to fundamental provisions of classic economics. It does not allow for the possibility of ignoring next:

- the balance market is characterized by market equilibrium;
- volume and intensity of investments in the production of goods is determined by the dynamics of market rate of return;
- prices for goods, services and labor are established under influence the dynamics of the relevant markets growth; the absolute level of prices determined by the quantity of money in circulation.

Simultaneously, the doctrine of economic balance is not used in the work as a methodological basis. The research results and conclusions can neither be considered nor treated as

equilibrium parameters for the economic system. A Priori, hypothetically is allowed the existence the relative conformity state of the complementary functional interconnections of elements in economic systems, where new quality relationships and substantial elements of the economic system are created by their functional realization. From the assumption of relativity functional relationships followed relativity of characteristics of built models , characterized by the general substantial constant. Such constant should be considered a "Time" or "timelag" in the dynamics of economic change.

Accordingly, the characteristics of determination of the functional elements have only a single objective criterion: relatively time of activation and the completeness of economic processes. Such approach let prevent to many assumptions and reservations permitted in neoclassical economic models and, simultaneously, to discover the essence of the economic changes in economic systems within the limits standardized statistical period.

The theory of innovation as a direction in economic theory was separated with studies of economic dynamics, causes of economic crises of capitalist society and cycles of conjuncture from the works M.I. Tugan-Baranovsky's (Tugan-Baranovsky M.I., 1984), Nikolay D. Kondratyev's (Kondratyev N, 1925), Schumpeter's J. (Schumpeter J., 1934). They laid the foundation for the study of innovation as an economic category and complex problems and interdependence of scientific discoveries, their implementation and application in the economy, the dynamic of movement and reproduction of capital.

N. Tugan-Baranovsky introduced into scientific economic lexicon the term "investment", that was different from the accumulation of capital, and reflected the movement of value and the potential development of the economy. N. Tugan-Baranovsky submitted that accumulation of temporary free capital, which as "borrowed capital" through the mediation of banks creates "pressure on the industry". It personifying "new purchasing power" and creating demand for new products, overcomes the resistance of the traditional mode of production and leads to the development of industry and expansion capital. Among the reasons for the evolution of the capitalist system he highlights improvements in the sphere of commodity exchange, that led to the development of organizational forms of enterprises in industry (appearance and distribution Joint Stock Companies), technological improvements, scientific progress. All these influenced the mode of production, changes in transport, exacerbation of international competition and, restructuring of industry in the direction of increasing the share of machine building.

N. Kondratyev examines in detail two important provisions in understanding the nature of the crisis. First, they are periodic, secondly, that they are organically inherent in the capitalist system. Studies of the nature of crises showed so it became clear, that the crises represent

only one phase, which consists of three: the rise - crisis - depression. So the crisis can be understood only in the study of all these three phases.

An important aspect of the genesis of innovation theory, we should take Zombart's position. He related to factors formation and development of "capitalism" a dialectical interaction of social principles and ideology, where the technology component is considered on the level of "economic system" as a whole as a technological mode of production. Some ideas of W. Sombart was developed in Schumpeter's works. Overall, it was worked out a quite solid theoretical basis to the theory of cycles conjuncture, where the nature of crises seen in the context of economic cycles. Also, J. Kitchin discovered short cycles (3.5 years) fluctuations conjuncture. (J. Kitchin, 1923)

N. Kondratyev, in studying the dynamics of capitalist society, highlights the existence of long and very deep and significant influence fluctuations on economic dynamics by analyzing some key elements of the capitalist economy, while recognizing all the elements interrelated. These elements are commodity prices, interest on capital, nominal wages, turnover of foreign trade, mining and realization coal, iron, lead. Based on statistical analysis curves that reflect the dynamics of individual elements he identified four empirical faithfulness in the development of large cycles. N. Kondratjev so describes the chronological sequence of changes during the arising waves. There is a critical mass of inventions and discoveries. Approximately with delay in the decade, these techniques are introduced improvements in industry, which leads to the formation of new industries, and in another existing industries led to improved production methods. These changes (new technologies) are accompanied by the two other major events: strengthening the US role on the world stage, and significant growth of gold mining in the United States and Australia, which led to changes in monetary circulation, growth of international trade volumes, turnover and strengthening the processes of the capital concentration (arise MNC on the world stage).

In explanation of these processes, it should be noted that the growth of the gold turnover reflects the valuable growth of newly created values and performs:

- the measure the volume growth of the market and ensuring the implementation of growth of productive forces in economic turnover;
- potential of creation future real investment social fund as the potential of market investment capital in the amount of savings;
- the value of real growth of markets, like realized gains of aggregate demand in the form of growth of production factors, that is equal to economic growth.

N. Kondratyev's general understanding the nature of interdependent of economic systems development and objective processes occurring in the market environment, in their

interconnections with laws of wave-like cyclical nature, is the theoretical basis for the modern understanding of the interdependencies in the context of the factorial impact of innovation in the economy development. The saturation of demand in industries, in state close to equilibrium, dictates the improvement of production technology, replacement of inefficient capital. It happens under influenced by growth of production scale when competitive advantages associated with it is fraying. Herewith, the growth of other sectors and the diversification of capital leads to a decrease in the rate of return in the industry, lower than alternative interest rate. All it leads to a drop in output.

But this is not the only factor. Another important factor is the growth of the market like a sublimated expression of demand increment, that materialized into the bringing to market innovative new products. Changes in demand as an expression of the potential of markets growth, initializes the proposal in the amount of economic growth, which is implemented in a qualitatively new characteristics of factorial components as increment quality characteristics of factors of production. Each stage of development invariably accompanied by changes in the production function. A common measure of changes technology base reproduction in production function will be the volume of growth of innovative type of economic system. Such "innovative restructuring" of economic system is characterized by the tendency of the economy to balance. The totality of technological innovation will determine path of innovation development of economy. In this system the characteristics of the dynamics of innovation development, a total increase of quality characteristics of the components of growth factor is the functional basis for innovative growth capital. General value expression of it is a growth of the volume markets like aggregated indicator of renewal values. Values's total increment over of it's reproduction part is the potential of future capital accumulation in social reproduction fund - social investment fund. The theory of large cycles gives such thought of the overall dynamics of the realization innovation cycle. N. Kondratyiv created long cycles model. He directly connected unevenness nature of scientific progress and the process of capital accumulation, salutatory technological changes in the structure of production and money circulation, the activation and the weakening of social and political processes and involvement of new countries into the global economy. He provides important methodological aspect of the study of the nature of innovation as a permanent process that comes of its foundation from socio-economic relations. And also about the development does not arise out of nothing, but rests on a certain level of development of the productive forces of the global economic system. This makes it possible to identify the main characteristics of innovation: scientific, technological, economic nature, integrative, global. J. Schumpeter first from all performs differentiation innovation on economic and technical combinations that take into account the needs and existing tools and combinations, which are

based on ideas, methods and which do not coincide with each other. (J. Schumpeter, 1934). His basic position is in understanding crisis as turning point of economic development. He separates economic processes by categories on the processes of economic turnover and processes of development (which is discrete and uneven), and processes, that impede development. Objectively, in such differentiation of fundamental economic phenomena is present a certain classification by functionality relationships and character of effects. The emergence of "new combinations" determines the pace and dynamics of innovation development. Development as a discrete phenomenon, it is - a serious violation of economic exchange such as depression, recession, recovery of production. Economic essence of depression is to spread, through the mechanism of desire for balance technological advances on the entire economy. The cause of crisis he defines as market saturation, when the total volume of new business reaches a size that brings the economy to a balance, credit inflation, falling prices, growth of spending, aggregate demand fall and destruction of values, that leads to following credit deflation. Herewith, widest facilitation of loan conditions causes to inflation similar to unsecured money issue. Under certain conditions it can stop the development of both normal and abnormal period of depression. In this time it deprives the economic depression of their inherent traits as function for replacement capital and "overload" the economy inefficient costs that associated with the existence of non-viable enterprises (J. Schumpeter, 1934). Implementation of innovation mediated by credit and financial mechanism. These reproduce the new conditions for economic turnover realized in the economy in the new quality standards also the level of organization of production. Along with the financial and credit mechanisms should be considered innovation together with enterprise in the unity of their economic characteristics, as a reason and mechanism of development. Reproductive properties of innovation appear at the micro level and in the economic system as a whole. Its play as development function for companies (as a new production function) and new business (as a "new technology combination"). Innovation is a cause of violations of economic turnover and replaying his new volume and structure. This concept successfully presented by P. Drucker and M. Porter.

Consequently, as general conceptual position, it should be noted historical and methodological basic for understanding of *dual nature of innovation and determine its reproductive nature within the economic environment of companies. The implementation of reproductive function of economic turnover transform to innovation development of economic systems.*

Exactly such interpretation might be taken as a general concept of systems development of innovative type of reproduction. The economic development process is initialized by the introducing and defined by the dynamics of basic innovation in the industry, and is chaotic.

So, innovations are introduced into the economic turnover and stimulates economic environment disrupting the balance of firms and markets. By the nature of the impact the technological innovation are unpredicted, but these are designed and controlled by the management and marketing innovation, so their chaotic, destructive effect is lost.

Innovations should considered in the context of development of the productive forces of society because it's strongly impacts the process of expanded reproduction and these are an active element for replacement and expansion capital. Technological innovation are always mediated by financing, so it leads to qualitative changes in economic turnover. All three of these are components of the mechanism of innovation development and its necessary should be considered in unity of enterprise. In theoretical aspect the innovation development should be considered like configuration changes factors with following generating a new production function. Also, it must be emphasized that innovations have a dual nature manifestation. They are endogenous factor for the development of enterprises, and at the same time these manifest themselves as reproductive function of economic turnover in economic relations and a factor of economic development of the economic systems too. But it is not enough simply understanding the dual nature of innovation for explaining the innovation dynamics. We should understand nature the driving force of innovation.

Some before, we talked about M.Porter. According to M. Porter “the only reasonable concept of competitiveness at the national level is productiveness”. (M. Porter,1980). M. Porter provides a some methodology of industrial corporations development, where the main factor is innovation like a product , technology and method of achieving competitive advantage. He calls that a competitiveness, innovation and informativeness are the objective characteristics the innovation development of corporation and those elements that are inherent in the totality of economic relations. In this aspect he considered innovation with standpoint of innovative classical theory, together with next thought about the innovations is created within the organization and these are a factor of enterprises development as a result of progressive changes. So, the researchs frameworks of innovation as endogenous factors or characteristics of enterprise business are overcome. It puts innovation to the rang of socially relevant categories. Understanding the innovation not only within the production process, but also investigation the nature of their implementation in the economic environment provides an opportunity to significantly expand the scope of the study. Consequently, innovation are a new technology, and secondly - a competitive advantage that is created in the process of life while expanding the scope of activity of the company in attracting new resources, skills or prospects to entrance to the new branches". (M. Porter, 1980) Thus, the innovation is a product and a competitive advantage. Also, innovations that are realized in economic relations should

considered as the development, tool for overcome competitive forces, a victory in the competitive rivalry. According to this sensation we can offer important methodological approach for determine the external industrial corporations environment for the success in competition in international arena and direct interconnection between the development of enterprises, national productivity (productivity social production) and country's competitiveness in the international arena. That is methodological basis for creating for government effectiveness to building of national innovation system: innovation environment and innovation infrastructure.

So, we should determine two way for following investigation.

**Firstly.** Nowadays, there is possible for clear structuring the corporate profits of innovation leaders in conditions of innovation economy. M. Porter argue it is heavy to explain the emergence the super-profits of innovation companies. These often haven't got the competitive strengths of post-industrial type, and these not so much creates the barriers to entry to industry, which related with economies of scale, differentiation etc., so as creating a new options for branches, the dynamics and direction of development, sets a new characteristics of competition ( M. Porter, 1980). It is important to note that profit growth innovative firms don't describe by linear function, and profit growth don't determine by economies scale and increasing scale of production. These are the proof when industries bear minor costs for creation of new technologies or for the improvement of the production process and all this leading to disproportionate growth of profit without substantial capital renewal.

**Secondly.** Variability competitive environment is largely determined by the dynamics of innovation implementation in economic turnover. Simultaneously, there is a reverse effect that encourages the company to significantly expand the scope of innovation. Just as in the field of choice of competitive strategies, the problem of choosing the direction of technology development arises for the companies. Such problems are resolved by the strategic management. For example, the strategy of technological leadership will require more dominant management, marketing, technological innovation. These must provide impact on the industry in general and in different directions: on customers, suppliers, competitors actual and potential. The implementation of various marketing strategies, such as: product differentiation or focusing, will require more motivated and effective R&D conducted within the organization, such as applied "intra-firm science". In this sense, the innovative product will not only goods, but also experience in a marketing or management techniques, new technologies. If the selection of basic competitive strategies of the leadership is the task of predictions of correlation competition strategy and the task in the field of increase income together with mission company coordination so it lead to choose of basic set of innovations according to the strategy of cost leadership in combination with innovation at the other strategies. The combination of different directed

strategy has the effect of the strengthening and multiplication. If firm is carrying out strategy of product differentiation or focus strategy, also simultaneously both of them, so marketing innovations are an instrument of accession effects from innovation of leadership in costs strategy. The combination innovation of different strategy provides an increase in market share, creates barriers to entry into the industry, so the company overcomes the competitive forces and goes into the lead. In this case, there is a multiplier effect of efficiency of innovation. The innovation of strategy of product differentiation or focusing can create a competitive advantage for the company. These are a factor of development and in conjunction with basic innovations of leadership in cost strategy or focusing strategy provides additional growth of profit (innovation profit). Simultaneously, there is some functional transformation where innovation already appears as a factor of development and a new product. So, it provides a synergy effect. Combination of innovation economies of scale with innovation of product differentiation focusing allows to achieve the resulting effect from three: profit growth and creating barriers to entry into the industry. The combination of innovation that we define the basic for the main types of competitive strategies is also possible to implement into some one of them. Innovation is a unique mechanism, that is able to combine in a mutual process different autonomous, multidirectional processes subjecting them to a single logic of innovation development. This is not the growth potential of the company. It is rather neutralization interference in the competitive environment as the capture of basic competitive forces. Domination involves the use of for their own benefit, manipulation.

The branches was clearly delineated in the era of "mass consumption" and most of them had good growth prospects. Only most enterprising company could engage in new activities thought out of overcoming borders of branches. As I. Ansoff argues, the transition from production to market orientation required another attitude to management tasks. It need to be considered not from the inside of the company, but outside, in the open prospect, where the future raised to the increasing level of uncertaine. (H. Igor Ansoff, 1979)

For companies with complicated technologies to develop new products has become an important component of their activity, that was embodied to creation of laboratories of "Dupont", "Bell Telephone", "General Electric" It became the beginning of spreading the practice of creation innovation inside of the firm. In the industrial era radically changing the situation impulses was coming mainly from leading firms, wich created how style so pace of progress. The effectiveness of the companies economic strategy of development of innovations has a deeper effect than the emergence of new products, because moral obsolescence threatens to lose investment firms in the previous technology, R & D, staff. That's why, there is a temptation for firms to diversify activities into another branch. In this context, the markets growth are not the

potential development of enterprises, but only volume the potential realisation. In the context of innovative development, consumption volume is equal to the volume growth of the markets or industries. In fact, we can see it is a potential implementation of innovative development of industrial corporations. That is one aspect, where the markets growth is an objective process. But there is a subjective factor. This is a modern monopoly, which transforms as scale so initialises the dynamic growth. In the modern sense, firm's monopoly status does not disappear after going out from the market or lost positions by innovative leader. Actually, monopoly is a very position of "innovation leader". So, competition is not to fight, but race for innovation leadership position to get a monopoly. In modern conditions the functional influence of innovation somewhat transformed. The main breakthrough force and crucial basic innovation in XX century was a change in public attitudes and influence public opinion on the philosophy of business in the United States. Actually, this is caused the reorganization of production processes, corporate structure, business relations and business environment, political and economic aspects of public life, globalization. All this we can call derivatives structural innovation. It changes in attitude to system-creation the business's role in society life together with openness of information were the mechanism of democracy and the liberalization of the movement to a freedom society. This by what Internet was initiated and generated as most fully realized innovation in the field of information transmission. And there is no contradiction with the thesis about innovative development as the realization of demand through the growth in supply. This demand was generated outside the economic sphere of society, namely the social and political sphere. This led to establishing high society requests to the intellect of worker and human, to humanize the science and economy. One of the aspects the definition of development is the formation, saturation and implementation of demand in all forms of expression. Orders for Keynesianism was dictated by the interests of America's leading corporations as the realization of industrial orientation in society development. Freeze of branches has led to capital pressure, under which was implemented the basic innovation in form of Keynes's theory multiplier and accelerator. So, first of all, we should consider the Keynes's theory as the basic manage innovation. Keynes's Theory replays the new technology of global economic environment growth, where each new development cycle was accompanied by the world market expansion or the involvement new countries in the global circulation of new values. In this is technologically reproduced the mechanism of changes the orientation and the mobilization of factors on priority directions, that is accompanied by the introduction into the economic relations the state and social institutions as a qualitatively new subject. State is a new "Technology of Motion Direction " values movement and system mechanism for determining the trajectory of social development. Actually, the state was introduced in economic relations as

a social institution. So it caused to socialization the economic spheres. Thus, scientific progress has become by socially accented, that lead to humanization of all spheres of public life. The significant competitive advantages was creating for countries by using the theories of Keynes, where the relationships and interdependencies was defined by competitive position in the world. The society innovative potential was formed by the countries competitiveness. So it determined the place of the national economy in the global division of labor, dynamics, direction and intensity of innovation development. Innovations are occur as an active element of formation and determine of dynamics the variability of the environment industrial corporations in economic space. It is important to consider in all aspects of innovativeness competitive factors in the development of industrial corporations. Simultaneously, innovations appear by competitive advantages of companies, that is differ qualitatively new not a linear effect on the companies productive efficiency. It should also highlight another important point. Innovation overcome systemic organizational gaps in the economy. These are the most powerful and most effective incentive development that arises from the objective conditions of competition on the foreign markets and implemented the company as its own innovative development. Innovation is changing not only nature of technology and production, management processes within the company. These are also changed the nature of competition, pricing as products so in factor markets. Under the growing influence in shaping demand, the nature and intensity of production, as well as pricing, innovation become by factors influencing the processes of creation, distribution and redistribution of values and replaying a whole.

*So, the functional content of innovation in the economic relations we should considered as reproducing factor transformation the economic systems of any level of structure.*

Innovations influences like external motivational force of firms development and at the same time these are the product of reproduction, which is implemented in economic turnover. So, innovations are the innovative implemented development of the companies.

This provision largely corresponds to the concept of techno-economic paradigm by the basic preconditions. [Dosi. G., 1982] Actually repeated occurrence of secondary effects in the processes of innovation development leads to consider the whole complex of economic relations as a unified system of reproduction. This is especially true for the multiplex synergies of technologies development. Actually, technological advantages should be regarded as a determinant of modern type of economic growth in system implementations different functional properties technologies. That's why we should be seen as a determinant of business processes initiated at the micro level the spreading influence technological factors on the effectiveness of a structured economic systems. The main property of technologies is the spreading their own productiveness to economic processes and generation on this basis, in the economic system,

certain directions the technological and economic progress. When considering the issues of innovative development is not as important to focus on the problem of sectorial structure of the economy. Reality is in significant concentration by leading multinationals the financial, intellectual, technological and information resources in scale of the global economy. Today the market is an oligopoly, where nature of competition dictates the availability from firms the significant potential. High-tech corporations represents whole industries and markets products or services. Thus, the significance of branches as the organizational structure of the economic system is transformed into the scale of industrial corporations, that is an important institutional innovation. Innovative development arises as a result the growth of factor components of social production. At the macro level this is manifested in the change in economic structure prevailing share of innovative high-tech industries, +effective system of higher education and science, high share of technology-information component of production resources markets and commodity markets, highly integrated economy in the world global economic processes. J. Stiglitz forms its position on the innovative development around the macroeconomic aspects of public policy and general economic growth. Herewith, the functional role of innovation is concentrated around the probable negative and the real effects of technological progress. (Joseph Stiglitz, 2014) Dynamic of unemployment and technological progress, innovation, GDP growth is all categories, which to some extent puts under "questioned" the effective functionality of innovation. But it is necessary noting Stiglitz's argumentation positions fundamentally raises the question of the functional significance of innovation in the dynamics of economic growth. Undoubtedly, the intensification of innovation and slowing GDP growth is a fundamental problem that can create the illusion ineffectiveness of innovations. So, there is certainly contradictions in understanding the functional nature of innovation for the economy, because innovation nonlinear influence economic mechanism of production. Innovations dramatically reduces the amount of costs, changes the configuration and the model of production function. Besides, there are processes of "merging" the commodity-complement markets. In the result the ineffective portion fallen technology markets is "disposing". We can call this a "natural disposing" initiated by activation of innovation. Restructuring markets leads to reducing their magnitude by inefficient parts and simultaneously it is happened increasing economic efficiency of the economic system. The process of replacing / dismantling inefficient mechanisms of production is happening as in the global economy, so the national economies, where industrial technology waged to the technological of collapse on the Earth, famine and social upheavals caused by probable systemic crises.

So, the problem is in lack of a common methodology the account of efficiency innovations into the total volume of world (national) product. Nowadays, the absence of the

same basic approaches to understanding the function of innovation in development of economic systems is obvious. Simultaneously J. Stiglitz's position was not fully reflected without reference to another his work, where he studies the trend towards decline in prices, motivated by the dynamics of innovation in the economic system [J.Stiglitz,2014]. Hence, actual interest in innovation by theorists of public finance and public policy indicates about expanding halo of research the role of innovation in economic development.

In according with the conceptualists position we should consider the innovative-institutional determinants (human capital, development institutions, administrative resources, etc) as main factors of economic development [L. Fedulova, 2013] That is determine the need to adapt existing theoretical models of economic growth on the base of integration of neoclassical and institutional paradigm. However, it must be emphasized that despite the diversity of research directions of innovation and their impact on the economy and society, all fundamental approaches the innovative development methodology were formulated by six main conceptions. It is about "occasional" pre-Shumpeter's theories, classic theory, the theory of economic growth, business cycle theory, evolutionary theory and social-psychological model. Definitely, the thesis about system-making function of innovations is deserving attention. Actually, the substantial integrity of contour of innovation systems is supported by intersystem interaction that is actually creates the innovation synergy. Interaction and Synergy determines the properties of systems where innovation develops their own functional nature into dynamic form the development of innovation systems. Actually, in terms of interactivity of methods, there is coincides the common position theoretical approaches and conceptualists about the technological components of innovation development. This can be considered the general common feature of the formation of the modern view of the problems of innovation. Also, there is strong tendency to form some general institutional-innovation conception of , based on which are formed, in fact, new views in macroeconomic research.

System-creation function of innovation presented by «innovation-driver» according with Bengt-Ake Lundvall's concept of national innovation systems [Bengy-Ake Lundvall, 2010]. Intersystem interaction allows to use the technological knowledge and competitive advantages to creation of national innovation systems. In this configuration, small-scale economies be able to concentrate and reproduce the innovative resources with dominant functional role of «learning mode». In this sense, innovations transform to interactive system of technology transfer and knowledge. These concentrate resources to progressive directions towards achieving competitiveness and creating systemic relationships for generating new knowledge. Thus, we can accent for two main approaches to defining the essence of innovation and innovation development between the different conceptions. Innovations are considered in terms

of statics, as a result of a particular type of implementation of scientific knowledge in production. The evolution of the approach outlined towards researching the concepts of "innovation process", "scientific research and experimental development", "diffusion of innovation". Next position is to consider the innovation in terms of the dynamics of economic processes where innovation is studied in the dynamics. Namely as a "new approach" for changes of innovative nature into the economic systems. Expanding the content of innovation by concepts of "innovation development", "innovation" "innovative economy" reflects the dual form of initialisation of innovation in functioning of economic systems, from enterprise to the national economy. Simultaneously by such differentiation it does not provide a unified approach to the understanding of innovation and innovative development as a single phenomenon. By this it possible to reflect the dynamic characteristics in defining innovation. Innovation changes the economic processes in production and changing yourself. Innovation product is created under implementation of innovation, enhancements, improvements. The result of technological innovations in the field of marketing or management is achieve a competitive advantage, development and leadership of firms on the markets. It is the mapping of dynamics process of economic development of organizations.

It was this aspect expands the field research of innovation. That's why we should distinguish the definition of innovation, product innovation and dynamic characteristics of innovation. So, we must determine complete effect of innovation to development of innovative economic system like more correctly and perspectively. Innovations arise spontaneously. These can be also designed. But innovation are always difficult predictable in terms of the final effect on the operation of the business or the economy. All dynamism and versatility innovation is realised in the complex their characteristics. Thus, we can separate a common features for all approaches to treatment innovations, which are unified static and dynamic characteristics of innovation, among them next:

- the ability of innovation to produce competitive advantages;
- innovation is completed by stage of the commercialization process (without commercialization, the introduction of the economic turnover, innovation is the usual novelty, "exclusive" and does not fall within the scope of economic relations);

The reason of such interconnection is obvious. Innovation in the form of new information is a factor of employee's intellectual growth and increase its expertise. Employee is produced the innovation for organization.

Necessary to select a functional influence of innovation in development of economic systems, which under cause-effect interconnection generates the innovation development as a new qualitative state of reproduction. Such qualitative transformation of economic systems is

caused by mutual regeneration their limit states. Simultaneously, these substantialize "innovation" and "innovation development" as an immanent critical conditions of economic systems development.

Thus, in according with unify approach we may interpret them within comprehensive unified concept, where:

*innovation - is competitive advantages which are produced within the organization, implemented in economic turnover, embodied (concentrated) in the commercialized product in the form of technology, licenses, patents, goods, etc.,*

*and: innovative development - is continuous reproduction the competitive advantages, which is characterized by the growth of firm's competencies and turning them into a product in the form of experience, technologies, licenses, patents, methods and models, services, products, etc. with a view to commercial realization (implementation and use) in economic turnover.*

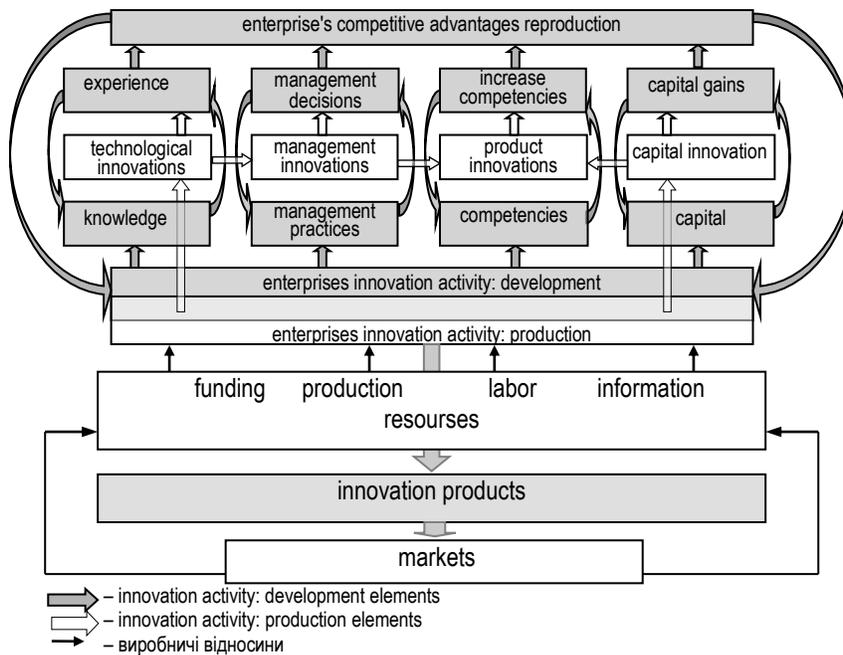
These definitions are intended to disclosure functional characteristics of innovation in their generating in the economies and also economic interaction with the elements in the processes of reproduction and development.

In this time, structural and functional interaction of elements of innovative development should be considered in according with the functional models in the level of company's economic systems. Also, there are additional specific effects of structural and institutional content in the progress of reproduction at the level of interaction between the economic system more aggregation. Consequently, the cyclic dynamics of interdependence the quantities and qualitative indicators of corporations development implemented in the area of industrial innovations. This allows to drive effectiveness of development and innovation implementation according with type of innovation. Obviously, the "innovation capital" provides capital growth. But technology, management, marketing and product innovations provides the extensive technology growth, organizational structure development and expanding line products of enterprise. New ideas become innovations under appropriate conditions when increasing the volume of enterprise competencies. As a result, competitive advantage is focused in innovation, which implemented in economic turnover in high-tech markets for commercial sale like innovation product. These interdependencies integrated into the machine engineering production processes and R & D, so it all ensures synergy of research and innovation performance. The loss of these interactions leads to loss of competitive advantage of the organization as the most significant characteristics of innovation. Also, it should be considered as one of the reasons causing technology gaps in engineering, and, as a result in industry in a whole. Thus, in engineering is functional unity transformational content: technological innovation↔capital innovations → product innovations, or in the other way: product innovation

→ (technological innovation ↔ capital innovation). That's how based on identical dynamics and synergy innovations are transformed to result of reproduction competitive advantages with following concentration of firm's competences into innovative product engineering company.

Competences are an essence of qualitative characteristics of reproduction competitive advantage. These are a functional element of the innovative reproduction too. Basic competences as essential characteristics of innovation development are reproduced into primary effects of all innovation production elements growth. Secondary effects are in the next subjective sense. Competences themselves are an innovative functional elements of reproduction, that in the complex of all economic company characteristics realized in "the Goodwill" concept as an element of market value competitive advantages.

Figure 1. Enterprises competitive advantages reproduction model



Source: developed by author

Thus, in the study of innovation development it is necessary differentiate the concept of innovation for the preservation their essential unity.

The first thing, knowledge, experience, competence, capital, technology, strategic management all these are the internal resources of reproduction in the process of innovation.

Secondly, the effectiveness of innovation ensured by attracted industrial and financial resources, labor, information according to directions of innovation development.

In machine engineering the production of innovation focused directly in the production process and extrapolated to the sphere of reproduction values. In the result there is identification and unification the production and innovation. In practice it is implemented in an objective needing for research and development, improvements to overcome the time lag diffusion of innovation. In this time there is large business risks security.

This obliges consider innovation as a core production. These interconnections (fig. 1) clearly reflect the structural unity the elements innovation such as: competitive advantages of organizations production (reproduction), implementation of innovation products and implementation of innovation into the economic turnover. The economic turnover of competitive advantages values creates a set of interrelated elements of a market economy: directly markets and reproduction productive resources of innovation companies. In this model, markets are used as a system of economic relations, which is established during the implementation of innovation. Thus, as innovation markets may be resources markets, Hi-tech markets, economic relations in the middle of associations of enterprises, the economic turnover conditions of strategic alliances.

### **Conceptual basis the financial mechanism of innovation development**

The movement of values in space and in the functional plane reproduces the latent functional dependencies under its own dynamic. It brings to derivative movement, which is mediated by two value's substantial states: the money supply and velocity of money turnover. So, for the base model of innovative development financing mechanisms advisable to choose I.Fisher's monetary model. In this time, the Fisher's model parameters are using as a common feature restrictions for building the predictive analytical models of economic systems innovative type of reproduction. Just necessary to formulate the first caution methodological plan.

In the basic of financial mechanism structure of innovative development should be considered industrial corporation, which is the most functional innovative economic system. Its economic content is such dialectical systemic interdependence as

**"capital ↔ staff ↔ reproduction processes".**

Second, the economic sense of Finance is the capital accumulation and reproduction process into a values cycle. The development is ensured by continuous of reproduction processes, and financing of innovation development is directed by the movement of capital. And this is a reason to consider these concepts in the context of a single task. Triad concepts of "Finance - enterprise - development" has always been the civilization mechanism of economic development and social progress.

So it is an objective basis of the chosen approach .

On the basis of neoclassical production function:  $Y = T f(K; L)$ , where  $T$  (technology) = const) they took conclusion about investment efficiency. But it was that technology not to be influence factorial components. But, in modern conditions the technology can not be considered as constant. Technologies makes a decisive influence on the industrial corporations business strategy. Its can also change companies position in market. So it can change decision about investment in R & D, technological development and innovation projects too. That's why, the investments today have a much broader meaning than just financial resources. Investing today is realised like a institutional function element of the economic system. That's why the investments are development tool and overcoming the crisis in the any level of economic systems aggregation. Functionally investments should be consider as instrument for other financial mechanisms.

Also, a most relevant changes related with profit. In high-tech industries through different standards of industrial consumption, it will be possible to creates a new technological sets. It let redistribute and concentrate the created value for income with follow provision a local increase profit margins of some companies. Just some economists defined it as "innovative effect".

The information is a functional basic for the formation of qualitatively new system of reproduction under the structural transformations, which there are in economy.

The profit also acquires new qualities. So, profit functionality is transformed, raised and structured in according with directions the realization. Actually, a new mechanism the reproduction system for society is formed as a "distribution mechanism" under innovative direction of economic transformations. In the result, the exchange and production spheres is transformed into it structural elements. The innovation profit has a key role as new it reproduction characteristics in a new quality of distribution.

So, innovation profit - is the profit that received above total rate of return in the industry, as the effect of enterprises innovation growth. Actually, the availability of innovation profit characterizes the innovative firms.

How do we define the "innovation growth" for themselves and for the community?

*Innovation growth - is the increasing scale of innovation enterprise activity.*

Where it comes?

*The most powerful initializer of innovation development is increasing human life-activity environment.*

In which functional categories we can seems complete to present the innovation development?

*In reproduction.*

The company innovation growth changes the perception of the source of profits in the industry. Profit enterprises is provided by using the "traditional" competitive advantages of the

company, reducing the cost from scale on competitive markets. But it does not change the situation in the industry and does not lead to development too. But, availability the innovation profit creates for innovation companies the possibilities to initiate and use the industry's imbalance for their own advantages. This appears justified for a raising the prices of their own products and also provides the change in demand in the industry, which makes it possible to determine the volume of production. In other words, innovation companies creates advantages for themselves in a competitive market like the benefits of monopoly – to fixed the price and quantity control. It uses fully and assigns economic effect from price changes and maximizes profit by increasing the production volume. Innovation enterprises development will provide competitive advantage creation and getting the innovation profits. Superprofitability of enterprise greatly enhances the financial provision opportunities of innovation enterprises development. It lets to get the effective financial mechanism. In this regard an exceptional relevant is the role of depreciation. As will be proven further in process of work, depreciation is a functional transforming form of innovation profit. Now we can focus only on the most common interpretation of the depreciation. It performs the providing of reproducing, distribution and controlling function under utilization, reproduction and constant updating of companies capital. The depreciation reproducing function we should understand as investment the replacement and upgrade production capacity. Distribution is implemented through the mechanism of the deduction of profits and accumulation in company's depreciation fund. Along with this we can distinguish the regulatory function as characteristic of depreciation, which is manifested in economic relations. Regulatory function of depreciation is to determine the rates, proportions and dynamic of enterprises innovation development. It can be as a separate function with some reservations, because depreciation is not fully authentic it to do and serves as an instrument of government economic policy. Depreciation financial resources as a mechanism of self-financing enterprise innovation development simultaneously is an economic policy instrument. In this sense these significantly influence to formation of external innovation environment. Such dual form of depreciation charges makes them adequate appropriate elements of the reproduction. Thus, depreciation should be consider as independent financial mechanism into financing of innovative companies development. Actually these two functional components "profit↔depreciation" under its own integrative functional interaction creates the basis to finance for getting the innovation profit. This is a method of development, its implementation mechanism. But more of it later.

Through this position we'll come to some non-system differences, which is the derivative methodological alternative. That means: they precisely focuses on the financial aspects of the innovation process. In according with this the financial method is taken as a given function. So,

the mechanism is seen as a functional determinant. Then, with specific facility, they develop specific funding mechanism. This is the basis for classification of financial mechanisms. Financial mechanism provides the synchronous implementation factors of innovative development of enterprises. Its goal is to implement into economic turnover the competitive advantages of the organization, which was embodied in an innovative product. Actually, it leads to a certain ambiguity in determining its functional content.

Questions: is financial mechanism a totality of methods or implementation some elements of the funding system? Actually, its functional content determines the economic category defines the structure and classification components, especially the complex objects of economics. Thus, the specifically content this contradiction is in determining differences between approaches to understanding the funding of innovation development mechanism and financial mechanism of innovation. There is obvious identity of these categories, but some differences must be identified as relevant stage of research. Financial mechanism is a method of implementation the financing system elements, and it is also the method to manage cash flows the innovation enterprise. So, it some extent stripped dynamic characteristics inherent innovation. So, financial mechanism is a method of providing the financial resources, while there is method of realization the finance of enterprises innovation development. It is also a tool for management of innovation development. Development of the method of funding the innovation is seen like a function where components are changing and determining the resultant effect. This approach provides greater mobility of financial instruments with widest range of implementation. Thus, the immediate task is to differentiate the objects in a focus of financial influence and also to create the approaches for application and adaptation the financial mechanisms. Functional unity the finance and innovation involves formulation dual essence of innovation financing mechanism. It should accept as innovation reproduction funding mechanism and also as method to design the finance relations of innovation development. So, the funding mechanism object has a dual structure too. There is a financial resources distribution complex for innovation and also innovation companies activity. In progress of financial relations of innovation activity is ensured the implementation of innovative development financing goal engineering enterprise. It is profitability of innovation investments and commercialization of innovation in economic turnover. Directly innovation activities doesn't fund because it's can't to be the property subject.

Innovative activity is a consequence and logic of economic relations for new technologies production. It comes to contradiction with the nature of financial relationships. There is factor of time for establish the functional interconnection between innovation and

financing costs. In practice it is implemented in innovative investment risk and falling the value of investments caused by the expectation of profitability growth of the company.

*So, the financial mechanism is a functional characteristic the financial relations content on providing companies innovation activity. It is component the funding mechanism for financing companies innovative development.*

*Thus, innovation development funding mechanism is a system of interaction forms, methods, models of implementation the financial relations which is concerning the forming, implementation, management and reproduction of financial resources for creation the enterprises competitive advantages.*

### **Resume**

Essence of innovations is a nature of dynamics of reproduction processes. Innovation are transformation of reproducing factor the economic systems development any level structuring. Innovation has potential to realize reproduction themselves in economy. Existence of innovations in two forms dictates the necessity of dual compatible determining them as innovation product in competitive edges of organization. Next essence is in innovation development as permanent competitive advantages reproduction, which is characterized by the growth of firm competencies and turn them into goods for commercial sale in the economic turnover.

In the field of innovations is realizing a cyclical interdependences of dynamic development of enterprises. Capital innovation provides the capital growth of enterprises. Technological, managerial, marketing, product innovations provide the extensive growth of technologies. Innovation is the result of consistent implementation these interdependencies. Violation of these interdependencies differentiates integrated production processes and research. This makes it impossible to use the synergy of efficient production and scientific knowledge.

Innovations has a dual productiveness in mechanical engineering. Primary productivity is realized in the creation of new innovative industries. The second productiveness is realized in the economic growth of the economy (economic environment development) due to operating of innovative equipment. On this basis is the unification of production and innovation activity. Loss of the interconnections scientific and industrial processes leads to the loss firms competitive advantages. It cause technological gaps in matching engineering. As a result, the production loses innovativeness, and available resources are not functional and productive.

Finance and innovation exist and interact due to creating and redistributing the new values. In the financing of innovation present "time factor", which in practice leads to risks of

innovative investment and falling value of them. This is a factor the ruptures of innovation and finance interconnections. This problem can be resolved by a new method of innovative companies profits funding, where it is the object of financial relations and the instrument for distribution the economic property in economic relations.

Finance and innovation under their functional unity creates two levels funding of innovation. These are innovation reproduction areas and financial relations of innovation sphere, which defining all funding mechanism components. The realization of financial relations and reproduction innovation is an object of the funding mechanism, where aim is to ensure the creation new values and their implementation into innovation products.

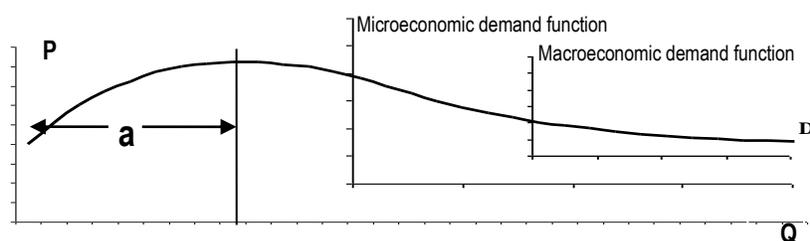
## **INNOVATION CYCLE AND FINANCIAL ASPECTS OF INNOVATION REPRODUCTION**

### **Innovation cycle**

When studying the dynamics of innovation processes we must consider the factors influencing to formation of the innovation cycle from the position of differentiated approach. On the other hand, the structure and tact of innovation cycle is formed under two factors: the dynamics of technological innovations and influence complete innovation environment or forming of innovation environment. Innovation tact  $TI \rightarrow CI \rightarrow TI$  has an objective nature and demonstrate realization of system development synergy law, where the process of implementing the innovation cycle is completely innovative development. The implementation cycle describes the dynamics of innovation in the economy.

On the other hand, the investment is a powerful economic accelerator and influences to formation and implementation innovation cycle and in general sense economic cycle. Investment "pressure" periodically initializes the economic activity. Investment "pressure" periodically initializes economic activity, which in turn provides growth the investment efficiency. Exactly transformation of the total investment into the growth investment profitability should be considered the primary cause of economic dynamics, which in turn causes the growth scale relevant markets. There are constant tunnel communication functionality in innovation cycle structural components for transfer the values in spheres of reproduction. The final substantial units is innovation production for CI (tehnolohichne equipment) and intangible assets in the form of intellectual property for CI (technological innovation). In this connection, when considering the entire spectrum of methodological approaches in forming innovation models of reproduction as a base, you must choose the trajectory of product innovation or innovative product life cycle.

Figure 2. Innovation cycle: formation of demand



It schematically reproducing the innovative product lifecycle based on data of 108 Ukrainian machine building corporation. It should be noted that these indicators of production were synchronized by time parameters due to main stages of innovation production output. Some data sets exceed the claimed temporal boundaries of the study.

This model is not entirely hypothetical. It quite clearly reflected the structure of the dynamics of innovative product to market in time. The main achievement of this phase of the study is the visual structuring in time to four aspects of innovative products lifecycle. Based on marginalism, in the fig. 2. we can see the demand model given quantification and price in third type of innovation cycle. It we can used for build enterprises model. It is also relevant for industry model. Actually, we can consider it as a graphical model of the production function of market demand. So, let's call it "microeconomic function" of innovation cycle. Accordingly, there is some Long term industry model in the fourth final step of the innovation cycle. Let's call it the "macroeconomic function" of innovation cycle.

What is relevant, if we considered innovation cycle as an innovation product lifecycle:

- there is nothing microeconomics demand function in the first step of the innovation cycle; so there is nothing margin for "development cycle";
- the Demand function is transformed into production dynamics given market price dynamics; so it is an actual innovation production function.

Thus, first step innovation cycle called "development cycle" is characterized by atypical supply function for which there is any long-term microeconomic functions as industry functions. So, the "development function" is actually increasing function given the market price at the margin production capacities of innovative technologies productiveness.

### Conclusive Remarks

- the first phase of innovation cycle is innovative development tact, which is accompanied by effects of economic growth. At this stage of the innovation cycle, supply is motivated by demand. It is accepted as production function component and innovative profit function substantial element;

- every implemented innovation (technological innovation) is general beginning of the innovation cycle and branch's birth and development cycle of new technological production level.

The fact that the "innovation cycle microeconomic function" is the primary to "macroeconomic functions industry" formatting proof the primary enterprises development dynamic for macroeconomic models forming. This means that the technological dynamics (dynamics of technological innovation) is a primary for innovation space development dynamics.

In terms of innovation dynamic theoretical description such interconnection can be displayed with the following:

- supply's complementary demand is transformed to the functional limitation for production function in the third step of the innovation cycle. It leads to dispersion innovative reproduction effects (such as innovation profit concentration in finance companies finance field). So, innovation production declines and innovative products passing to typical but there is effects of innovative environment diffusion;
- the formation of economic channels of micro level interrelated economic systems is relevant for the fourth step of the innovation cycle. It leads to increased the functionality long term production function ("functions macroeconomic field"), which is diffused to optimizing effects the total cost of innovation core technology for the production on micro and macro level economic system.

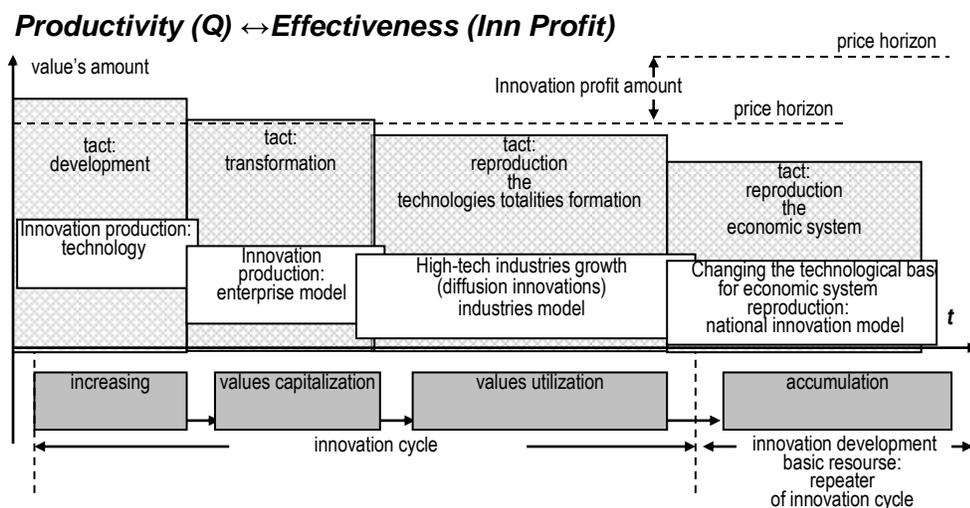
### **Conclusive Remarks**

- demand for innovation is not motivated or adjusted by costs function on the stage of increasing innovation production, but it is considered on the stage of decline innovation production and move to typical branch products;
- the demand function being the restriction for production function in the innovation dynamics is untypical at the "increasing" stage innovation cycle; actually demand function substitutes innovative production function;
- any transformations economic systems, such as enterprise, industry, national economy, caused by innovation; these are consecutive, synchronous with the growth of innovative environment initialized by implementation of innovative product and limited by completed innovation cycle.

All general effects of the innovation cycle which are substantiated by these theoretical assumptions, we should consider as productivity effects (production effects) and profitability effects (financial effects). Moreover, it is necessary accentuate the cyclical nature sequential arising these effects during innovation cycle realization. Cyclicity also implies mutual stipulation

for arising such effects. Consistency and cyclical effects interdependence are forming some reproduction mechanics in implementation innovation cycle process. So, general view the innovation cycle theoretical model should be consider like some transformative model of functional determinants:

Figure 3. Model of innovation cycle structuring: structure of reproduction



Source: developed by author

This innovation cycle model can be represented by the dynamics process of reproduction. It is necessary for this to identify the innovation dynamics tacts in according to sequence and interdependence them due to reproduction spheres (see fig. 3).

### There are two relevant aspects

What is the growth of economy system and where the sources and mechanism of accumulation which allows to create a new level technologies for economic system reproduction, in recession conditions, slow performance and loss innovation status for output?

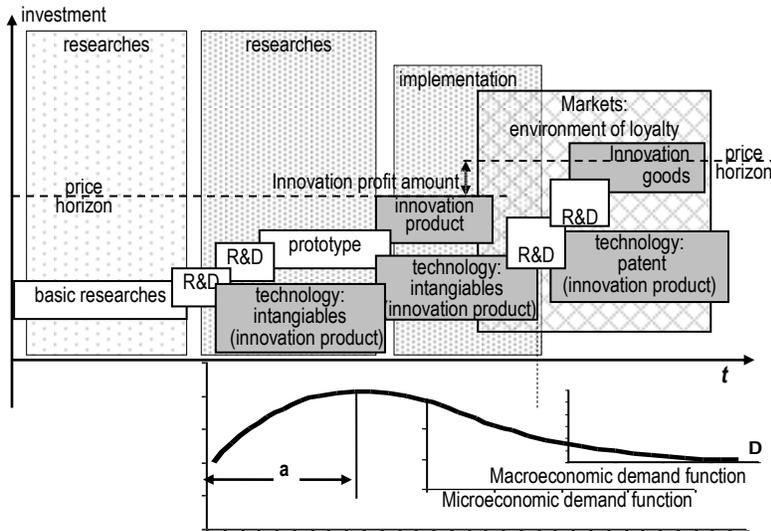
### That is relevant too

How the increase (displacement) the price level (fig. 2.1.2) is happened in step of potential depletion the innovative technologies productivity the phases of growth. Let's define it depression.

**So, as a result of the innovation cycle development, it is happened the deactualization of industry and market sectoral structure for any level economic system with following focuses**

economic efficiency to concentration of competitive advantages, which are based on technological leadership.

Figure 4. The Model of structuring the innovation cycle: innovation productivity shift

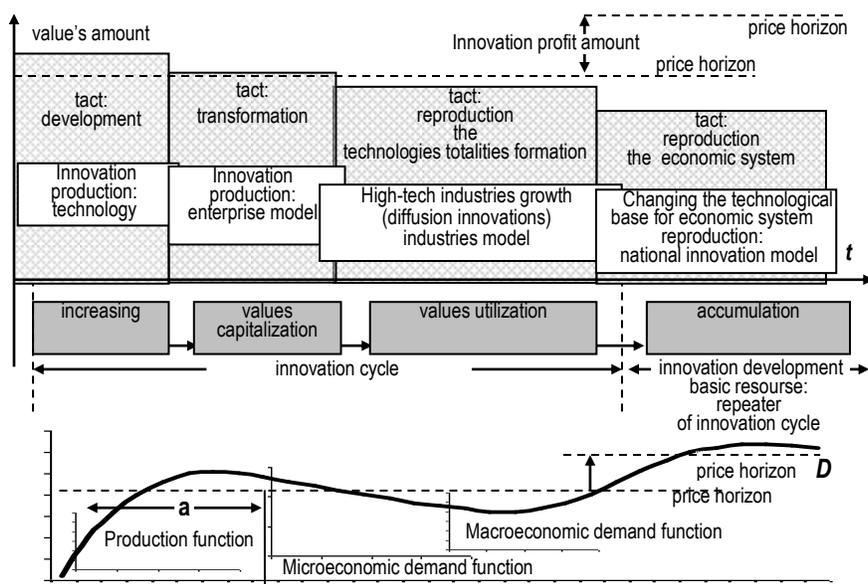


Source: developed by author

Hence, there is "innovation displacement" in innovation cycle general model by reducing its temporal characteristics based on denser structuring the innovation process. So, it is caused by the combination of the basic models "productivity(Q) ↔ efficiency(Inn Profit)" in the stage of "innovative products implementation" and "R & D".

At the same time, developing of new technologies and other R&D is activated on the stage of innovation products implementation, (see fig. 4). The large-scale systemic involvement of the public sector scientific knowledge by forms of systemic institutes into the economic cycle is a consequence of 'innovation productiveness shift'. Thus, the effects of economic development are formed without traditional factors of economic growth realization, such as: investment growth, entering foreign markets, internal market growth: consumption, investment, and so on. It is actually the effects of growth through the institutional filling of the economic environment. In fig. 4, we can see the "innovative shift" ("technological shift") by structure is a dual-synchronized tactic in innovation production processes. This is a "development tactic" (sector "a" fig. 4). The other feature is that this tactic is realized completely in development and innovation products market introduction and submitted in innovative technological goods and intangible assets.

Figure 5. Innovation cycle systemic model



Source: developed by author

So, the innovation cycle system model is completed into a double-innovation cycle of innovation technologies productivity in turn to innovative product (function  $f(Q)$ ) and for innovation technologies value utilization which is implemented to intangible assets value increasing (fig. 2.1. 4).

### Conclusive Remarks:

- the trajectory innovative reproduction is formed under the functional determinants transformative model realization in according to innovation cycle contour;
- the intangible assets value is a source of accumulation and element of economic systems innovation development; in the another word, the intangible assets is utilized into enterprises innovative technologies value in economic system.

This "technological shift" model interpretation we should see like answer the question about innovation dynamics mechanism and new reproduction technology sources formatting features in economic system reproduction processes. However, it should be noted that the problem of the innovation cycle in dynamic models doesn't focus only on innovation dynamics structure the competitive advantage reproduction. The comprehensive study the dynamic of technologies and innovation finance reproduction factors will provide a broader understanding the innovation cycle nature. Let's consider some theoretical aspects of innovation production function.

## Innovation production function and innovation cycle

The sense of innovation cycle problem is in compatibility processes which is initiated by different functional and, simultaneously, identical by nature factors such as: capital, labor and knowledge. It is necessary to substantiate the dynamic features of innovation production function and to give it interpretation for innovation reproduction.

It should be noted that author didn't see any reason to refuse neoclassical conception to resolve issue the forming a methodological platform for innovative production model parameters substantiation. Econometric models are the basic element for microeconomic modeling study. In this sense, the production function is the quantitative estimation for production factors interrelations. At the same time it determines the changes the structure of production factors in reproduction process. Exactly, technology function determines them as higher order reproduction model and, it is also as technological level production for more structured economic models.

Let's consider Cobb-Douglas production function.

(2.2.1)

$$Y(Q)=A;C^{\alpha};L^{\beta}$$

However, after each "technological leap" there is setting a new price horizon for baseline reproduction level the production technological base. The total factor productivity "A" doesn't characterized by function constant. It means for every other models a new value "A"-factor will be different. It's logical to take into account that each subsequent production function will take account the technological change level in production, due to the innovation cycle development.

**Thus,** *for any numerical parameters of production functions, a total factor "A" determines the quantitative parameter the system economic development level, so called some minimum level of technological reproduction for which relevant determinants of functional communication will possible.*

It can be also characterize the minimum required volume production for any technological level of reproduction in economic system.

In economic systems of innovation type the reproduction, factors of productions are transformed into a functional elements of reproduction. So the production model is transformed into a system of interaction between its components, and the total factor value can be ignored. However, it does not mean that relevant characteristic will be lose, because factor components are transformed into the functioning system mechanism elements in the increasing economic system. This is too relevant when considering the innovation reproduction function model due to exactly objective transforming mechanism of innovation development models. Thus, transformation mechanism is priority, when the production factors turnover mechanism does not explain the characteristics of the technological processes, which are generated in economic

systems development. Actually, interconnection between the economic crises due to arising the technological gaps in the reproduction process may be explain by them. Such approach is a clear needed to understanding a general approach to linear models construction for nonlinear economic processes.

To what extent does this problem is relevant for economics and practical economy? So, numeric parameters the production function constitutes the investment management model of economic systems the innovative type of reproduction.

There is thesis about production function as a technological model of production. At the same time, there is considered different variants signify elements of the system "cost-output-income" which is interpreted by marginal revenue the heterogeneity of factors of production hypothesis.

Sollow's neoclassical exogenous economic growth model and multiplicative production function keeps methodology optimized models. So, all the same, albeit with limitations, but it outlines the vectors to overcoming the static production factors configuration by introducing determinants of scientific progress and implementation time lag technological change.

So, although, in the mathematical model the technical progress is understood like totality of qualitative changes in the factors of production but, obviously, technical progress nonlinear functionally influences to factors production performance. Accordingly, scientific progress doesn't fully functional adequately in according with his impact presents by indicator in the mathematical model. However, to the same extent that technical progress is an indicator of qualitative changes in technological models, respectively, in the same way the time factor functionality is extrapolated them in the dynamics of production factors productivity.

There are two production function which we can consider as technical progress exogeneous implementation models with calculation the indicators influence into production. So, Cobb-Douglas dynamic model of the production function ( $Q = A C^{\alpha} L^{\beta} e^{rt}$ ) is characterized by "e" argument impact to reproduction options in turned the elasticity scientific progress and time factor. The multiplicative production function ( $Y = A \times C^{\alpha} \times L^{1-\alpha}$ ) is based on neutrality factor of technological progress, its impact equivalent distribution to production factors and time factor extrapolation. So, let's take four vectors for factorial impact on output, such as: labor, capital, technology, time factor and present them to the general view of innovation production function:

$$(2.2.2) \quad Y(Q) = f(C; L; Tech; T)$$

Thus, T (technology) can not be distributed to output elasticities because it's influences not only the function Y (Q), but also on the value K and L function factors. We should not forget that the reason of production function Y (Q) is a technology, which is as a mathematical model reflects the proportion and intensity changes of production.

The question is how we can enter the production function technology?

The production function interpretation provides answers to questions about the variability resources and impact estimation them to parameters the objective function. It is necessary to change substantial accents from cost production to production resources values and, also we should focus to values dynamic in innovative production process. So, to this approach the price resources dynamic and values transformation dynamic will accept to factor determinant of production function numerical parameters. If we should consider the values motion as cost basis of innovation reproduction, so the production function will essentially transform and in theoretical form look like:

$$(2.2.3) \quad Y(Q) = C^{\alpha} (L); L^{\beta}$$

it should read follows: *innovation productiveness*  $Y(Q)$  will be determined by transforming vector "labor↔capital". *Capital productiveness* is determined by function of differentiation capital cost for labor  $K\alpha' (L)$  and it will depend of changing the labor functionality under producing of technological innovation.

A given formulation in value interpretation will look like:

$$(2.2.4) \quad W(Q) = (C^{\alpha} (L))'; L^{\beta}$$

$$1 - \alpha = k$$

It means: *the cost of production*  $W(Q)$  equals to the original function of capital in turned labor productivity, adjusted for the cost of management, where " $1 - \alpha = k$ " is a factor labor productivity by capital. In according with this model capital organic structure optimizing is solved by a shift towards labor productivity, namely by replacing labor. The higher the  $\alpha$ -coefficient - the lower the capital productivity. " $\alpha$ "-coefficient shows the cost of capital, based on the cost production, thus innovative equipment (intellectualized complexes) will have the lowest cost and maximized productiveness. In this approach, it is possible to ignore assumption about equilibrium models, actually it doesn't investigate the equilibrium of economic system. The subject of research are the processes of innovation reproduction in movement, the character and parameters the innovation elements transformation, where substantive unit (integer) is value. The transforming changes inherent in the innovation production function requires consideration the innovative production as a permanent process. So, change of production technology leads to new production function which will mediate the changes in mechanism of formation and distribution factors (resources) of production. Thus, there are time gaps in processes play in economic systems. We must take it as objective for factor model. For production function value model the material basis production change is mediated by a dynamic factor of change in capital productivity in turned of labor. This provides to consider its own transformation dynamics in the changing technological base of production. The valuation of changes and cost distribution the

reproduction factors lets possibilities to consider innovative process in time limits of innovation cycle full completion.

Let's consider model of the formation of market demand for technology products. Actually, this model is typical for any technological production market. In this case, innovation production function will combine as enterprise models so branch models too. It also reflects resolving of optimization problems described before (see. Section 2). Thus, the general form of innovation production function (labeled by segment "a", fig. 2) to create the innovative profit function:

$$(2.2.7) \quad V_G (fQ(T;C;L)) = f I_{pr};$$

will be form the growing discrete function of dependences innovation factors installation like technological innovation (IT) and capital innovation (CI) in dual efficiency of their implementation:

$$(2.2.8) \quad Y(Q;I_{pr}) = f (TI;CI)$$

Thus, the main task of optimization of innovative production is transformed into a target of construction the systemic integrity and innovation cycle functional completeness. Thus, the innovation cycle is formed by consistent implementation of innovative functional factors in three forms:

1. labor→capital→ intangible assets);
2. capital and its transformation forms (fixt assets→amortization(sinking funs)→investments);
3. information in the form of value "information flow →knowledge→ experience".

Thus, there are objective conditions for the development of innovative production function taking into account the effects of the innovation cycle which was considered before (see. Equation 2.1.1). However, you should also consider the time factor, in mathematical models of production function for innovative production system. So, the problem of substitution factors for a given volume of output is solved due to vector of mutual transformation factor productivity in the innovation cycle, "TI→KI→AM→ON". It is accompanied by the formation of investment resources at every specified stage of innovation cycle . However, the base of investment resources for innovative production in modern conditions is so wide that it can consider the economic system as a whole: resources market, financial, investment, stock markets. In this contents, we should be consider the time factor in different processes.

So, why capital cost functionally affects to investment funds forming? The cost of technical and information providing takes part in information value reproduction process for management decisions. Let's look the data of price changes on the IT market and we can see the difference compared with the traditional markets. So the dynamic of metal prices, consumer, construction products, machinery (excluding IT products) is quite strongly correlated with the

dynamics of business activity, hence investment activity. It has undulating, and multidirectional nature (recession, growth). But the dynamics of prices for IT industry products (computers, technologies) has a clear decreasing tendency. So, if you compare the life cycle of product and price dynamic we can state about a clear chronological price and value synchronism. The depreciation is a financial mechanism which mediating the value formation mechanism.

In traditional industries, in addition to price mechanism for values formation and implementation affects technological cycle of production. And reproduced values of capital, labor, natural resources is fixed in time. I.e. in process of direct investment implementation in addition to production factors there is the time factor, and it is so significant that we should take into account its functional influence like a production. The time factor structure in manufacturing process has the following form:

$$(2.2.9) \quad f(T) = T_{\text{технологічний}} + T_{\text{маркетинг}} + T_{\text{виробничих операцій}} + T_{\text{трансакцій}}$$

The time factor structure that element by element distributed to capital and labor creates a complex acceleration coefficients:

$$(2.2.10) \quad k_T = 1/T$$

In this case, the overall feature is that the technological innovation is the only factor of productivity change in production. Technological innovation directly affect to capital productivity, and giving the dynamic, irregularity, asynchrony to reproduced values implementation process. At a cursory glance (without a serious analysis) it seems that asynchrony could be replaced by stochasticity of innovative processes. And in this respect unacceptable allowed two assumptions: the reproduction value process is identified to new value creation innovation process but actual acceleration reproduction is accepted as incidental bifurcation. This is not corresponds to economic realities, because there is so called "revival" innovative corporate leaders phenomenon: IBM, Google, Microsoft, Apple, Toyota; Samsung; Sony, Lenovo-IBM; Apple-Mackintosh; Google-android.

The manufacturing operations time factor a quite approximates the peak acceleration of productiveness efficiency. In the case of synchronizing capital innovations and technological innovation is happened also synchronization the time factor coefficients in production. As consequence there are changes the parameters of the production function. In this case the technological innovation commits a functional effect. These are expanding "gateway" (their influence leads to reducing the time limits in the reproduction process) and increases "the width of the stream" value reproduction in the production. In practice there is accelerating the depreciation fund formation and growth the accumulated value into the financial and industrial sphere. At the same time, in temporal aspect, there is time gaps reduction in investment

implementation, production processes and acceleration the investment fund reproduction formation. The main reproduction resources is depreciation fund.

The structure and tact of innovation cycle is formed as a result of two factors realization: the dynamics of technological innovation and development/impact the innovation environment. Tact innovation  $TI \rightarrow KI \rightarrow TI$  has an objective nature and includes synergistic law implementation of development organization. In this context, we can talk about actually innovation cycle implementation, as characteristic of innovation development. Cycle describes the dynamics of innovation implementation into economy. The "time" determinants implementation into innovative production function is based on innovation cycle temporal structure. Tact of development is equal the innovation cycle duration, and ratio of business cycles is based on the cycles of the minimum period technological dynamics (correlation to Kitchin's cycles ("a" – 3 years):

$$(2.2.11) \quad a + 3a + 16a = \text{long cycle K-wave, or } t_1 + 3t_1 + 16t_1 = t_1 + t_2 + t_3$$

It must be emphasized that in innovation there is a clear functional interconnection between dynamics of intangible assets and technological innovation, intangible assets and depreciation, the technological innovation and profits. In this context, innovation development is the implementation of technological-capital-renewal double cycle, but the complex of quantitative and qualitative changes implementation in organization is a function of innovation profits dynamics. It also relevant we should be based on value production model for designed the innovation production function, since this approach allows to take into account the parameters of production factors transformation to the objective function. Actually based on the dynamics of transformation it is possible to implement the time factor influence into the system of innovation production function arguments.

As an innovative production target function must be selected twofold impact of innovative production ( $Y(Q; Pr)$ ), and the innovation cycle elements should be also considered as factors: technological innovation, capital innovation, depreciation, intangible assets. Thus, the innovation development function, which considers implemented time factor in innovation cycle development becomes:

$$(2.2.12) \quad Y(Q; Pr) = f(lpr); f V_{lin}; f V_{lr}$$

$f V_{lin}$  - innovation cycle function;

$f V_{lr}$  - intonative growth industry function.

Herewith, we should considered this model like synchronized relatively innovation cycle, by the equation 2.2.11. For model (2.2.12) the general function of time factor influence to technological cycle in production (Kitchin's cycle (3 years)) is the innovation profit function  $f(lpr)$ , (see equation 2.2.12). The capital reproduction cycle "t2" (t2 we can consider like  $f V_{lin}$ ) is

represented by function:  $Y(Q; Ipr) = f(TI; CI)$ . The long cycle implementation "t3" will mediated by function  $f = V_{I_r}$  which includes the structural transformations effects.

However, it will be allow another interpretation of time factor influence in the innovation processes for interconnection the innovation production function arguments.

For example, productiveness is consolidated in accordance to three directions in investment model of innovation production function: innovation productivity, staff quality, innovation profit consolidation. If we assume that output function is discrete for a particular technology, then the profit consolidation function has discrete nature too. Then the labor factor will exert influence to objective time function in technological and manufacturing process. It influence is characterized by the degree of staff (intellectual level), information production and quality of information used in business processes. So, this dependence can be represented as a model:

(2.2.13)

$$\begin{cases} Y(Q) = (C^\alpha(L)); L^\beta \\ T \rightarrow 0 = f L^j \end{cases}$$

In this model the investment ("Invest") is achieved indirectly through financial mechanisms to ensure profits consolidation in high-tech innovation corporations, and staff ratios (j) is characterized by level of training, informatization on production (workplace+quality information). In this case, the time factor will influence to the productiveness and efficiency innovation production objective function. It gains dynamics under the influence of increasing the intellectualization labor (L) and affect to technical and technological productiveness (C) as by changing the parameters of function arguments  $Y(Q)$ , and directly to the arguments  $C^\alpha(L); L^\beta$ . At the same time, the function of "time" ( $T \rightarrow 0 = f L^j$ ) will heavy affect to investment component of reproduction due to directly reducing gaps in forming the financial resources in the innovation cycle implementation. The offered theoretical models should be considered as general approaches to understanding the properties and the impact of innovation to the dynamics resources allocation in economic systems of innovative type the replaying. These approaches will be discussed in more detail in section IV for designing the innovation development economical-mathematic model based on the identified of dual target functionality the innovation and also continuity and cyclicity of the innovation process.

### **Resume**

There is a tight functional relationship productivity and profitability of innovative production in the development of the innovation cycle.

The production and income increasing are equally directed processes in innovation manufacturing. Herewith, the "traditional" consequences impact of changes in demand in the

market as a whole is compensated by increased innovation technologies performance that provides production growth and profitability over the next cycle.

The assumption of a possible constant depending type:

$Y(Q; I_{rr}) = f(TI, CI)$  which stored in market structure dynamic changes, can be considered as the basis for innovative enterprises development parameters planning, cost and profitability based on the general structure of innovation cycle and taking into account of innovation environment development effects.

The innovation process has a continuous cyclical nature. Its continuity was proved by value approach to evaluation the processes of formation reproduction resources based on innovation cycle.

In innovative-investment model of production function the performance is consolidated to three vectors: innovation technologies, quality of personnel and the consolidation the innovation profit in the functionality of innovative investment reproduction fund.

There are two ways for time factors implementation to innovation type increasing models. It can be by synchronizing the innovation production function parameters regarding the innovation cycle structure. Another way is implementation to models of concentration and distribution reproduction resources processes in terms of systemic interaction of technical, technological and investment reproduction component.

### **Innovation reproduction: unequal exchange and investment power of money**

Consideration of some aspects unification the innovative production function and innovation cycle showed some regularity of systemic interconnection installation the of innovative productivity in the form of dual target functional orientation of innovation development type:  $Y(Q; I_{pr}) = f(TI, CI)$ .

In this section will consider the properties of forming reproduction resources in innovative production in the monetary sphere and their impact on investment.

Today the Distribution theory and the theory of production does not give answer to resolving contradictions technical-economic (NTP) and industrial relations. The general theory of economic development should include the methodology of innovation process, economic and financial turnover, which should objectively apply to study the structure of the innovation cycle.

What factors determine the cyclical processes of economic systems development?

If we look at Keynes's theory in terms of innovation, then the introduction Government into the economic relationship was considerable influence not only to economic structure, but also to economic interconnections functionality and financial turnover. But cycle remains unchanged, despite these transformations. So there is a reason to consider it by objective economic

phenomenon. Accordingly, vector the transformations in different fields has a general thrust. This is to some extent suggests proportionality the innovation development.

So let's distinguish two functional constant of innovation development:

1. Systemic unity of economic exchange elements "product - cost - price - money (profit);
2. The consumption function (the nature of consumption).

Let's omit hypothetical considerations about the main reasons of chronological parameters the economic dynamics cyclicity. We need allocate significant relationships. There is a question in this context: "investments - individual income - expenses - income innovation firms" traffic circle is a primary to "value - consumptions - production market price" cycle or vice versa? In this scheme the structure of dynamics "cost - savings" function will be determined by the degree of satisfy a individual wants. However, this factor can not be decisive, so should find a more general factor. In this regard, the production costs is costs to productivity. In theoretical sense, it is an initial (basic) function for consumer demand, investment and financial credit. In other words, savings and consumption is a costs for factorial productivity function. The consumption function could be considered as production costs multiplier, making them to a part of consumer demand. The consumption expenditures creates potential of income innovative firms. The savings function is a production costs multiplier, transforming them due to a credit-financial mechanism for investment or lending.

All firms of industry forms the consumer demand across the costs in innovation economy. But only monopolies appropriates income together with credit. Monopolies is those, that won the competition. Thus, the basis of the concept is the prevalence of profit for a minimal spending. The continuity tact "product - value - price" determines the frequency of the economic cycle, but internal dynamics these functional constants defines the economic cycle structure. If "products" dominants so it is "growth" phase in cycle. If value is dominant - it leads to "crisis". If price dynamic happens to dominant its oscillations, its own inner cycle is dominant in internal interaction "product - value - price ", so it means "depression ". Dominant status does not exclude own dynamics other components whether product, value or price. The cycle phase will be determined namely by a dominant in this triple constant while maintaining the dynamics of other components.

This tact regarding innovation cycle can be described as follows.

During the growth the product innovations are dominant. The innovation products determines market prices or heavy influences to market prices level and their dynamics. Market saturation period is a time for value complete realisation into economic turnover. Namely value realization eliminates the innovation products relevance, transforming them to a category of ordinary goods. This is defined as the inflation phase of innovation and investment in such innovations

will be the most risky, these doesn't be reproductive. Firms should avoid this. The realised values are concentrated in investment funds and implemented in reproduction processes for shaping economic turnover due to financial mechanism. Namely value complete realisation with following concentration them to financial resources funds causes to inflation lending and leads to distribution process completion due to the price. Recession and depression - is a price dominant phase when forming the structural, institutional, technological characteristics of economic environment (market) is over. It can be defined as tendency the economy to equilibrium. The prices of depression completes the distribution of created values in economy, the market rests to effective productive forces. The items that are not able to reproduction utilized due to competition market mechanism and effective resources distribution. What is business-cycle motivate? This is a rate of return. It's the motivation factor and mechanism of cyclical economic development. In modern conditions, the economic rate of return has own dynamics, ability to change and change the nature and intensity of economic processes. It motivating the interaction of production factors realization in economic turnover and namely values economic turnover. Modern understanding the rate of returned can be considered as a functional part of the renewal value in the expanded reproduction of productive forces and base for cost structuring. Accordingly, the profit shows the dual nature and ability to be structuring. This is reflected in superprofit allocation or monopoly innovation profit. Its functionality allows excessive focus significant resources that differ extremely high mobility. It does not need to change the organizational structure of the company, merger or acquisition. Staying practically by competitive firm the innovative profit owner gets role monopolist which is much more mobile and influential than just ensuring the elimination of competition. Innovation profit can also be characterized as actively reproducing functional part of the newly created value. So, innovation profit is reproductive characteristics of the active part of the profit, its quality and its basis for differentiation. This means there is possibilities to allocation and redistribution the innovative profits through economic mechanism.

The reason for lower profits as branches so in economy is the established of equivalent values change. In the result there is disappears / decreases the investment power of money in favor of purchasing power of money. This assertion corresponds with Kondratiev's postulated "empirical fidelity": the depression crisis phase of agriculture is accompanied by synchronic rise the agricultural goods prices. This statement comes from the general objective laws of functional implementing money, which actually defines the objective nature of money.

So, at this stage it is necessary to formulate some interim conclusions:

1. studied before the economic cycle structure and its functional interpretation gives understanding about dynamic disequilibrium in the production;

2. money is most integrated in the functional model of economic development money, because as profit so investment and finance has money basis;
3. the allocation of money's symmetrical dynamic properties together with profit, finances, investments, allows to state about functional unity all spheres of social reproduction.

This can be also consider as theoretical basis of modern methodology of innovative type economic development. It's essential basis is profit ability to differentiate itself in the process of reproduction. It allows to consider innovative profit in the complex categories of cost and interest rate. The profit differentiation is the objective phenomenon, which manifests itself in innovative processes. It doesn't motivated by economic mechanism and other processes inherent productive and market forces. Autonomy of structuring profits from production processes and dynamics of commodity markets largely motivated by arising a new functional properties of money, which in turn motivated the introduction of information into economic turnover (information economization ).

What is the question. The functions money complex is in basis of Fisher's [Irving Fisher, 1930] monetary law. The purchasing power of money indirectly (through velocity of money determinant) postulates the money's unified functional properties, let's call it "investment power." The term "unified functional property of money" comes from the economic nature of money. It is caused by the movement of money within a large values turnover mediated by financial-economic mechanism. If we consider the movement of money in terms of movement values and formation of funds financial resources, will be a clear imbalance in the financial and commodity turnover. Money mediating the movement of financial and commodity turnover. So, money distributes unevenness and install the proportions of exchange based on the dynamics of their own value. This is fundamental principle, which can explain the original dynamics on the currency, financial and commodity markets. Thus, the nature, origin and existence of money is grounded on equivalent exchange. It has the objective nature of the dynamics the formation and implementation values and features of regularities.

Law of "unequal exchange and investment power of money" is based on the assertion about:

- *money as an economic category finds its own functional implementation with the emergence of unequal exchange*
- *unequal exchange generates and enhances the investment power of money;*
- *the investment power of money is implemented in the organization of trade flow in of primary exchange model: money-commodity-money<sup>1</sup>. Namely initial movement of money motivates movement of capital, but it is nothing like investment.*

*This relationship is regular. We offer understand it as Law of "unequal exchange and investment power of money".*

We suggest understood basic definitions follows:

**"Equivalent exchange"** is the situation in exchange sphere, that characterized by gaining the absolute dominant purchasing power of money and loss of strength in their investment power in currency, commodity and financial turnover;

**" Unequivalent exchange "** is an interaction between investment and purchasing power of money, which has a dialectical nature.

**So:**

- I. The money find its functional implementation with the emergence of unequal exchange. The emergence of unequal exchange generates and enhances the investment power of money.
- II. I. Money has a dual nature of implementation: functional and dynamic, which is embodied in interconnection between investment power and purchasing power of money.
- III. II. Implementing the functionality of money creates organizational mechanism of economic relations. In functionality of money is implemented the economic environment development potential.
- IV. The economic mechanism of management (management functionality: coordination, motivation, controlling and regulation) and market self-regulation mechanism (Adam Smith's "invisible hand") is realized through dynamic functionality of money.
- V. Establishment of equivalent exchange creates the balance of purchasing power of money and investment. It leads to depression of the economy at any level of aggregation. The beginning of economic growth is setting an imbalance in favor of the purchasing power of money.
- VI. Rising purchasing power of money is embodied in the growth of prices for agricultural goods in the stage of depression economy as a whole and accompanied by a crisis in agriculture.
- VII. Turnover of money is based on investment strength of money.

### **Conclusion of the Law**

Interaction of "purchasing power of money" and "purchasing abilities of money" becomes inversely proportional. Rising purchasing power of money is the basis for intensification of inflation and there is raising agricultural prices in depression. There is a loss of functionality of money static characteristics, leaving money on the functionality level measure of value. Pricing does not take any economic mechanism besides market. Such a price is equal to monopoly price, where a monopoly is an objective power of market. Consequently, reversibility of money

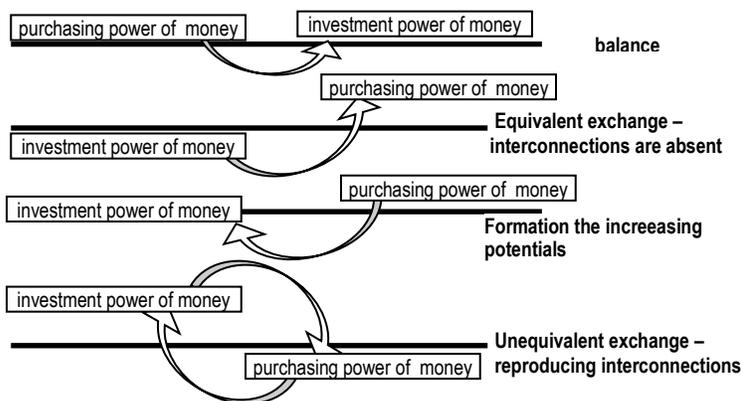
is based on investment power of money. Why the depression reigns? It is because the circulation of money serves actually the private (household) consumption. Consequently, the crisis strength and duration is the difference between the actual private consumption and the market volume. The real GNP value, which is not involved in turnover, storing in cash in accounts in banks.

What is the essence of things, ie in balance/imbalance the investment and purchasing power of money. The primary condition is that private consumption fails to restore the economic growth because too less than its potential. The purchasing power of money motivates only one of the five functions of money.

Implementation the law of "unequal exchange and investment power of money" leads to initialization the law of "monetary pendulum":

- the internal dynamics of functional money constants (the purchasing power of money and investment) is the reason of general economic dynamics;
- the functional interconnections of money's functional constants is spent along with dominant purchasing power of money and rising prices. The unequivalent exchange potential is formed along with the price increasing;
- the money's functional limitation motivates monetary pressure of unrealized values. As a result, investment power of money increases and functional interconnections the functional constants of money are renewed. This is realized in arising the capital investment pressure and innovative investments realization.

Figure 6. Monetary pendulum low



Source: developed by author

This monetary model needs testing in complex the models of innovation reproduction. Detected functional structuring of money is synchronous with dynamics of transformations in innovation production sphere. It indicates to identity of economic transformation and presence the unify

basis for economic progress. Mutual identity and unstable structuring points to the existence unified economic progress function. This function is unified for the reproductive system of "production - exchange - distribution". This function is solely inherent to information-innovation economy.

### **Resume**

The innovation development methodology should be based on the regularities of reproduction elements unification and reproductive properties transformation to top-level generalization categories. Economic categories become larger simultaneously with increasing economic turnover of values. Such transformations do not occur without adequate morphological changes. This is the essence of economic development.

Money as an economic category finds their own functional implementation with the emergence of unequal exchange. The emergence of unequal exchange generates and enhances the investment power of money. Actually initial movement of money (it is nothing like investment) motivates the movement of capital. This should be seen as prerequisite for building the investment-innovative model for innovation development of economic systems, where the total volume of commodity turnover clearly structured to innovation, science and information component.

The internal dynamics of functional constants of money: the purchasing power of money and investment is a primary reason of economic dynamics. Simultaneously with dominant purchasing power of money and rising prices the functional interconnections of money constants is lost and forming the potential of unequal exchange. Functional limitations of money motivate monetary pressure of unrealized value in the form of investment capital pressure and exceptionally implementation innovative investment. Unequal exchange is the motor function of economic dynamics and methodological basis of innovation development. In a more aggregated form the unequal exchange is the base of unequal distribution.

In the process of economic growth together with expansion of economic values turnover is taking place transformation all components of economic relations. Such transformations are synchronous. However, there aren't constant proportions in the dynamics of these changes. The direction of these transformations is in the fictionalization of static categories, which gives them flexibility, elasticity, which results in smoothing the cycles and increases tact of economic cycles.

Functionalization the categories forms the functional connections of elements of economic processes and their components under the information influence. The nature of such interconnections is not linear. This opens up the possibility of more in-depth functional and

dynamic analysis of economic processes and also creates business models of economic behavior and economic relations in the long term. This enables resolved the problem of prediction of economic development under adequate methodological basis.

### **Innovative reproduction: investment power of money and of innovative investment implementation**

The observed functional "proximity" innovation and money is their synchronous systematic reproducibility in economic turnover. Dynamics of innovation is synchronous to functionality of money dynamics. Therefore, to design the financing innovative development mechanism for innovative economies we should consider the processes of funds formation at the level of the general model of innovation dynamics and the dynamics of the money supply.

Author used the following assumptions when considering this issue, namely:

- structure and tact the innovation cycle is formed due to two factors: the dynamics of technological innovation and the impact of innovation environment;
- tact Innovation  $TI \rightarrow CI \rightarrow CI1$  has an objective essence and includes implementation of synergistic law of development organization; in this case the cycle describes the innovation dynamics implementation in economy;
- investment is a powerful economic accelerator; it influences to forming as the innovation cycle so economic cycle in the whole;
- investment pressure periodically increases the economic activity in production  $\rightarrow$  trade  $\rightarrow$  banking sector (financial markets); investment pressure symmetrically increases the economic activity in the field of credit  $\rightarrow$  the gold market and real estate; this impact is realized into the interest rate growth; it is a primary and it leads to increase the relevant markets volumes;
- innovative product initiates the increasing of innovation demand dynamics;
- innovative demand isn't motivated by cost function, it takes them into account only on the stage of recession innovative productions (transmits them to typical production);
- demand function simultaneously is the restriction for production function; it should be consider as innovation production function;

So let's consider the interconnection "innovation cycle  $\leftrightarrow$  investment cycle" through cash flow formation and realization. Demand provides the functional connections "purchasing power of money  $\rightarrow$  investment power of money." This leads to activation of relations "kredyt  $\leftrightarrow$  investytsiyi" where investment power of money is realized complete. However, demand is limited by growth opportunities of the economic system (market volume). Accordingly, growth potential is

determined by lending: **VGrowth = Vcredit**. Lending is determined by such relation: **Vconsumption + Vsavings = V lending**. Thus, the general model of functional balanced of funds formation (money supply) and total potential of investment will come like this:

**M (money supply) = purchasing power of money = V lending**

**Thus, the volume of lending determines the volume of money supply and it is equal to purchasing power of money.** This ratio can be regarded like static monetary model of reproduction. The velocity of circulation of money indirectly expresses lending intensity and "investment power of money model" in a functional form of the dynamic model. Consequently, the value is capitalized by turnover. Accordingly, the development is a function of turnover. Value is utilized by transforming to competences growth. The base of development is created in the production in the first quarter of the cycle of reproduction: the transformation of values into reproductive competences. So, there is a distribution of values in according with following algorithm:



The potential of reproduction is in consumption. The reproduction competencies is formed in consumption with this way: capital gains + technologies increase (change in manufacturing technology base) + increase employee competencies. Technologies productivity is maximized in first quarter of the innovation cycle, there is further decline in performance due to the decline of transformation values into reproductive competencies. So, there is consumption in the second, third and fourth period of the cycle of reproduction. There is such value distribution: **"disposed value → Δ development → base of capitalization"**. Recession is characterized by values capitalization which can be presented through the functions in dynamic:

"consumption ↔ capitalization» → the function of business decline;

"production → transformation» → function of economic growth.

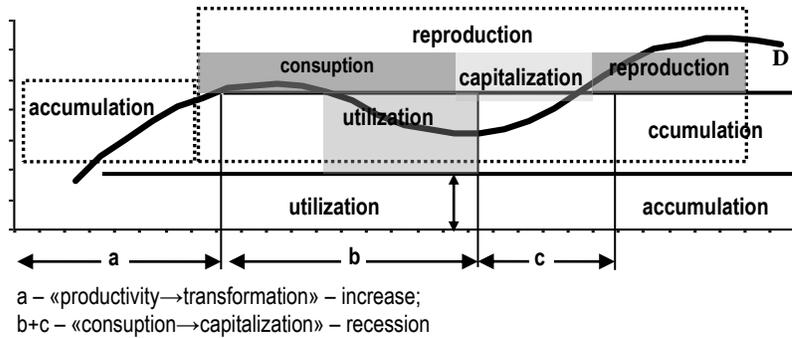
This model describes the trajectory of development, which in fact ignored in classical models of economic growth. Classic models is based on integrated indicators (production). It doesn't consider the potential complete realizing the innovation cycle.

The value distribution in innovation cycle includes two functions in temporal aspect:

Accumulation =  $f$  «productivity ↔ transformation» → growth -  $\frac{1}{4}$ ;

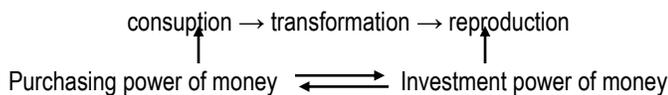
Reproduction =  $f$  «consumption ↔ capitalization» → decline -  $\frac{3}{4}$  (fig. 7)

Figure 7. Innovation reproduction model



Source: developed by author

In innovation reproduction model, the volume of transformed values is determined by velocity of circulation of money at each point of the reproduction cycle trajectory (curve D, fig. 2.4.1). Reversibility of money are functionally identical lending. Increasing the reversibility intensifies the values transformation. Growing demand  $\Delta D$  in liquid funds mediates the growth of business activity and values movement to implementation trajectory "reproduction  $\rightarrow$  consumption" due to increasing investment and growth the payments for services. Liquidity of monetary dynamics is a money's functionality aggregated indicator. Ratio of functional units are determined by structure of product movement (value): "consumption - transformation - reproduction". Ratio in consumption (excluding savings) determines the vector providing the cash flow dynamics. Thus, consumption is functional basis for product movement (product dynamics) due to trajectory: "consumption  $\rightarrow$  transformation  $\rightarrow$  reproduction". Transformation is some mediating function. Cash flow mediates movement values:



To what extent can increases the purchasing power of money? To the extent that investment power of money decreases, within the beginning of motion reproduced product (reproduced value), from reproduction to consumption.

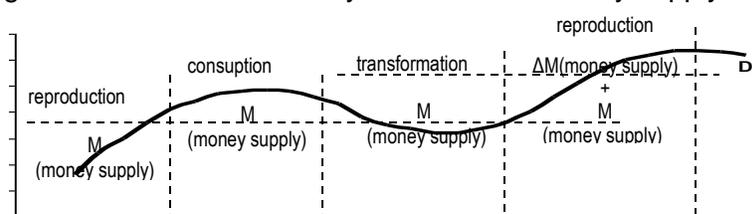
Ratio "Playback  $\rightarrow$  consumption" is a functional relation, that is separated from temporal and functional parameters of the production process. Production "fits" or fall out of this dynamic speakers. This is basis of efficiency. The main method of reproduction efficiency is to synchronize the dynamics of reproductive factors and dynamics of values (product). This can be used to design the methodological approaches to strategic management development, or this can be a strategy. Money loses own values characteristics and transforms them into their

functional characteristics in the process of economic growth in turnover globally. We can see the increasing number of riches on Earth. When innovations become the factor of influence on economic processes, money transforms basis functionality lending and other financial instruments. The increasing money's functionality through forming the unified "accounting" function leads to increased lending functionality beyond its emission function. In the result the lending reproductive function is activated. It is important that indicators  $\Delta GDP$  can definitely relate to the dynamics of the exchange rate, and it's possible to find some interdependence. Actually, balance of supply / demand money motivated by demand increase of the liquid assets for accounts( $\Delta D$ ).

Therefore,  **$\Delta D = \Delta \text{increase investment} + \Delta \text{ increase in payments for services}$**

This leads to intensification of business activity and values movement along trajectory "reproduction  $\rightarrow$  consumption".

Figure 8. The model of the dynamics of the money supply during reproduction



Source: developed by author

In this model (fig. 8) change in the demand for money ( $\Delta D$ ) describes the investment power of money and the money supply ( $M$ ) characterizes the purchasing power of money. Calculation the liquid part of money supply ( $M$ ) accepts amount utilized values inception base cycle and following cycle of reproduction. This volume of growth of money supply ( $M$ ) is the most "purified" from exposure irrelevant factors. But it includes significant factor component of international currency market speculative trends. In the context of innovation reproduction the growth of money supply ( $\Delta M$ ) reflects also overall equivalent growth reproduced competences. Increasing competencies is development. The innovation cycle is a common basis for innovation monetary model. However, such conclusions characterizes exclusively modern model of innovation reproduction. In such model there are general patterns the economic development cyclicity of innovative type in the form of functional transformation.

But, during the gold standard growing money supply was mediated by increasing mining gold and it was also limited by them. Kondratiev still emphasized about increasing in mass of gold in money circulation actually during crisis. This means that values was reproduced during the

cycle but had not yet found own material form. It was mediated by economic cycle and remained in the ratio of material production and lending (in the broader sense - finance). Thus, it could disappear after fall in business activity at any moment. It was creating a frenetic demand for gold under these conditions. Regarding the utilization of capital, the amount of utilized value was equal to scrap from machines, factories, and other material objects without the values of reproduced competencies. The volume of gold in circulation was remaining with increment in the new cycle ( $Q = Q + \Delta Q$ ). Thus, the total amount of gold is volume saved but doesn't utilized values.

What is the difference. Part of the stored value in gold is lost when converting gold into investment capital: lending, real assets, intangible assets etc. In this case, part value of gold is lost through cost of lending and growing credit rate later. It should be consider like cost for values utilization. Lending hasn't got such heavy basis for potential of development like gold because it is category of turnover. The lending's value and cost characteristics are lost through decreasing velocity of circulation of money. It doesn't being only in crisis but also due to money supply structure imbalance. Such "price" is catastrophic for industrial economy, but not for innovation reproduction.

*The methodology of funding innovation profit can be consider as theoretical basis for economy of innovation type of reproduction.*

Applying this theory it is possible to prevent losing of values due to their utilization. It also allows to avoid losing time due to overcoming time gaps of funding at all stages innovation process. The functionality of monetary component of money can be defined as the purchasing power of money in relation to the exchange quotations. Herewith, growing rate leads to increasing investment (it means investment power of money implementation ).

But supply exceeds demand situation should be accepted as a "correction" - leveling speculative trends leveling and other ones. Any decline is only "correction":

1. speculative trends;
2. trends caused by transaction costs;
3. diversification trends;
4. transformational trends (these conditions will be used to design (see. Table. 1 and Table 2).

Quotations of currency pairs will measure ratio of purchasing/investment power of money. Dollar USA being the currency of investments reflects in practice the mechanism of monetary pendulum through quotations world currencies dynamics. The change of total investment innovation during the internal and external funds for financing the economic systems innovative development of production should be treated as objective function for the dynamics of currency pairs. It can be presented follows:

### $\Sigma \ln \text{Inv} = f(\text{lending; profit})$

Ratio of functional states of money supply and lending functional interconnectedness under its transformation to innovation investment is a latent functionally relevant elements of the innovation cycle. However, there is a certain contradiction. Accumulation and innovation development, which gets resource from turnover and credit is like functional basis for them.

The money supply growing mediates innovation development, but accumulation slows turnover and relieves functionality lending. Lending could be motivated by investments, but it is functionally identical to accumulation. Accordingly, credit motivated by accumulation but accumulation determines the base lending (This complex configuration will be considered in chapter IV for solving the problem of innovative investment and lending functionality.) At this stage, it is necessary to emphasize accumulated value creates an investment loan pressure in financial turnover. As a result there are scientific progress and innovations. So we can say about innovation is an accumulated values realized productivity. Thus, there isn't "innovations-lending" direct communication. Lending just motivated by transforming accumulated value to innovations.

*Relevantly! Credit is only mediating the innovation development but doesn't providing them.* Accumulation is a functional basis for innovation development. Investment has got properties "be late". Investments are asynchronous to development because these is a function of consumption. Their reproductive potential is realized during the recession reproduction functionality. In this case investing is a function mediating the development, so it is synchronous with the lending in this sense. But there is any direct connection between innovation and investment. So we should seek higher functional level interconnection. This study confirmed that the performance of the social product ( $\text{GDP}_{\text{world}}$ ) somehow correlated with money's dynamics (see tab. 1).

Table 1. Functional correlation money and the dynamics of  $\text{GDP}_{\text{world}}$

| PiK  | USD to major world currencies |             |             |             | $\text{GDP}_{\text{world}}$ | $R_{\text{GDPw}}$ | $k_{\text{in}}$ | $k_{\text{w}}$ | $V_{\text{AS}}$ | UA<br>output | $R_{\text{UA}}$ | $k_{\text{in}}$ | $V_{\text{AS}}$ |
|------|-------------------------------|-------------|-------------|-------------|-----------------------------|-------------------|-----------------|----------------|-----------------|--------------|-----------------|-----------------|-----------------|
|      | usd/<br>euro                  | usd/<br>gbp | usd/<br>chf | usd/<br>yen |                             |                   |                 |                |                 |              |                 |                 |                 |
| 1992 | 0,796                         | 0,556       | 1,400       | 127,19      | 27,801                      | –                 | –               | –              | –               | –            | –               | –               | –               |
| 1993 | 0,837                         | 0,664       | 1,472       | 113,05      | 28,943                      | –                 | –               | –              | –               | –            | –               | –               | –               |
| 1994 | 0,836                         | 0,657       | 1,373       | 103,15      | 30,486                      | –                 | –               | –              | –               | –            | –               | –               | –               |
| 1995 | 0,737                         | 0,6         | 1,188       | 93,55       | 32,191                      | –                 | –               | –              | –               | –            | –               | –               | –               |
| 1996 | 0,762                         | 0,643       | 1,243       | 107,44      | 34,010                      | –                 | –               | –              | –               | –            | –               | –               | –               |

|      |       |       |       |        |        |       |         |        |        |       |      |      |   |
|------|-------|-------|-------|--------|--------|-------|---------|--------|--------|-------|------|------|---|
| 1997 | 0,867 | 0,609 | 1,449 | 119,83 | 36,078 | 0,69* | 135,69* | –      | –      | –     | –    | –    | – |
| 1998 | 0,9   | 0,603 | 1,5   | 132,05 | 37,579 | 0,78* | 106,09* | –      | –      | –     | –    | –    | – |
| 1999 | 0,922 | 0,616 | 1,497 | 115,63 | 39,452 | 0,82* | 126,18* | –      | –      | –     | –    | –    | – |
| 2000 | 1,059 | 0,649 | 1,681 | 107,15 | 42,357 | 0,88  | 121,85  | –      | –      | –     | –    | –    | – |
| 2001 | 1,117 | 0,691 | 1,697 | 120,16 | 44,389 | 0,89  | 101,92  | –      | –      | –     | –    | –    | – |
| 2002 | 1,072 | 0,671 | 1,570 | 125,14 | 46,477 | 0,92  | 96,24   | –      | –      | 0,311 | –    | –    | – |
| 2003 | 0,901 | 0,617 | 1,360 | 116,79 | 49,117 | 0,85  | 120,94  | 62,69  | –      | 0,367 | –    | –    | – |
| 2004 | 0,817 | 0,551 | 1,258 | 107,95 | 53,003 | 0,82  | 75,37   | 145,27 | 80,08  | 0,44  | –    | –    | – |
| 2005 | 0,794 | 0,544 | 1,228 | 108,58 | 57,193 | 0,81  | 83,61   | 159,33 | 104,02 | 0,478 | –    | –    | – |
| 2006 | 0,803 | 0,545 | 1,261 | 116,23 | 62,643 | 0,77  | 170,94  | 240,25 | 121,3  | 0,503 | –    | –    | – |
| 2007 | 0,739 | 0,502 | 1,208 | 117,70 | 67,922 | 0,76  | 168,8   | 199,88 | 143,3  | 0,635 | 0,99 | –    | – |
| 2008 | 0,671 | 0,52  | 1,078 | 104,32 | 71,966 | 0,75  | 174,9   | 204,22 | 166,98 | 0,952 | 0,8  | –    | – |
| 2009 | 0,834 | 0,583 | 1,101 | 112,28 | 72,517 | 0,80  | 177,11  | 303,3  | 166,62 | 2,834 | 0,98 | 6,1  | – |
| 2010 | 0,748 | 0,644 | 1,047 | 88,03  | 76,647 | 0,79  | 189,7   | 122,95 | 172,53 | 0,765 | 0,98 | 7,07 | – |

Source: developed by author based on: The World Bank Search: Data section: GDP (current international)// [http:// search.worldbank.org](http://search.worldbank.org);

There are also regularities into interdependence between currency market and  $GDP_{world}$  and engineering output of Ukraine. Consequently, these laws are objective and independent of economic development level different countries. Thus, it becomes possible monetary model and innovative reproduction model methodological systematization. Let's consider the model of maximum efficient value distribution social product to public reproduction innovation funds (table 2).

Table 2. Model of distribution of social product to public reproduction innovation funds

| Years | USD to major world currencies |          |          |          | Database |             |          |       |          | Model modeling calculation |             |          |       |          |
|-------|-------------------------------|----------|----------|----------|----------|-------------|----------|-------|----------|----------------------------|-------------|----------|-------|----------|
|       | Usd/ euro                     | Usd/ gbp | usd/ chf | usd/ yen | $GDP_w$  | $R_{GDP_w}$ | $k_{in}$ | $k_w$ | $V_{AS}$ | $GDP_w$                    | $R_{GDP_w}$ | $k_{in}$ | $k_w$ | $V_{AS}$ |
|       |                               |          |          |          |          |             |          |       |          |                            |             |          |       |          |
| 1992  | 0,79                          | 0,56     | 1,40     | 127,19   | 27,801   | –           | –        | –     | –        | 27,801                     | –           | –        | –     | –        |
| 1993  | 0,83                          | 0,66     | 1,47     | 113,05   | 28,943   | –           | –        | –     | –        | 28,943                     | –           | –        | –     | –        |
| 1994  | 0,83                          | 0,66     | 1,37     | 103,15   | 30,486   | –           | –        | –     | –        | 30,486                     | –           | –        | –     | –        |
| 1995  | 0,73                          | 0,6      | 1,19     | 93,55    | 32,191   | –           | –        | –     | –        | 32,191                     | –           | –        | –     | –        |
| 1996  | 0,76                          | 0,64     | 1,24     | 107,44   | 34,010   | –           | –        | –     | –        | 34,010                     | –           | –        | –     | –        |

|      |      |      |      |        |        |       |         |        |       |        |      |        |       |       |
|------|------|------|------|--------|--------|-------|---------|--------|-------|--------|------|--------|-------|-------|
| 1997 | 0,87 | 0,61 | 1,45 | 119,83 | 36,078 | 0,69* | 135,69* | –      | –     | 36,078 | 0,69 | 135,69 | –     | –     |
| 1998 | 0,9  | 0,60 | 1,5  | 132,05 | 37,579 | 0,78* | 106,09* | –      | –     | 37,579 | 0,78 | 106,09 | –     | –     |
| 1999 | 0,92 | 0,62 | 1,5  | 115,63 | 39,452 | 0,82* | 126,18* | –      | –     | 39,452 | 0,82 | 126,18 | –     | –     |
| 2000 | 1,06 | 0,65 | 1,68 | 107,15 | 42,357 | 0,88  | 121,85  | –      | –     | 42,357 | 0,88 | 121,85 | 59,6  | –     |
| 2001 | 1,12 | 0,69 | 1,7  | 120,16 | 44,389 | 0,89  | 101,92  | –      | –     | 44,389 | 0,89 | 101,92 | –     | –     |
| 2002 | 1,07 | 0,67 | 1,57 | 125,14 | 46,477 | 0,92  | 96,24   | –      | –     | 50,110 | 0,93 | 110,29 | 53,8  | –     |
| 2003 | 0,90 | 0,62 | 1,36 | 116,79 | 49,117 | 0,85  | 120,94  | 62,69  | –     | 52,166 | 0,85 | 130,93 | 77,7  | –     |
| 2004 | 0,82 | 0,55 | 1,26 | 107,95 | 53,003 | 0,82  | 75,37   | 145,27 | 80,1  | 54,748 | 0,83 | 165,19 | 90,9  | 80,2  |
| 2005 | 0,79 | 0,54 | 1,23 | 108,58 | 57,193 | 0,81  | 83,61   | 159,33 | 104,1 | 57,193 | 0,83 | 177,09 | 97,9  | 100,5 |
| 2006 | 0,80 | 0,55 | 1,26 | 116,23 | 62,643 | 0,77  | 170,9   | 240,25 | 121,3 | 60,139 | 0,81 | 185,16 | 239,9 | 113,4 |
| 2007 | 0,74 | 0,50 | 1,21 | 117,70 | 67,922 | 0,76  | 168,8   | 199,88 | 143,3 | 63,281 | 0,8  | 184,2  | 269,1 | 129,9 |
| 2008 | 0,67 | 0,52 | 1,08 | 104,32 | 71,966 | 0,75  | 174,9   | 204,22 | 167   | 64,997 | 0,8  | 188,14 | 275,6 | 145,7 |
| 2009 | 0,83 | 0,58 | 1,10 | 112,28 | 72,517 | 0,80  | 177,1   | 303,3  | 166,6 | 64,442 | 0,81 | 169,2  | 278   | 148,5 |
| 2010 | 0,75 | 0,64 | 1,05 | 88,03  | 76,647 | 0,77  | 189,7   | 122,95 | 172,5 | 67,669 | 0,79 | 178,62 | 260,7 | 152,9 |

Source: developed by author

R - ratio in density of money and social product value dynamic;

kin - indicator of efficiency: the quantity conventional investments into money supply;

kw - value saving factor: the quantity conventional value units transforming to accumulation ("Kw" factor is out for Ukraine)

UAoutput - quantity by 108 machine-building enterprises output of Ukraine (bln. USD).

"-" - ratio is out

VAS - volume accumulation, trillion USD

So, money's and product's dynamics is synchronous but doesn't identical. For example, the Ukraine's innovation reproduction system (engineering industry) is almost clear synchronous to money's (world) functionality dynamics (see tab. 2.4.2 ( $R = 0,98$ )). However, "Kw" factor is not for Ukraine (see tab. 2.4.2).

*Thus, Ukraine produces reproductive system resources in world reproduction system but didn't created tools (systems) for value accumulation. So, it lacks a system for accumulation and it lost the base for development. Values is diversificated and piled to economies of other countries.*

This is a systemic problem in a whole. On the tab. 2.4.2 we can see that between 2005-2006 ye. there are 68 added conventional "kw" ( $909 - 978 = 68$ , accumulated values) which is correlated to 119 added conventional investment "kin" ( $1770 - 1651 = 119$ ). These are also correlated to created world product (3 trillion USD). Herewith, being functional identical between 1997-1999 ye. for reproduction product model (tab. 2.4.1) the innovation factors rates becomes statistical relevant for innovation investments in distribution product for innovation funds model (tab. 2). This is money's power. We should design the relevant methodology and it must be general methodology of distribution. For that we should offer mechanisms for values of transformation as opposed to "modern" financial and monetary mechanisms values preservation. This model indicates opportunities for values transforming to accumulation and thus creating the basis for technological and innovative development of national economic system. But, it is most importantly that such distribution and transformation values initializes arising reproducing factors dynamic, which accompanied by generation of new competencies with following direction them towards science and innovation technologies development.

We should be noted that world's product reproduction model has some approximation effects observed in peaks economic dynamics. Including smoothing effects of investment downturns, the effects of time and technology gaps in production which caused by them. Investment ratios are indicators of maximum efficiency innovation investments, which forms the economic dynamics model in financial sector in complex with of accumulation ratios. This model (tab. 2.) also determines effective distribution of social product. So, we can say that corresponding amount of investment resources reproduction on market is formed for each basic volume generated social product. This investment forms needed effective volume the technological development funding of economy. Let's regarded these investments as primary lever for economic dynamics. This mechanism of activization of economic dynamics leads to distributing entire volume values to reproduction and accumulation funds. Forming an innovation reproduction dynamic common model can only be under synchronization and systemic unity processes the formation investment funds and accumulation funds. In this regard, any economic model of balancing proportions doesn't take into account the dynamic characteristics innovative

model of economic systems development. Violation of balance is the essence of development. The development should be seen in terms of the imbalance in economic systems and move it from "equilibrium model" to "fulcrum support model". Systems doesn't find the balance or "compensation" destabilizing factors in development. Systems reproduces the functional constants of development, turning them into functional reproduction determinants (substantial reproduction characteristics). This model is a common funding model of social product reproduction in terms of solution of optimization, forecasting and analysis (evaluation). We should see modeling, forecasting and optimization are functions of efficiency in systems management. Thus, what is development methodology? Is it prediction or optimization model? The best solutions for resolving this model could be methodological basis for choosing management methods in forecasting and innovative production, knowledge and technological development.

It is relevant for resolving forecast tasks to design the predictive models type:  $Q; Pr = f \text{ Tech}$ , where technological factor function taking into account by operating effectiveness of innovation production. Typical economic analysis and strategic management solution is grounded on extrapolated trend taking into account the time factor in economic processes. Complexity analysis of innovative efficiency is:

- there isn't interdependent of retrospect of innovative processes, so technological determinant devoid of functional constant characteristics, i.e. determinant is a dynamic factor;
- every tact of innovation development is described by a new function (separate functional model).

This complex provides systemizing consistently realized models of functional factors of innovation development:



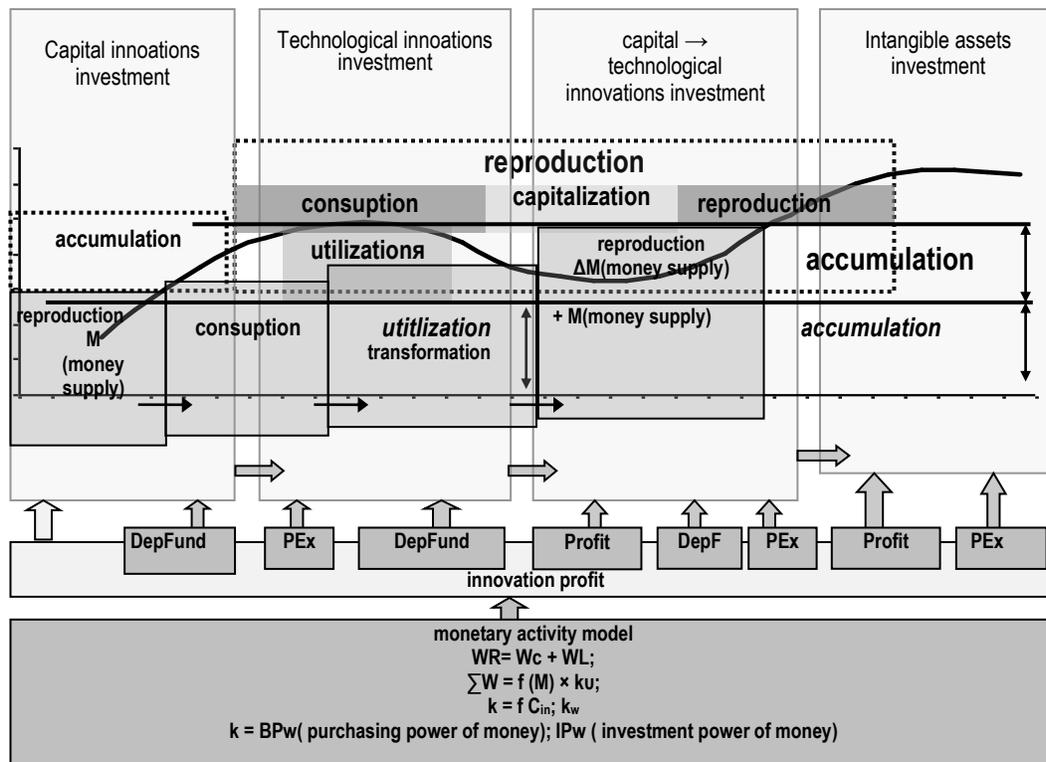
Herewith, optimization target should be resolved by design the model such factors combination which would made possible systemic unity of innovation cycle separated components and forming "complete reproduction cycle" (CCR) of innovation development. Therefore, the main task is to build an innovation development system model. A common solution for innovative reproduction models should be synchronize the functional completeness innovation cycle model and monetary model to innovative investment implementation. Thus, we can reasonably

consider the innovation cycle structure as for overall dynamics of innovation reproduction so to complex general model of innovation investment implementation.

In this case we should consider cycle synchronous implementation of innovations and financial factors of innovative development.

Thus, managing of liquidity at distribution function is a relevant tool for initialization economic growth. All amount the money supply should be distributed according to increased accumulated values. It is consumption + servicing transformation "consumption - capitalization - reproduction" (see fig. 9).

Figure 9. Functional model realization of innovative investments



Source: developed by author

So, macroeconomic preconditions for economic growth arises in innovation-intensive industries at industrial-innovative economies. For innovative economies the initial resource reproduction distribution occurs by system of development institutions, attracting institutional investment, public-private partnership with subsequent forming of innovative development investment funds. But, in the systems of industrial-innovative type needed money supply of reproduction phase ( $M + \Delta M$ ) must be provided by depreciation enterprises and corporations certificates. It activates investments in innovation. In this case, depreciation serves a substantial meaning of accumulated values. It has a financial base, and, simultaneously, it services financial

instrument. So, depreciation fund turnover should be mediated by financial instruments but doesn't liquid cash. In addition it's most importantly, such tool (depreciation certificates) is maximum deprived impact of time factor. Thus, depreciation fund should be considered as functional determinant in the development models.

To solve the problem of innovation investment activation we should change the ratio in money supply structure in according to a new level of global GDP (new base of reproduction). That is to restore liquidity base according to a new level of accumulation.

The market itself is structuring the transformation process by types of crises. Their sequence mediates restructuring of money supply and forming a new ratio of monetary aggregates according to new level values accumulation. So, what transformation occurring in the money supply and how and in what sequence unfolding economic crisis?

1. The mortgage crisis (investment): the values are utilized and receive the cash equivalent due to exhaustion of technological base reproduction productiveness and synchronous transformation investment power of money. There is a decreasing money supply turnover in economic reality.
2. The liquidity crisis - there is a money supply structure discrepancy: the amount of liquid funds, generated by turnover of investment doesn't meet amount of utilized values. There is increasing the gold price.
3. Financial (debt) crisis is always a technical solution for transforming the utilized values to investment. The law of monetary pendulum implementation is realised. Utilized values is transformed to investment resources on a new liquidity basis (the purchasing power of money) in according with amount of accumulated value (new base development). It synchronizes processes of servicing the public debt (bonds floatation). In another words - exchange the current liquidity ( $\Delta M$  - increased money supply) on future reproduced value (% bonds). Functional transformations are occurred in money supply functional structure. Money acquire the internal dynamics due to movement in time purchasing power of money. Thus, money functionality is expanded. Money gets an investment strength.

The communications of innovation profit and model of monetary activity is crucial in functional innovative investment model (Fig. 2.4.3). In this context, one of the main theses of methodologies of innovative profit management is synchronous values distribution in production, distribution and reproduction processes. This process is permanent and mediated by cash turnover. Determination ratio "kupiveln $\leftrightarrow$ investytsiyna" power of money is one of the most difficult tasks. It has the form of general equation nonlinear dependence type:  $k = f(kin; kw)$  at monetary activity model. Calculation the money turnover multiplier (k) for the second

equation:  $\Sigma W = f(M) \times ku$  (interpretation I. Fisher equation of exchange) is key to solving task of innovative investment activation and overcoming the economic crises.

In the system methodological approaches to innovation development, we should see reproduction as a structured system of elements, which include important functional elements of values transformation and utilization. The establishment of such elements occurred under the influence of innovative production due to transformation of production factors into reproductive factors. As a result, the functionality of innovative reproductive factors upgraded to level of socioeconomic reproductive systems.

Actually, this is a "functional" entropy i.e. there is uncertainty increasing in short term due to spread the functionality of production factors productivity into functionally compatible reproductive system. Functional cumulative capabilities of innovation reproduction determining uncertainty within innovation cycle.

### **Resume**

1. Movement and accumulation values is the primary basis for reproduction in innovation economic systems. Accumulation is going to first quarter and it is the first tact of reproduction cycle. Herewith, the cycle is interrupted by accumulation. It is a development phase, which takes the form of technological displacement. Simultaneously, there are forming the investment resources of innovation development. The accumulation effect is implemented due to increasing the innovation environment (macro level) and through emergence technological gaps innovation production (micro level).
2. Accumulated values creates loan's investment pressing, which is motivated and realized by investment mechanism. The amount of accumulation determines the lending base which is forming material and intellectual base of scientific progress and innovation in economic turnover.
3. Money turnover becomes periodically autonomous. This is a moment of loss of functional interconnections in money's functional structure. So, money's functionality is concentrated in purchasing power of money. There is depression in economy. There is transformation values into the reproductive resources based on non devalued value which is a reproductive ability of the land. Transformed values "moves" (displace) the money supply amount ( $\Delta M$ ). The growth of amount utilizing values increases the amount of liquidity in money supply due to monetary low implementation and under the market mechanism influence. As the result, the structure of money supply is changed and it

creates a monetary pressure to transformed (accumulated) value which is development base.

4. Revitalization of innovation demand and lending is functionally interrelated by structural ratio of functional units of money supply. Ratio purchasing/investment power of money determines the amount of investment and the amount of accumulation.
5. The innovation management should be methodologically bases on monetary activity model, where functional elements of investment enhance is a managing of money liquidity which is mediated by funding instruments. Thus, the depreciation funds is a functional element of formation and implementation the innovation investment, where in each tact of funding innovation reproduction there is a basis factor of depreciation fund.

## CYCLICITY OF INNOVATIVE PROCESSES IN ECONOMIC SYSTEM

### General principles structuring of innovation

Studies of innovative processes in innovation system has its own specifics. It means that we should differentiate bouth innovation and manufacturing process, which has different efficiency models. The challenge is to structure components of innovation dynamics. Proof opportunity the eliminating restrictions of innovation models functionality by taking into account latent mutual transformation elements of innovation dynamics is too relevant.

**So, first rule is:** *structuring of innovation should be based on their functional characteristics in implementation dynamics.*

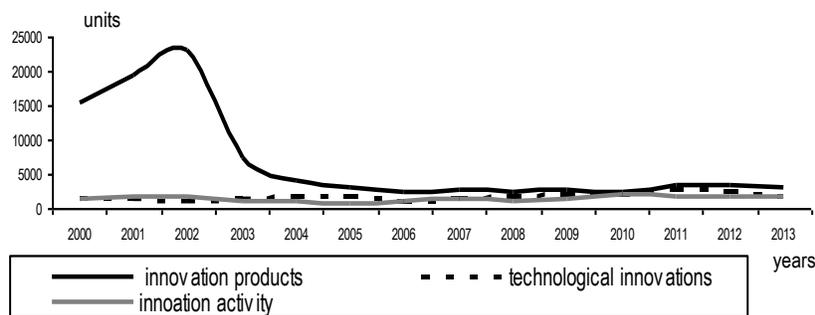
Innovations are produced by economic system where machine engineering is core. Accordingly, the innovation economic system design is possible only through a combination two general system models based on technological chains: machine engineering (core) ↔ technological-industrial economies + macro-logistical subsystem of economy systems, which providing communications "internal market ↔ foreign markets ↔ global market". That's why, the development of innovations should be considered through machine engineering model. All other models of economic systems are adaptive. These will get limited productiveness in general rotio "productiveness ↔ efficiency". So, it is more important generating strategic management innovation model together with Forsyth of inovations. It's methodologically imposible to unified general economic model without innovation management model. Accordingly, as administration so funding mechanism should unified through innovation dynamics. In turn, it is necessary to design new methodology to formulating the principles innovation of structuring.

**Basic principle is:** *structuring innovations in production processes must be based on general regularities of innovation cycle dynamics, which structure is the basis for economic systems development any level aggregation.*

In the fig. 10 we can see innovation model which accurately reproduces both short and medium cycle of business activity. In this model short cycle is a new technological processes implementation. It is chronologically synchronous to dynamics (cycle) of innovative products implementation with a corresponding interval. There are also obvious synchronization dynamics of business activity and the dynamics of innovative product implementation. Thus, the technological factor (technology innovation) providing increasing the business activity dynamics in the economy as a whole. Technology is a catalyst imbalance in production. Such active element of imbalance extrapolates development opportunities into the capital reproduction sphere. So, there is derivative dynamics in finance. We should be noted that the product-process approach is the most relevant for structuring elements of innovation process.

Let's look at a model of innovative activity in the industry of Ukraine based on product innovations and technological/process innovation data.

Figure 10. Innovation in industry of Ukraine



Source: developed by author in according to the State Statistics Service of Ukraine data

And here's the thing. Product and process innovations has some feature to differentiation. But this differentiation is more general to dynamics of the interaction of elements structured according to innovation process. Accordingly, these are displayed beyond functionality of innovative models developing the innovation models. That's why dynamic characteristics of the innovation cycle displaced to field of production and processes innovation trends approximation. Thus, there is a conditional abstracting from innovation dynamics effects in reproduction processes in favor to equilibrium reproduction models. It is a methodological mistake for innovation development studies.

Why it's relevant?

In according to this approach, all effects of technological renewal capital fall at zone approximation by time parameters of function, so these are differentiated by tact of renewal the

technological base of production. So, the significant accelerated effects doesn't accepted. That is a reason discrepancy of innovation development forecast models.

Product innovations cycle reflects the cycle with a period of 7-10 years. At first glance, there is some controversy because medium cycle is an capital changes period, the creation of depreciation fund and reproduction of capacity. The capital reproduction (reproduced competitive advantages) is considered as an element of innovation development. The processes of capital reproduction is occurred by transformation type: "funding→real capital→funding". The period of production capacity replacement should be considered as realized fixed capital productivity (innovative products) so transformation restored fixed capital values to finance (depreciation fund formation). The source of this dynamic is the implementation of the newly created value (competitive advantages values or innovative production values) in economic turnover.

So:

- there are certain elements of innovation in enterprises: technological innovation or "technologies" and innovative products;
- actually technologies factor is a catalyst for increasing the dynamics of innovation activity in machine engineering and therefore the industry as a whole;
- technological innovation (technological dynamics) is the basis for structuring innovation. It is a primary for innovation reproduction of capital and it initiates and implements sequence of innovation reproduction cycle as a system of innovation development elements type: "technological innovation → enterprises innovative activity → product innovations→capital innovation→creating intangible assets".

In this way, there is highlighted stages differentiation in innovation dynamics structure. Moreover, there is a clearly defined structure innovation cycle in economic turnover of values. Actually, it is much more important.

So, product innovations is the original function for dynamics of capital innovation reproduction. This thesis does not contradict to general approach in economics where, in particular, capital goods are considered as investments to improve production. Capital goods (capital investment) is an exogenous source of increased productivity of innovative production. That's why it is important to separate "capital innovation" from total volume of technological innovations as structural element of innovative dynamics for innovation cycle model design. Differentiating technological innovation and capital innovation is based on differences in duration tact their reproduction in innovation cycle and their functionality in reproduction processes. In addition, capital innovation is an exogenous factors for structural transformations in economic systems. These acquire functionality through investment beyond innovation processes purely in the

production system. In this way, restructuring function of "capital innovation" is an important characteristic as for enterprises innovation system so more aggregated systems up to the national innovation system. It allows to consider "capital innovation" as for innovation production process, so dynamics of innovation cycle and forming the structure and technological base of innovative environment of national economy.

Transformative unity different forms of capital is also present in funding sphere. Funding is formed due to innovation product movement with following distribution to capital productivity reproducing in production and creation the innovative investment reproduction fund.

Productive innovations are allocated to competitive advantage values (brand competence) and intangible assets values, which is technological competitive barriers for entering to industry. Intangible assets quality and cost structure reflecting technological level of production in industry. Product innovations can't motivate technological dynamics and changes in technological base of production in economic system. Technological innovation is the primary function for innovation activity dynamics. Frequency of technological innovation is multiple to frequency of capital reproduction which includes two technological cycles. Technological innovations begin and complete innovation cycle. Technological innovation is a direct functional competitive advantage. Technological innovation is not distributed in innovation production cycle. These are primary element of innovation dynamics

**Consequently**, the general principles of structuring innovations are as follows:

- innovation cycle chronologically and functionally is clearly structured for technological innovation dynamics and capital reproduction dynamics;
- innovation dynamics is mediated by changes in the production processes and economic environment, herewith these changes are innovative and synchronous;
- these changes leads to growth of innovative environment, implementation of innovation products, renewal the technological base of production, growth of capital, forming the intangible assets and innovative investment fund;
- innovations are structured to factorial elements and effects of innovation development as follows: technological innovation (IT), capital Innovation (CI), intangible assets (ON) and depreciation (AM) all of them are factorial elements of innovative development. Capital gains, changes in the technological base of production, changes in the technology industry, the growth of innovative environment of investment resources and innovative reproduction are the effects of innovation development. Innovative activity and innovation product implementation in economic turnover are the substantial innovation development units;
- factor elements of innovation dynamics are the statistically significant in studies of innovative development.

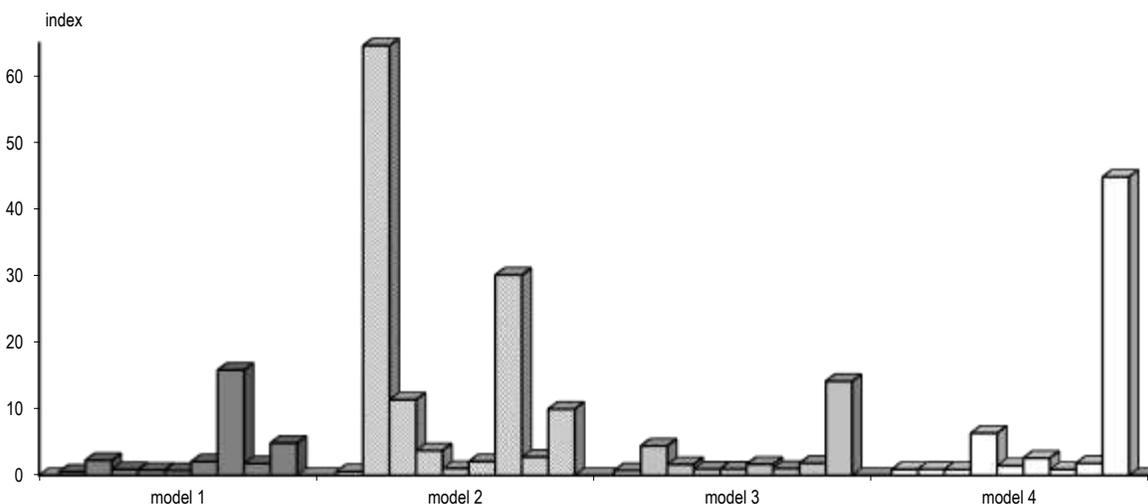
These principles doesn't reflect any aspects of synchronization because it's relevant for substantiation improving the mechanism of funding the innovative development, where one of the main issues is to study the nature this dependence.

### Formation and development of innovation cycle in intangible assets modeling

Two factors of innovation development forms the dynamics of business activity (innovation activity), among them: technological change (technological factor) and capital productivity dynamics, based on innovative products implementation dynamics (product innovation factor). The intangible assets formation is a common for innovation dynamics as a whole. However, there are heterogeneous dynamics of this process at different industries in different models. Complex of four models was developed (fig. 11). There are two cycles of intensify process the intangible assets formation. So, identity of intangible assets formation dynamics is an important argument in support of cyclicity innovation processes to any aggregation economic systems and economy as a whole.

General estimate 4 models allows to calculate indicators for determining temporal boundaries of innovation cycles in the economy (see fig. 11. "Innovation entrepreneurship model").

Figure 11. Growth intangible assets Index in according to 4 models (2002-2010 years data)



| Intangible assets value dynamics in Ukrainian economy* |      |       |       |      |      |      |       |                    |       |       |                 |                  |                   |
|--|------|-------|-------|------|------|------|-------|--------------------|-------|-------|-----------------|------------------|-------------------|
|  | 2002 | 2003  | 2004  | 2005 | 2006 | 2007 | 2008  | j<br>2002-<br>2008 | 2009  | 2010  | j 2008-<br>2010 | j <sub>гтп</sub> | j <sub>отбв</sub> |
| Model of economy: model 1                              | 0,52 | 2,26  | 0,90  | 0,79 | 0,72 | 2,07 | 15,81 | 1,78               | 4,85  | 4,85  | 3,316           | 1,01             | 1,0               |
| Innovation in environment: model 2                     | 0,58 | 64,55 | 11,34 | 3,71 | 1,05 | 2,08 | 30,09 | 2,75               | 9,95  | 9,94  | 6,349           | 0,39             | 0,87              |
| Innovation leaders: model 3                            | 0,73 | 4,43  | 1,64  | 0,96 | 0,95 | 1,68 | 1,02  | 1,80               | 14,12 | 14,12 | 7,96            | 4,88             | 1,87              |
| Optimized model : model 4                              | 0,90 | 0,92  | 0,88  | 6,34 | 1,16 | 2,60 | 0,89  | 1,80               | 44,80 | 44,79 | 23,24           | 11,63            | 3,36              |
| Intangible assets growth average index                 | 0,68 | 18,04 | 3,69  | 2,94 | 1,04 | 2,14 | 11,95 | 5,78               | 2,01  | 18,42 | 10,22           |                  |                   |
| Innovation enterprises model                           | 0,9  | 0,91  | 0,87  | 6,33 | 1,46 | 2,6  | 0,89  | 1,997              | 1,68  | 44,79 | 23,24           | 11,63            | 3,36              |

\* – index estimation method

$j_{gtii}$  - growth potential of technological innovation index,

$j_{gutbpi}$  - growth update technology base of production index

Source: compiled by the author based on data: [http // www. smida. gov.ua](http://www.smida.gov.ua).

This transformative effect can have different interpretations. In microeconomic aspect, such effect initiates the changes in structure of production function in terms of resource allocation mechanism in the innovation process. In the macroeconomic aspect, there is restructuring market model of national economy, which leads to qualitative changes in the system of national accounts indicators, consumption and accumulation. Such transformation is the final stage of innovation reproduction cycle. Accordingly, the time series 2002-2008 years are meaningful to constituents of factor analysis of innovation dynamics, as evidenced by presence transformative effects for all studied models.

In addition, this opinion confirmation will be substantiated to section IV.

At this stage of the study should note the following regularity:

- *the cyclical fluctuations frequency is decreased in according with increasing degree of economic system innovation capacity. Cycle's periodicity is synchronous to two successive technology cycles (cycles of technological innovation). Herewith, the innovation system increasing leads to approximation the fluctuations of enterprises innovation activity indicators;*
- *to developing economies the frequency and amplitude of cyclical fluctuations are large, but they are reduced (goes to «min») due to growing share of high-tech industries;*
- *the intangible assets value increase reflects the intensity degree of innovation processes industries as a whole. Volume of intangible assets value growth allows to estimate the quality of innovation implementation and innovation development cycle dynamics. Herewith, it is relevant as intangible assets growth index so its deviation from the average level.*

### **Conclusive Remarks:**

1. The nature and dynamics the intangible assets growth doesn't depend on technological level of production in industries. The composition and value the intangible assets doesn't dependent on amount of capitalization companies or businesses diversification. The formation intangible assets is a synchronous to enterprises innovative activity dynamics, innovation implementation and dynamics of increasing innovative environment of economy.
2. The formation and increasing intangible assets should be consider as characteristics process of "utilization", e.i. transformation the technology innovation factor into it's market value. In this case, intangible assets is irrespective and indirect rate of economic system innovation development. This determines its autonomy. It should be considered as a determinate element, which doesn't have substantive or functional significance of technological factors of innovative development.

Such element is a technological innovation costs to acquisition and creation the intangible assets. Their implementation has its own dynamics, which is synchronous to the capital innovation dynamic. Efficiency of technological innovation is always realized in product innovation. In engineering there isn't a clear differentiation the efficiency implementation capital and technological innovation, such as in chemical or food industry. The implementation of capital innovation is always functional interconnected with technological innovation. Herewith,

technological innovations and capital innovations should be considered as autonomous factors of innovation development. Technological innovations in engineering is implemented into the structure of capital and production efficiency. The dynamics of technological innovation is synchronous to the dynamics of innovation efficiency of production but capital innovation is to the dynamics of innovation product implementation. The technological and capital innovations implementation is closely linked to productivity and efficiency of innovation development.

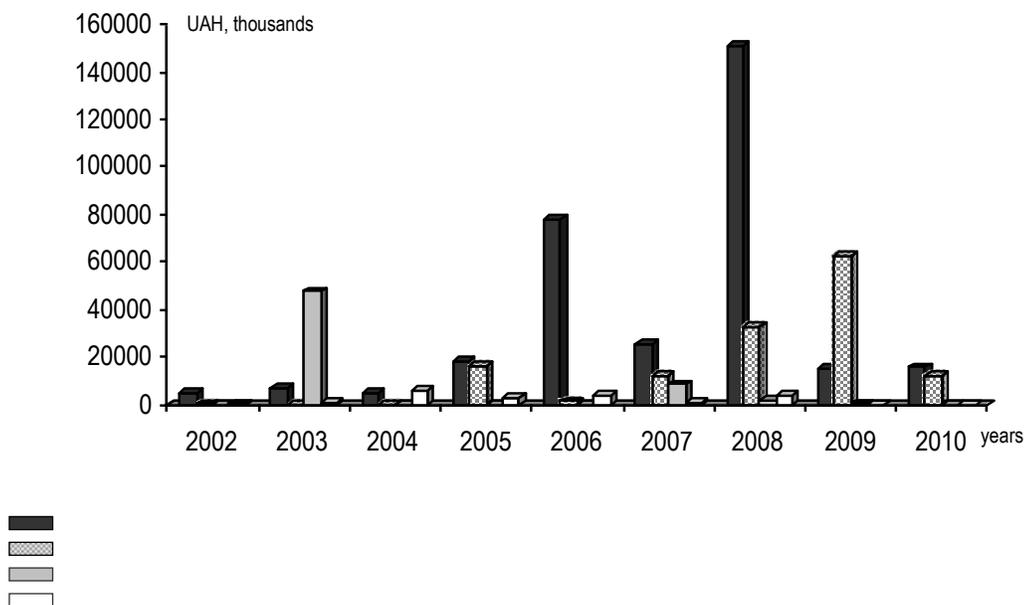
**Cyclicality of funding the enterprises innovation activity in Ukraine**

The most important among current trends is an available functional connection funding and production processes as to dynamics of formation resources, so value concentration rate into the tools of it's implementation.

In this context it is crucial to identify cycle in funds of financial resources formation. It is important to make in complex financial market instruments and finance of enterprises.

The functional interconnection investment in innovation and lending is confirmed by general regularity strengthening dominant of investment mechanism due to increasing dynamics of innovation in industries. "Functional model of innovative investments realization" is also cyclicality formation element through concentration the enterprises innovative development financial resources.

Figure 12. Funding innovation of machine-building enterprises in Kyiv



|              | 2002   | 2003    | 2004   | 2005    | 2006    | 2007    | 2008   | 2009    | 2010    |
|--------------|--------|---------|--------|---------|---------|---------|--------|---------|---------|
| Власні кошти | 4678,1 | 6577,7  | 5085,2 | 18310,8 | 77918,2 | 25220,5 | 151234 | 15425,1 | 15536,7 |
| Кредит       | 20     | 0       | 0      | 16226,7 | 1276,7  | 12121,1 | 2412,4 | 62263   | 11768   |
| Інвестиції   | 0      | 47699,6 | 0      | 0       | 0       | 8390,3  | 1760   | 83      | 0       |
| Інші джерела | 29     | 426,8   | 6010,6 | 2648,8  | 3998,2  | 569,7   | 4048   | 0       | 0       |

Source: compiled by author based on data: [http // www. smida. gov.ua](http://www.smida.gov.ua).

Herewith, we should distinguish functional component of investment. We should also see them as dominant value financial resources movement so mechanism of values redistribution. In the fig. 3.3.1 we can see largely proportional distribution of total amount funding financing the enterprises innovation within one financial period (one year). However, there isn't any clear functional interconnection of distribution between different financial mechanisms. This allows us to formulate some interim conclusions:

- changing the sources of financial resources is irrespective to innovation activity, but borrowed funds dynamics does not impact to innovation dynamics of enterprises (first of all in engineering);
- the cyclicity financial resources of innovation enterprises activity is formed under investment and lending domination. It leads to forming the general fund innovation. The general funds formation is completed of each financial period in various amounts. It cause to cycle forming through complex implementation of all innovative financial instruments of enterprises;
- the financial cycle trend of innovation development is based on maximizing the value concentration into the relevant financial tools;
- completeness the cycle for enterprises and economy in the whole depends on perfection/completeness system/complex available financial tools. It allows to overcome the technological gaps through innovation development process.

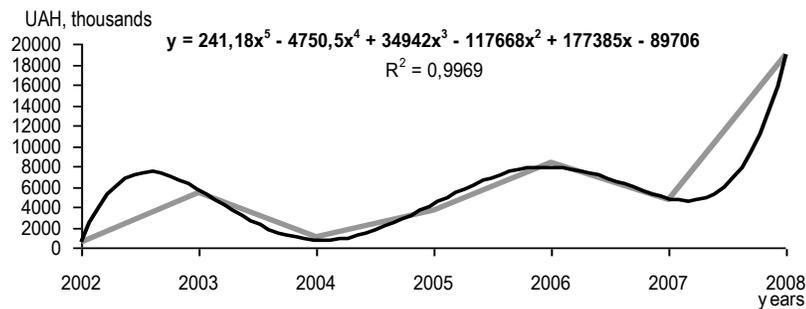
From these conclusions, one should single the functional importance of innovations funding dynamics through the total amount innovations expenditures. Every structural element of total amount funding innovation (capital innovation (CI), technological innovation (TI), depreciation (D), intangible assets (IA) should be considered a functionally autonomous factor. The combination of these factors indirectly determines the trajectory and dynamics the economy systems innovation development. At the same time, the innovation development funding function is a common and independent on any financial mechanisms. It can be considered as a

single innovation development function. The funding model of innovations has got a view of polynomial function, it's equation the trend is built of approximated rates following:

$$(3.3.1) \quad Y = 241,18x^5 - 4750,5x^4 + 34942x^3 - 117668x^2 + 89706$$

(verify equation:  $R^2=0,9969$ )

Figure 13. Feature financing innovation in engineering



Source: compiled by the author based on: [http // www. smida. gov.ua](http://www.smida.gov.ua).

The first thing that needs to be said is the model, however, is purely descriptive sense because it's predictive characteristics is not significant. Despite that this is a theoretical model, it's confirmed the innovation cycle existence in demand formation processes and structuring the innovation process in reproduction of economy systems higher aggregation. A distinctive feature of this model should be considered full innovation cycle completion during 2002-2008 years. This confirms the hypothesis about arising the approximation effects of statistical estimates due to more broader temporal scope of study.

### **Resume**

In practice the funding of enterprises innovation activity is really structured to implemented innovation factors, such as innovation profit, depreciation fund and common external mutual/direct funding of innovation reproduction. Such structurization and its mechanism is based on an innovative dynamic of capital reproduction. Herewith, the financial mechanisms elements doesn't find direct functional implementation to financing innovation. It is necessary for this to develop a method of synchronous implementation processes of reproduction innovations and funding the enterprises innovation activity.

The dynamics of intangible assets recreates the capitalized values movement, in which basis is dynamics of technological factors. The enterprises intangible assets productivity can not be adequately estimated based on a linear function.

The dynamics of efficiency of innovation activity is cyclical in nature, with an expressive cycles of attracting the financial, technological and capital resources. Dynamics of innovative products implementation is caused (initiated) by technological innovation factor. This effect can be functional, that allows to consider technology (Tech) as a single argument of production function together with capital (C) and labor (L). Technology factor forms also total amount of businesses profitability. Thus, technology can be considered as cumulative aggregated factor of enterprises innovation development.

Technological innovation induce to accelerate of depreciation fund formation processes. These motivate acceleration of fixed capital utilization and following transforming it to form of finance. In the efficiency and productivity models the depreciation should be considered as a factor of increment and productivity of capital through innovation products implementation

That's why it is necessary to transform the intangible assets value to liquid form through depreciation mechanism or placing on the market on the beginning of technological cycle. It should be done because at this stage, these assets is a ballast and subject to mandatory "disposal". So, their values must be transform to innovation development funds. Otherwise intangible assets reduces company profitability and slows development.

Financial factors are autonomous elements of funding innovative development, their implementation has a functional nature. The innovation development financing function is mediated by self-financing and investment mechanisms of funding. Actually development is realized on the basis of functional transformation of innovation activity efficiency and innovation manufacturing productivity. It can be represented follow:  $f_{efficiency} \leftrightarrow f_{productivity}$ , where for each innovation development tact "capital innovations $\leftrightarrow$ technological innovations" there is a single function of innovation funding.

Formation the financial resources is identical to structure and dynamics of enterprises innovation processes and innovation cycle.

Within the capital reproduction cycle the funding function won't depend on the characteristics of innovation processes in the enterprise. It's will include such financial factors: investment amount, innovation lending amount and depreciation fund amount used in innovation.

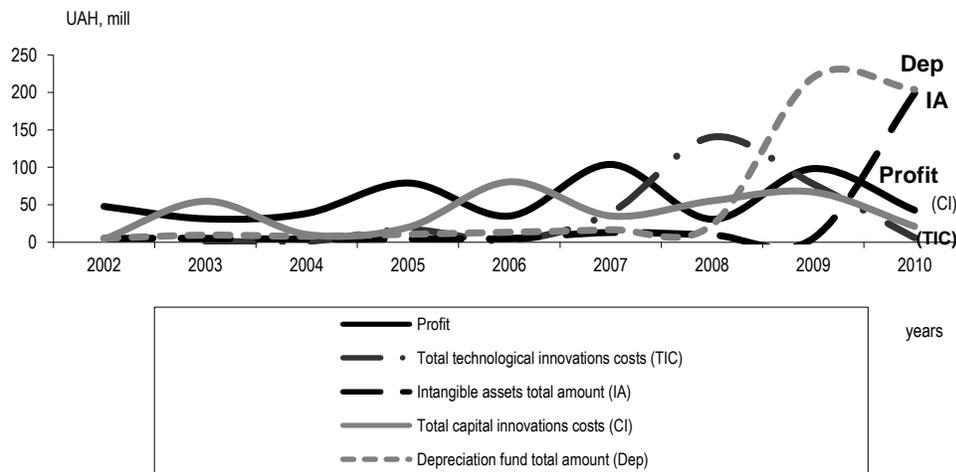
To ensure the growth of effectiveness of innovation implementation the machine-building enterprises should stick to a progressive structure introduced innovations where technological innovation should be at the level of 45 - 55% of all innovations in the enterprise.

## MODELING THE FUNDING INNOVATION DEVELOPMENT BASED ON INNOVATION CYCLES

### The innovative development effective funding function

The general characteristic of cyclicity economic processes is the regular sequence of functional impact factor implementation. The financial potential of depreciation fund in fact doesn't integrated into the economic turnover whereas one has a primary functionality and, therefore, to funding mechanism for innovation-technological development of economic systems. Interconnection "profit - depreciation" clearly indicates the object of financing, which should be seen as a processes of profit generating in economy systems, if we accept it for functional and, importantly, functionally relevant. In turn, the system of interconnections elements industrial innovation system through depreciation fund formation should include to structure of functional determinants of designing Forsyth innovative economies. It is also important to unify the dynamic model of innovation-technological development of economic system and innovation cycle model. It will be use to designing a common model of economic systems reproduction based on financial factor and production factorial elements. Let's consider the innovation factor "intangibles" (IA) and "depreciation" (Dep) graphics ( see fig. 14).

Figure 14. Profit and innovation cost model for innovation activity in engineering



Source: compiled by the author's own calculations based data: [http // www. smida. gov.ua](http://www.smida.gov.ua). Annual reporting issuers. Information Disclosure System Securities Issuers

So, there are two fixed periods, where these factors interaction density reaches "max", ie linear interconnection their implementation is established. As the result substantial functionality was established, which we could call some materialized substantial unit. We can also see it to at

point of intersection IA and Dep trends in 2002 and 2010 years. How should be interpreted the points of contact data graphs.

Let's write it as follows:  $\Delta \text{Dep}_{2002-2010} = \Delta \text{IA}_{2002-2010}$

Their linear interaction allows turn equation to functional:

$$(4.1.1) \quad \text{Dep}'_{2002-2010} = \text{IA}'_{2002-2010},$$

That would mean derivative of a function  $f(\text{Dep})$  is equal to derivative of a function  $f(\text{IA})$  in every time period, which implies the following: ***in each time period, the linear interaction "Dep" and "IA" leads to constant equality***, that can be written in changes dynamic follow:

$$(4.1.2) \quad \text{Dep}'_{2002-2010} = \text{IA}'_{2002-2010} = 0$$

Consequently, there is nothing development. Actually, there is nothing transformation of technological changes (technological displacement). So development is static, its own dynamics is realized to accumulation reproductive potential accumulation. Let's call this cycle ***"productivity↔concentration"***. The technological displacement is characterized by simultaneous co-directed change of innovation factors "Dep" and "IA". So, the factor's own linearity is transformed to linearity their functional implementation. In this way the maximizing linearity interconnections different innovation factors is achieved together with losing of factor's linearity. Thus, a new equality order in the system of equations is formed follows:

$$(4.1.3) \quad \left\{ \begin{array}{l} \text{Dep}_1(2010) = \text{IA}_1(2010) \\ \Delta \text{Development} = 0 \end{array} \right.$$

Thus, the numerical increasing volume between two "substantial units" of linear implementation "Dep" and "IA" (i.e. between two technological displacement or technological transformations) indicates the initial values base level distribution for a new economic cycle/economic growth. Such value's volume can be considered as a parameter  $\beta_0$  of linear regression equation for economic-mathematical models. The value's amount the innovation-technological factors for economic system reproduction in a new economic cycle is about 25 billion USD for example to Ukrainian engineering industry. At the same time, in the fig. 4.1.1. we can see a similar linear interaction of capital innovation factors "CI" and "TI" (technological innovation factor) in 2009. However, it doesn't lead to increasing the enterprises innovation activity or in industry as a whole. **Consequently, a new development cycle won't begin until simultaneous maximize linear interaction all innovation factorial elements become for equality:**

$$(4.1.4) \quad \text{Dep}_1(2010) = \text{IA}_1(2010) = \text{TI}_1 = \text{CI}_1$$

It indicates a common amount investment for a new technologies and industries development. It also indicates a scale technological modernization for every economic system any aggregation. For Ukraine it is equivalent to 25-30 billion USD investment to "CI" and "TI" for industries technological modernization.

Thus, capital innovation factor "CI" and technological innovation factor "TI" forms implementation cycle of innovation realisation, that in functional view can be written follows:

$f(\text{technological innovations}) \leftrightarrow f(\text{intangible assets}),$

as dual form the mutual technological factors dynamics, and:

$f(\text{capital innovations}) \leftrightarrow f(\text{depreciation}),$

as a dual form of capital gains factor.

The correlation of innovations activity indicators dynamics indicates an economic development trajectory as a sequence of transformations:

**Profit** → (TI ↔ IA) → (CI ↔ Dep) → **Output** → **Profit1**

, where function of a Profit is a dynamic substance unit through movement of innovative factors.

Table 3. Regression-correlation analysis of innovation engineering enterprises  
(model time series)

| function: Profit                             |   |           |           |           |           |           |           |
|--|---|-----------|-----------|-----------|-----------|-----------|-----------|
|  | 2002                                    | 2002-2003 | 2002-2004 | 2002-2005 | 2002-2006 | 2002-2007 | 2002-2008 |
|  | <b>Correlation rates</b>                |           |           |           |           |           |           |
| <b>Output</b>                                | 0,9924                                  | 0,9916    | 0,9850    | 0,9887    | 0,9843    | 0,9800    | 0,9878    |
| <b>Total innovation costs</b>                | 0,9401                                  | -0,0751   | -0,0548   | 0,2815    | 0,8316    | 0,8336    | 0,9615    |
| <b>Total technological innovations costs</b> | -0,1008                                 | -0,1783   | -0,1625   | 0,9875    | 0,9808    | 0,9763    | 0,9968    |
| <b>Total amount intangible assets</b>        | -0,2031                                 | -0,2322   | -0,1881   | -0,2014   | -0,2449   | -0,0494   | -0,0788   |
| <b>Total capital costs</b>                   | 0,9496                                  | -0,0620   | -0,0520   | 0,0075    | 0,7762    | 0,7739    | 0,8194    |
| <b>Deprciation fund total amount</b>         | 0,9872                                  | 0,3814    | 0,4041    | 0,4687    | 0,5304    | 0,6061    | 0,6894    |
|  | <b>Profit function regression rates</b> |           |           |           |           |           |           |
| <b>B<sub>1</sub></b>                         | 0                                       | 0         | 0         | 0         | 0         | 0         | 0         |
| <b>Ti</b>                                    | 0                                       | 0         | 0         | 8,9340    | 9,7028    | 13,6259   | 1,7886    |
| <b>IA</b>                                    | 0                                       | 0         | 0         | 0         | 0         | 0         | 0         |
| <b>CI</b>                                    | -<br>12,4339                            | -2,8652   | - 3,1003  | 0         | 0         | 0         | 0         |
| <b>Dep</b>                                   | 16,9548                                 | 2,7567    | 3,2444    | 0         | 0         | 0         | 0         |
| function: Output                             |   |           |           |           |           |           |           |
|  | 2002                                    | 2002-2003 | 2002-2004 | 2002-2005 | 2002-2006 | 2002-2007 | 2002-2008 |
|  | <b>Correlation rates</b>                |           |           |           |           |           |           |
| <b>Total innovation costs</b>                | 0,9261                                  | 0,0304    | 0,0898    | 0,3857    | 0,8903    | 0,8888    | 0,9702    |
| <b>Total technological innovations costs</b> | -0,0741                                 | -0,1823   | -0,1386   | 0,9835    | 0,9787    | 0,9720    | 0,9921    |
| <b>Total amount intangible assets</b>        | -0,2535                                 | -0,2638   | -0,2186   | -0,2231   | -0,2577   | 0,0315    | -0,0050   |
| <b>Total capital costs</b>                   | 0,9284                                  | 0,0434    | 0,0925    | 0,1183    | 0,8442    | 0,8379    | 0,8428    |

|   |      |         |         |         |        |        |        |          |
|---|------|---------|---------|---------|--------|--------|--------|----------|
| <b>Deprciation total amount</b>         | fund | 0,9721  | 0,4806  | 0,5361  | 0,5715 | 0,6336 | 0,7002 | 0,7250   |
| <b>Output function regression rates</b> |      |         |         |         |        |        |        |          |
| <b>B<sub>1</sub></b>                    |      | 0       | 0       | 0       | 0      | 0      | 0      | 0        |
| <b>Ti</b>                               |      | 0       | 0       | 0       | 8,4132 | 9,0943 | 8,8676 | 1,7256   |
| <b>IA</b>                               |      | 0       | 0       | 0       | 0      | 0      | 0      | 5,8068** |
| <b>CI</b>                               |      | 0       | -5,4300 | -4,5802 | 0      | 0      | 0      | 0        |
| <b>Dep</b>                              |      | 20,3775 | 5,5092  | 5,1993  | 0      | 0      | 0      | 0        |

\*\* - these indicators require further study

Source: compiled by the author's own calculations based on data: [http // www. smida. gov.ua](http://www.smida.gov.ua). Annual reporting issuers. Information Disclosure System Securities Issuers

Thus, innovation production and getting a profits are the constants and doesn't determine development of cycle. Accordingly, the cycle can be presented by aggregated view follows: **Profit**→**Output**→**Profits 1**. Dynamics of innovation productivity factors is formed on this basis. On the Table 4.1.1. we can see the Profit is only single factor which explains and describes the technological innovations implementation since 2002 to 2008 year. This belief comes from fact of establishing periodic and consistent systemic linear relation:  $f(\text{Profit}) \leftrightarrow f(\text{Capital innovations})$

and  $f(\text{Profit}) \leftrightarrow f(\text{Technological innovations})$ .

The total amount innovation expenditures (TIEx) is synchronous to dynamics

$f(\text{Capital innovations}) \leftrightarrow f(\text{Technological innovations})$  and determining the function of a "Output". The changing correlation of functional relation  $f(\text{Output}) \leftrightarrow f(\text{TIEx})$  represents dynamics of efficiency and productivity realization of innovation factors. We can also see periodic established correlation indicator **TIEx** to **function of a Profit** and **function of a Output** in 2002 and 2006-2008, that indicates period and trajectory of innovation environment development for economy level.

So, *the innovative factors implementation has a functional nature and can be described and modeled by a linear regression function. Linearity involves direct implementation innovation factors to the production process.*

Thus, this study proves follows:

- technological factor and capital gain factor are the primary factors for innovation development of economic system. These directly implements its own productiveness to innovation processes;
- consistency and frequency implementation the capital innovation (CI) and tachnological innovation (TI) creates an innovation development dynamics, which is

- mediated by periodically establishing dense correlation of these factors and production efficiency;
- in economic-mathematical models the innovation development cycle is described by sequence implementation of innovative factors that can be reflected by regression coefficients of dual linear function of efficiency  $f(\text{Profit})$  and productiveness linear function  $f(\text{Output})$ .

Accordingly, cycle of innovative development factors implementation can be schematically represented follows:

$f(\text{Depreciation} \leftrightarrow \text{Capital innovations})$

$\rightarrow f(\text{Technological innovations} \leftrightarrow \text{Intangible assets}) \rightarrow$

$f(\text{Capital innovations}) \rightarrow f(\text{Depreciation})$ .

Following to this model, enterprises could be provide its own progress using it as a basic algorithm for innovation development with effects similar to economies of scale in a competitive industry.

The model (see Table 3) gives clearly vision 4 years period complete for technological innovation factors cycle implementation. It will be inception transition to a new technological basis of production.

Accordingly, the cycle of reproduction the innovation factors capital gain will more than seven years, besides it's efficiency realization in time is about three to four years. Four years of technological innovation will finish by transformation productivity of technological innovation to intangible assets.

From these calculation, one may conclude that general efficiency of innovation production can be represented by a linear function:  $f(\text{efficiency}) = f(\text{TI}; \text{CI})$ .

The enterprises innovative development is defined by periodic implementation of innovation factor into innovation production efficiency, which has a linear nature.

Nevertheless, it is necessary emphasized about polynomial function doesn't describes the dependence between productivity and total funding amount of innovation in the industry, exactly like efficiency function. If we use generally accepted approach in justifying parameters funding model, where, among function arguments takes into account the total amount of financing innovation, the leniar modeling (multiple linear regression, including acceptable conversion) doesn't give a satisfactory quality of innovative development funding model.

So, one can reasonably assert: *innovative development is functionally independent of gross investment industries and we should look for another type of dependency factors of productivity and efficiency of innovation activity.*

Therefore, it is necessary overall funding of innovation to differentiate to separate financial mechanisms due to their density functional interconnections criterions. So, function of finance is some different from previously developed. In this context, we can based on premise about finance doesn't create values and can't create their own productivity into economic turnover. Фінанси обслуговує господарський оборот, зокрема інноваційної продукції. Проте, фінансування є динамічною категорією. Він реалізований в глобальній економічній системі під впливом макроекономічних чинників динаміки. Therefore, in the context of this study the primary cycle of innovation finance cycle can be considered capital reproduction cycle of 7-10 years. (Medium cycle). Thus, the primary base of innovative development financing mechanisms should include the capital reproduction cycle elements. In the context of innovative development financing models, certainly capital innovation funding cycle (7-10 years) will be considered as primary basic cycle for innovation development funding. It will include direct investments capital, long-term loan, depreciation, which can be represented in functional form follow:  $Y_{\text{efficiency}} = f(\text{Investment}); f(\text{Lending}); f(\text{Depreciation})$

In this case, the technological cycle funding (financial mechanism for technological innovation funding) will look like:  $Y_{\text{efficiency}} = f(\text{prepaid expenses amount})$ .

In this way, it is achieved the methodological partition for innovation development self-financing mechanism to cycles of innovative growth factors implementation. It should be noted that the function of financing will not have any differentiation to static or dynamic model. The funding model is a common model innovation development. The first thing it is necessary to emphasize, the funding function implementation provides to separate the general amount of innovation funding through self-funding to profit, prepaid expenses and depreciation, which we can define a functional components of profit. On the other hand, taking into account macroeconomic function of innovation development there is functional interconnection type  $\text{Profit} = f(\text{Credit})$ , where profitability factor implements the lending capital renewal function. Therefore, the profit becomes a general factor among the other innovation funding factors. It has functional nature and carried out the following areas:

**Profit = f (Efficiency)**

**Profit = f (Productiveness)**

**Profit = f (Funding).**

In the context of innovative development funding modeling, the changes in one of the functional components of profit will lead to a change of the rest parameters. At the same time, enterprises self-funding factors doesn't exert decisive influence to innovative investments function. This makes the investment an autonomous financing element (see. Table 4). Instead, investments is

functionally dependent from the dynamics of macroeconomic indicators, which gives them uncertainty and the consequent unpredictability.

Table 4. Level interconnection density funding sources of innovation in engineering

|                  | Efficiency | Output | Funding resources for innovation development |                  |              |         |            |
|------------------|------------|--------|--|------------------|--------------|---------|------------|
|                  |            |        | Profit                                       | Prepaid expenses | Depreciation | Lending | Investment |
| Efficiency       | 1          | 0,9877 | 0,9983                                       | 0,9970           | 0,9882       | 0,9211  | -0,1085    |
| Output           |            | 1      | 0,9923                                       | 0,9903           | 0,9776       | 0,94663 | -0,0563    |
| Profit           |            |        | 1  | 0,9984           | 0,9909       | 0,93497 | -0,0841    |
| Prepaid expenses |            |        |  | 1                | 0,9934       | 0,92663 | -0,1329    |
| Depreciation     |            |        |  |                  | 1            | 0,91628 | -0,1589    |
| Lending          |            |        |  |                  |              | 1       | 0,1358     |

Source: compiled by the author

Financing innovative development function includes a linear regression equations, which display a double funding dynamic (efficiency) and financial support the innovative production increasing (productiveness):

$$(4.1.5)^{\circledast} \quad Y_{\text{efficiency}} = 8762,869 + 2,216515 \times \text{PEX}$$

$$(4.1.6)^{\circledast} \quad Y_{\text{productiveness}} = 12153,73 + 2,319388 \times \text{PEX}$$

quality of the model:  $R^2_{\text{efficiency}} = 0.996005$ ;  $R^2_{\text{Productivity}} = 0.999950$ .

Herewith, the investment, lending, depreciation regression coefficients hasn't statistical significance and doesn't impact to function. So, the enterprises funds is an innovation development funding factor through prepaid expenses (PEX). It also proof that hypothesis about primary technological factor influence to cyclical realization of innovation development is true.

Nevertheless, there is a function of external financing innovation, for which investments is a statistically significant:

$$(4.1.7)^{\circledast} \quad Y_{\text{efficiency}} = 8,777227 \times \text{Investments}$$

$$(4.1.8)^{\circledast} \quad Y_{\text{productiveness}} = 6,77452113 \times \text{Investments}$$

quality of the model:  $R^2_{\text{efficiency}} = 0,978956$ ;  $R^2_{\text{Productivity}} = 0,9720175$ .

It also proof that investments is an autonomous funding factor. Moreover, it must be emphasized that efficiency and productivity innovation investment implementation has a linear functional nature. At the same time, investment implementation is able with existing lending, as well as through depreciation. A single linear function of innovative investment is inadequate (statistical irrelevant).

Depreciation is a single financial factor on which may be committed by subjective impact, in order to optimize the volume attracting funds of funds in innovation. The self-funding function represented by profits factors (including PEx) where was found the parameters of distribution financial resources for dual directions Y (efficiency) and Y (productivity). Nevertheless, it was determined that financial factors correlation is manifests itself through synchronous changes of dynamics borrowing and own enterprises funds.

Such general regularity doesn't manifest in the external innovation financing model for innovation capital increasing enterprises. In order to confirm this assumption it was constructed funding function based on an overall approach for external funding and self-financing. But, we have received only partial efficiency of innovation funding. So, the capital productivity reproduction function is completely irrelevant, i.e. it does not exist. This means that any external funding will be providing only operational business efficiency. It won't be distributed to funding the renewal technological basis of reproduction. So, innovation funding model for these initial conditions will look like partially realized functions:

$$(4.1.9)^{\circledast} \quad \begin{aligned} Y_{\text{efficiency}} &= 11108,91 + 2,250334 \times \text{PEx} \\ Y_{\text{productiveness}} &= 0 \end{aligned}$$

Model's parameters will be significantly change if we solve this problem regarding to financing capital growth function:  $Y_{\text{efficiency}} = f(\text{investment})$ . So, among all models of effective financing (at 100% of depreciation funding to innovation) and exclusion lending factor, there is more relevant funding function which looking follow: (4.1.10)  $Y_{\text{efficiency}} = 1,71214 \times \text{PEx} - 0,04253 \times \text{Invest} + 0,18903 \times \text{DepFund}$

quality of the model:  $R^2_{\text{efficiency}} = 0,9949$ ;  $se_{\text{PEx}} = 0,2435$ ;  $se_{\text{Invest}} = 0,3753$ ;  $se_{\text{DepFund}} = 0,4465$

$$(4.2.11)^{\circledast} \quad Y_{\text{productiveness}} = 2,133797 \times \text{PEx} - 0,45429 \times \text{DepFund} + 0,707133 \times \text{Invest}$$

quality of the model:  $R^2_{\text{efficiency}} = 0,9872$ ;  $se_{\text{PEx}} = 0,4014$ ;  $se_{\text{Invest}} = 0,6186$ ;  $se_{\text{DepFund}} = 0,7360$

This model should be interpreted as a effective funding function of innovative capital growth, which provides synchronized implementation actually innovative capital growth and technological growth. This synchronizing is accompanied by a drop innovation investment profitability and offset by increasing the capital productivity. At the same time, we should note that exclusion the lending factor out of funding function doesn't significant improve the overall model quality. This is confirmed by experiment. So, lending is not advisable to exclude from funding function because it can be functionally implemented under certain conditions. It is significant that reduction of the depreciation fund to 32% level use, leads to removed the self-financing mechanism from the funding model (PEx loses statistical significance):

$$(4.1.11)^{\circledast} \quad Y_{\text{efficiency}} = 2,86022 \times \text{Dep} - 0,752321 \times \text{Investments}$$

quality of the model:  $R^2_{\text{efficiency}} = 0,9934$ ;  $se_{\text{Invest}} = 0,1344$ ;  $se_{\text{DepFund}} = 0,0968$

$$(4.1.12)^{\circledast} \quad Y_{\text{productiveness}} = 2,337738 \times \text{Dep} - 0,624222 \times \text{Investments}$$

quality of the model:  $R^2_{\text{efficiency}}$ :  $R^2 = 0,98634682$ ;  $se_{\text{Invest}} = 0,22417777$ ;  $se_{\text{DepFund}} = 0,4737761$

So, prepaid the expenses increasing is significantly reducing the efficiency of all financial factors in funding model. This function describes the implementation of self-funding mechanism, in which capital investments does not define (reducing) as investment efficiency dynamic so innovation productivity dynamics. It is accompanied by loosing of innovation investment profitability. This is a function of simple reproduction, it doesn't accent to innovation dynamics. At the same time, the lending financial factor loses the statistical significance in this model too. The strong correlation of lending and profit is the reason for inadequacy lending to finance innovation in the industries. Herewith, namely profit is a functionally determining. When fully functional self-funding factor realization, lending factor loses significant because the of innovative development funding function ( $f_{\text{efficiency}} \leftrightarrow f_{\text{productivity}}$ ) implementation is defined by enterprises own funds, within a technological cycle growth. From these results one may see that self-funding factor loses significant in capital increasing model. This explains the similar functional status for lending.

In practice, it can be reasonably substantiated by outdated methodology of lending, despite it considerable functionality in funding innovation. This means that lending functional role to funding innovation development will decrease.

So, we can formulate some interim conclusions the study.

1. Financial factors of innovation development are autonomous funding elements, their implementation has a functional nature, which should considered in the most general sense follow:  $Y(\text{innovation}) = f(\text{investments})$ .
2. The effective funding function of innovative development is mediated by self-financing mechanism and investment. The development is provided by a mutual functional transformation the efficiency of innovation implementation and innovation production productiveness ( $f_{\text{efficiency}} \leftrightarrow f_{\text{productivity}}$ ), where there is a single function for complex financial mechanisms of financing innovation for each innovation development tact technological innovation  $\leftrightarrow$  capital innovation.
3. Within the capital reproduction cycle the funding function will look like:

$Y_{\text{efficiency}} = f(\text{Investment}); f(\text{Lending}); f(\text{Depreciation})$  and won't depend on characteristics of innovation processes in the enterprises.

This described method of design the effective funding function was used to substantiation the model of enterprises innovation development funding.

## Resume

Evaluation of innovative development funding efficiency should take into account dynamics of transformation innovation factors "Technological innovation ↔ Intangible Assets" and "Capital innovation ↔ Depreciation." Their implementation creates a of innovation development cycle "Capital Innovation → Technological innovation → Depreciation" during 3 - 4 years. There is an innovation development trend, which creates a more aggregated innovation cycle through innovative product implementation to market. This trend is a reflection of capital reproduction cycle "Depreciation → Capital Innovation → Technological innovations → Intangible Assets" during 7 - 10 years. Technological innovation induces to acceleration the depreciation fund formation and "capital recycling" with following transformation them to finances.

The effectiveness funding of innovative development should be assessed based on cyclical innovative factors implementation, which can be represented by a linear function. Technology factor and capital gain factor both are the primary factors of innovation development, which are directly implements its own productivity into the innovation process for economic systems any level aggregation. The sequence and frequency their implementation forms the innovation development dynamics, which is implemented by periodic establishment their close linear interaction.

The design of effectiveness innovation development funding function should base on permanent capital transforming type " $f$  utilization ↔  $f$  reproduction". To solve the problem of design a common reproduction model for economic system through financial factors we should unify the technological-innovation development dynamic model to innovation cycle model.

To design effective innovation development funding function we should methodologically differentiate self-funding mechanism due to innovation factors cycle implementation. This requires separation the innovation development funds to profit, prepaid expenses and depreciation, which are the profit's functional components. Herewith, actually "prepaid expenses" forms the innovation cycle.

Profit is a single factor, which explains interconnection the technological innovation implementation. It is proofed by establishment the periodic, consistent and systematic linear relation " $f(\text{Profit}) \leftrightarrow f(\text{Capital innovation})$ " and " $f(\text{Profit}) \leftrightarrow f(\text{technological innovation})$ ". Herewith, dynamics of interconnection " $f(\text{Capital innovation}) \leftrightarrow f(\text{technological innovation})$ " is synchronous relative to  $f(\text{Profit})$ .

The effectiveness funding innovation models based on self-funding mechanism and investment are functionally compatible, autonomy and equally relevant. These can be considered as basic resources for economic system innovation development.

## **Economic-mathematical model of funding the economic systems innovation development**

To modeling innovation development we should implement the general regularity of linearity realization the innovation factors, which manifests itself in long term (innovative environment increasing function) and also during technological growth period. So, it must be dualistic model, based on linear interconnection the innovation factors in their aggregated form of implementation. The unified model of innovative development funding will consist of system equations of linear multiple regression.

It requires solving a number problems.

Firstly, it is necessary to unify parameters implementation the innovation dynamics factors within the productivity functions and efficiency function and consider its to funding function.

Secondly, we should overcome differences characteristics the funding function and production function.

Finally, the characteristics of innovation cyclicity must be consider within the synchronization to resolve target the unifying the technological development cycle model and capital innovative gain cycle.

So, the unified model implementation innovation factors is based on regularity of causal interconnection in development of cycles. The main idea for this model is in decisive influence more aggregation cycle which is forming the limitations for innovation factors implementation of their own smaller cycles. Within the cycle of capital reproduction the extent (completeness) innovation development is defined by changing of dynamics "productivity ↔ utilization" cycle, which reflected through positive dynamics of innovation products implementation to opposite dynamics of forming enterprises depreciation fund. In this case, the premature achieve maximum development growth leads to prematurely utilizing productivity factors. It means that enterprises doesn't complete reproducing their reproductive factors. "Premature achieve maximum development" means that "factors utilization" is happened during increasing productivity, which is dictated by growing demand for innovation products. The uneven of innovation development is dictated also by differences characteristics the technological cycle and capital reproduction cycle. To begin with difference in periods. The technological cycle is about three years, opposed capital cycle is 7 - 10 years. Herewith, capital reproduction cycle includes three technological cycles and these are synchronous.

Secondly, if technological cycle dynamics forms exclusively endogenous factors (such as: technology, informativity work), so capital reproduction dynamics provides by endogenous factors own dynamics and technological dynamics as exogenous impact factor. Herewith technology innovation factors will determine the capital reproduction volume and potential of

enterprises innovation reproduction. So, the total cycle model of enterprises economic system innovation reproduction (7-10 years) includes some function of industries innovative growth, enterprise innovation function and innovation factors funding function (see Table 5)

Table 5. Model of enterprises economic system innovation reproduction

| Pik      | Industries modeling:<br>innovation cycle function  | Enterprises modeling:<br>static model   | Unified funding<br>function<br>for innovations                                     |
|----------|--|---|--|
| 20<br>02 | $Y(Pr)=16,955 \times Dep - 12,435 \times CI$<br>$Y(Q)=20,201 \times Dep$                 | $Y(Pr)=16,875 \times Dep - 12,264 \times CI$<br>$Y(Q)=20,379 \times Dep$        | $Y(TI)= 1,0903 \times PEx$   |
| 20<br>03 | $Y(Pr)=2,757 \times Dep - 2,866 \times CI$<br>$Y(Q)= 5,509 \times Dep - 5,430 \times CI$ | $Y(Pr)=901,37 + 0,994 \times Dep$<br>$Y(Q)= 3,343 \times Dep$                   |  |
| 20<br>04 | $Y(Pr)=3,244 \times Dep - 3,100 \times CI$<br>$Y(Q)=5,191 \times Dep - 4,578 \times CI$  | $Y(Pr)=$ function doesn't exist **<br>$Y(Q)=$ function doesn't exist *          | $Y(CI)=1,228 \times Invest$<br>$+ 0,637 \times Lending$<br>$+1,675 \times DepFund$ |
| 20<br>05 | $Y(Pr)= 8,934 \times TI$<br>$Y(Q)= 8,4132 \times TI$                                     | $Y(Pr)= 4,502 \times TI$<br>$Y(Q)=$ function doesn't exist **                   |  |
| 20<br>06 | $Y(Pr)= 9,702 \times TI$<br>$Y(Q)= 9,094 \times TI$                                      | $Y(Pr)= 0,3346 \times CI$<br>$Y(Q)= 10,763 \times TI$                           | $Y(Dep)= 0,9383 \times Invest$   |
| 20<br>07 | $Y(Pr)= 13,625 \times TI$<br>$Y(Q)=8,866 \times TI$                                      | $Y(Pr)=$ function doesn't exist **<br>$Y(Q)=$ function doesn't exist **         |  |
| 20<br>08 | $Y(Pr)= 1,788 \times TI$<br>$Y(Q)=1,663 \times TI + 5,806 \times IA$                     | $Y(Pr)=$ function doesn't exist **<br>$Y(Q)=1,732 \times IA + 0,7094 \times TI$ |  |

\*\* - function doesn't exist; it means the impossibility desing relevant linear function. It used to indicate the technological gaps.

Source: compiled by the author's own calculations

The innovation reproduction model peculiarity is that the last technological cycle within the capital reproduction cycle is supplemented by transformational dynamics the technological factors to form of intangible assets. The intangible assets is a productivity function innovation factor. It seen from Table 5, where Intangible assets doesn't explained by any funding innovation factors. Therefore, it is an objective element of productivity dynamics within the capital innovative reproduction cycle. The capital innovative reproduction cycle is one fully functional transformation cycle of innovation factors type "productiveness ↔ utilization". So, transformation the technological innovation productivity factor to intangible assets leads to potential threat blocking the enterprise innovation development without the technological innovation cycle (3-4 years) and capital innovative reproduction cycle (7-10 years) completeness synchronization. So, let's write a system equations of innovation development function in general view:

$$(4.2.1)^{\circ} \quad Y_{\text{development}} = \begin{cases} Y(Pr) = f(TI \leftrightarrow IA) \\ Y(Q) = f(CI \rightarrow Dep) \end{cases}$$

where:  $Y(Pr)$  – efficiency function of innovation development;

$Y(Q)$  – productivity function of innovation development

In functional form it can be write follows:

$$(4.2.2)^{\circ} \quad Y_{\text{development}} = \begin{cases} Y(\text{Pr}) = f(\text{TI}), \\ Y(Q) = f(\text{CI}), \\ Y(Q_1) = f(\text{Dep}; \text{IA}) \end{cases}$$

A common view of innovative development funding function based on total innovation reproduction model (see Table 4.2.1) is follows:

$$(4.2.3)^{\circ} \quad Y_{\text{funding}} = \begin{cases} Y(\text{TI}) = b_{1;2} \times \text{PEX}; \\ Y(\text{CI}) = b_{2;2} \times \text{Invest} + b_{2;3} \times \text{DepFund} + b_{2;4} \times \text{Lending}; \\ Y(\text{Dep}) = b_{3;2} \times \text{Invest}; \end{cases}$$

Unlike the funding models there is a dualistic model of economy system innovation development. It is realized in a time and statics. So, let's implement the rate  $Y(\text{TI})$ ,  $Y(\text{CI})$ ,  $Y(\text{Dep})$  from 4.2.2 system of equations to equation 4.2.3, without the  $f(\text{IA})$  functional implementation. Thus, we get solution for equation system an innovation development funding function:

$$(4.2.4)^{\circ} \quad Y_{\text{фінансування розвитку}} = \begin{cases} Y(\text{Pr}) = b_{1;2} \times \text{PEX}; \\ Y(Q) = b_{2;2} \times \text{Invest} + b_{2;3} \times \text{DepFund} + b_{2;4} \times \text{Lending}; \\ Y(Q_1) = b_{3;2} \times \text{Invest} \end{cases}$$

Moreover, we can find solution for the function  $f(\text{IA})$  based on solution for innovation funding function as follows:

$$(4.2.5)^{\circ} \quad Y(\text{IA}) = 0,3824 \times \text{Lending} - 0,045 \times \text{Invest} - 0,588 \times \text{DepFund}$$

If we compare  $f(\text{IA})$  and  $f(\text{CI})$  it can be argued that capital innovations is a factor which is mobilizing financial resources and fully implement financial factors of development. Opposite, the intangible assets haven't been a factor of implementation the financial resources to enterprises development.

So, from these calculations one may present the basic model of innovation development funding (see. Table. 6)

Table 6. The basic model of funding enterprises innovation development\*

| Pik  | Innovation cycle function  | Static function   | Funding function  |
|------|--|---|---|
| 2002 | $Y(\text{Pr})=16,955\text{Dep} - 12,435\text{CI}$<br>$Y(\text{Q})=20,201 \text{ Dep}$                    | $Y(\text{Pr})=16,875 \text{ Dep} - 12,264\text{CI}$<br>$Y(\text{Q})=20,379 \text{ Dep}$               | $Y(\text{Pr}; \text{Q}) = 19,893 \times \text{Invest} -$<br>$- 7,812 \times \text{Lending} - 20,542$<br>AMφ   |
| 2003 | $Y(\text{Pr})=2,757 \text{ Dep} - 2,866\text{CI}$<br>$Y(\text{Q})= 5,509 \text{ Dep} - 5,430 \text{ CI}$ | $Y(\text{Pr})=901,37 + 0,994 \text{ Dep}$<br>$Y(\text{Q})= 3,343 \text{ Dep}$                         | $Y(\text{Pr}; \text{Q}) = 901,37 + 4,0693$<br>Invest  |
| 2004 | $Y(\text{Pr})=3,244 \text{ Dep} - 3,100\text{CI}$<br>$Y(\text{Q})=5,191 \text{ Dep} - 4,578\text{CI}$    | $Y(\text{Pr})=3,244 \text{ Dep} - 3,100\text{CI}$<br>$Y(\text{Q})=5,191 \text{ Dep} - 4,578\text{CI}$ | $Y(\text{Pr}; \text{Q}) = 7,9145 \times \text{Invest}(\text{IA})$<br>$- (9,4285 \text{ Invest} +$<br>$+ 7,812 \times \text{Lending}$<br>$+ 20,542 \text{ DepFund})$ |
| 2005 | $Y(\text{Pr})= 8,934 \text{ TI}$<br>$Y(\text{Q})= 8,4132 \text{ TI}$                                     | $Y(\text{Pr})= 4,502 \text{ TI}$<br>$Y(\text{Q})= 8,4132 \text{ TI}$                                  | $Y(\text{Pr}; \text{Q}) = 14,1270 \times \text{PEx}$  |
| 2006 | $Y(\text{Pr})= 9,702 \text{ TI}$<br>$Y(\text{Q})= 9,094\text{TI}$  | $Y(\text{Pr})= 0,3346 \text{ CI}$<br>$Y(\text{Q})= 10,763 \text{ TI}$                                 | $Y(\text{Pr}; \text{Q}) = 0,4108 \times \text{Invest} +$<br>$0,2131 \times \text{Lending} +$<br>$0,5604 \times \text{DepFund} + 11,7348$<br>PEx                     |
| 2007 | $Y(\text{Pr})= 13,625 \text{ TI}$<br>$Y(\text{Q})=8,866 \text{ TI}$                                      | $Y(\text{Pr})= 13,625 \text{ TI}$<br>$Y(\text{Q})=8,866 \text{ TI}$                                   | $Y(\text{Pr}; \text{Q}) = 24,5219 \times \text{PEx}$  |
| 2008 | $Y(\text{Pr})= 1,788 \text{ TI}$<br>$Y(\text{Q})=1,663 \text{ TI} + 5,806 \text{ IA}$                    | $Y(\text{Pr})= 1,788 \text{ TI}$<br>$Y(\text{Q})=1,732 \text{ IA} + 0,7094 \text{ TI}$                | $Y(\text{Pr}; \text{Q}) = 2,7229 \times \text{PEx}$<br>$+ 0,6623 \times \text{Lending} +$<br>$0,0779 \times \text{Invest} + 1,0184$<br>DepFund                      |

\* - economic-statistical modeling innovation of engineering companies in Kyiv.

\*\* - the purely conditional rate which was modeled to funding of 100% of the actual use enterprises depreciation fund to innovation.

Source: compiled by the author

From this model one have defined the multiplier rates the financing influence to the model functional components, which is defined as the effectiveness of innovation implementation and innovation production productivity. Thus, these basic parameters of innovation dynamics is one's of functional integration the general dynamics of innovation environment development and the dynamics of enterprises innovation development. From this model (see table 6) it is possible to form a dynamic model parameters of innovative development funding, which includes the funding function for capital innovation reproduction cycle and system model of financial-investment alternatives (see. Tab. 7).

Table 7. The innovation development unified model

| Unified innovation cycle model                                 | Function for development (through innovation cycle)                          | Funding function (through innovation cycle): financial-investment alternatives systemic model   |
|--|--|---|
| <b>Technological cycle (enterprise model)</b>                  |  |   |
| Capital innovations ↔ Depreciation                             | $Y (Pr;Q)= 9,82109 \times (Dep;CI)$  | $Y(F)= 1,0151 \times (PEX; DepFunds^{**});$<br>$Y(F)= 0,7867 \times (DEpFunds^{**}; Lending)$   |
| Depreciation ↔ Technological innovations → Capital innovations | $Y(Pr;Q)= 4,23422 \times (TI;Dep;CI)$<br>$Y (Pr;Q)= 4,23422 \times TI$       | $Y(F)= 1,0344 \times (PEX; Invest);$<br>$Y(F)= 1,0344 \times (PEX; DepFunds^{**});$<br>$Y(F)= 1,0344 \times (PEX; Lending)$   |
| Capital innovations ↔ Technological innovations                | $Y (Pr;Q)= 0,300054 \times (CI;TI)$  | $Y(F)= 2,177 \times (DepFunds; Profit)$   |
| Technological innovations ↔ Intangible assets                  | $Y (Pr;Q)= 0,98172 \times (TI;IA)$   | $Y(F)= 4,3669 \times (DepFunds; Profit)$  |
| <b>Capital reproduction cycle model (industries model)</b>     |  |   |
| Depreciation   | $Y (Pr;Q)= 9,82109 \times (Dep;CI)$  | $Y(F)= 0,7867 \times (DepFunds^{**}; Invest);$<br>$Y(F)= 0,7867 \times (DEpFunds^{**}; Lending);$<br>$Y(F)= 1,0385 \times (Profit; DEpFunds^{**})$  |
| Depreciation ↔ Capital innovations                             | $Y (Q; Pr)= 1,55257 \times (CI; Dep)$  | $Y(F)= 0,7767 \times (Lending; Invest);$<br>$Y(F)= 1,4791 \times (DEpFunds^{**}; Kp; Lending; PEX)$   |
| Capital innovations ↔ Technological innovations                | $Y (Q;Pr)= 9,594317 \times (TI;CI)$<br>або<br>$Y (Pr;Q)= 12,89311 \times TI$ | $Y(F)= 1,0342 \times (Invest; PEX);$<br>$Y(F)= 1,479 \times (DepFunds^{**}; Lending; Invest);$<br>$Y(F)= 5,3443 \times (Profit; DepFunds);$<br>$Y(F)= 4,3597 \times (PEX; Lending; DepFunds)$ |
| Technological innovations ↔ Intangible assets                  | $Y (Pr;Q)= 1,74609 \times (TI;IA)$   | $Y(F)= 1,029 \times (Lending; PEX);$<br>$Y(F)= 1,0331 \times (Invest; PEX);$<br>$Y(F)= 1,0344 \times (PEX; DepFunds);$<br>$Y(F)= 5,0065 \times (DepFunds; Profit)$                            |

\*\* - the purely conditional rate which was modeled to funding of 100% of the actual use enterprises depreciation fund to innovation.

Source: compiled by the author

This model contains a most optimal combination the innovative factors. It takes into account effect of technological cycle implementation and the potential general trend implementation of innovation environment development. In other words this model concentrates a perimeters of innovation development static model, where innovations are implemented as an endogenous

factor of development. It also contains a mechanism for implementation/extrapolation the potential growth of innovative environment to the capital innovation reproduction.

Always, this model implements the method of enterprises innovation development funding in time and it has a significant forecast characteristics within the medium economic cycle (7 - 10 years).

So, total unified model for innovation development funding can be write follows:

$$(4.2.6)^{\circledast} \quad Y = \begin{cases} Y(Q;Pr) = 9,59431 \times 1,0344 \times (11,7348 \times PEx + 0,5604 \times DepFund) \\ Y(Pr;Q) = 4,32422 \times 1,0344 \times (14,127 \times PEx + 7,914 \times Invest_{depFund}) \end{cases}$$

On which extent this unified model solves the main issue of this study?

The model is a tool design the method of implementation the innovative development funding.

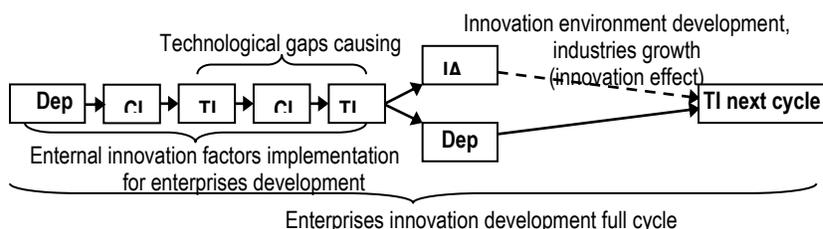
**Relevant resume**

In conclusion one can say, through funding the innovative development on the stages of technological cycle implementation there is formed so-called systems creating financial factor which should be considered the innovation profit in it's functional implementation forms. It functional forms transformation decisive influences to general structure of innovation development funding mechanism.

**Resolving the methodological problem of functionality innovative investments and loans**

Financing innovative development of economic systems is mediating processes synchronous implementation of innovative factors within the capital reproduction cycle (7-10 years). The innovation factors dynamic is synchronous and enhanced by funding factors realization. Herewith, the own dynamics such financial factors as investment and lending is regardless and autonomous to technological cycle. Before, the objective circumstances loosing the lending functionality together with innovation investments were identified through their cyclical nature in accent to innovation cycle model. For better understanding we should back to static model of enterprise (see. Table 6), where there are two technological gaps in 2004 and 2007. Let's see to dynamic innovation reproduction cycle through innovation factors implementation (fig. 15).

Figure 15. Innovation reproduction cycle in engineering



In this study, we should see **technology gap** – as a state of loss causation the innovation factors functional implementation through the enterprises innovation activity within saving possibility of compensation economic waster due to overall innovation increasing dynamics in industries or economic system.

The main reason of technological gaps is an objective needs to production facilities update and its synchronization to completion the technological cycle. In terms of functional simulation it is the ensuring of transformation productivity of technological development factor (TI) into the productivity of innovation production. In this way the growing dynamics of permanent development is provided. This cycle of innovation development is initiated by technological innovations (TI). It is transformed into capital innovation productivity (CI), which, in turn, realizes the synergies of both innovations (TI + CI) in innovative products. Synergy (TI + CI) is a source of innovative production efficiency. It provides following tact of development, with next distribution of financial resources to create enterprises innovative profits. In industrial economy capital reproduction cycle is determined by period of fixed capital depreciation. The basic neoclassical production function ( $Y=T f(K^\alpha;L^\beta)$ ,  $de T(technology)=const,$ ), doesn't respond to innovation reproduction, where the technology is not constant. In economic systems innovative type there is implementation of two technological tacts during the capital reproduction cycle. That's why we can talk about two capital reproduction tacts which is initiated by technological dynamics: "CI→ Dep→TI" and "TI → CI→ TI":



It should be noted exceptional importance aspect. The capital dynamics is mediated own mutual transformation, namely fixed capital↔finance. Technology is an endogenous factor of productive capital dynamics. It in turn is a labor factor. The dynamics of productive capital is created by a synergy of capital and labor factorial markets interaction. The finance dynamic is irrespective to technological dynamics (TI). The finance markets dynamics is an endogenous factors for concentration of financial resources to innovation funding. The ignoring of innovative nature the capital reproduction, declaration the reducing innovation product life cycle where internal impulse for innovation reproduction was interpreted as a phase of bringing new product to market, all this becomes the basis for implementing the method of accelerated depreciation. This is - the false vision. Namely accelerated depreciation deprives companies the financial resources for provision the transformation "TI↔CI". As the result enterprises refuses to implement innovation products, and therefore, these loses the possibility to accumulate innovation profit. So, these can't realizes innovation type competitive advantages. Accordingly, there is "premature" concentrated financial resource and accelerated concentration of finance

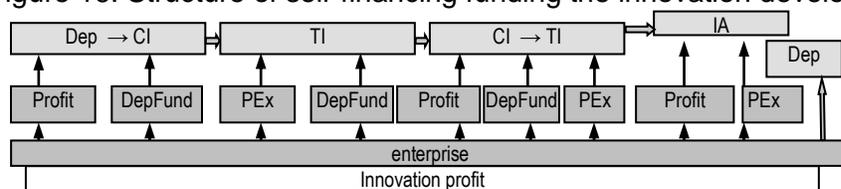
resources to funds. This creates a diversification capitals and pushes them to other sectors, leaving own industry in fact on the increasing trajectory. This is a loss of development opportunities. After the cycle of reproduction of capital (2-3 years after diversification) the corporation at any level resources concentration has to involve much larger than diversified financial resources to achieve the appropriate requirements of modern production technological level.

In terms of financing innovative development, lack funds for financial support of transformation "TI → CI → TI" is a reason of technological gaps. In these calculated funding model parameters (Table 4.2.2) one may say the innovative activity is provided by self-funding (profit, prepaid expenses (PEX), costs depreciation fund in the amount of 100% conditional use). That's why, technological tact and capital reproduction tact must be provided by liquid funds for funding the innovation development. Actually this approach was applied to scheme of innovation development funding mechanism.

The question is: in what extent and which method must be applied for calculating this amount? In according with innovation development funding model (see table 4.2.2) the cycle "capital of innovation → technology innovation" implementation is determined by using the 100% depreciation fund and profit: **(CI → TI) →  $f_{\text{Funding}} = 2,177$  (DepFund, Profit)**.

**So, based on functionality of profit in combined with proposed method of using instruments the depreciation fund capitalization could be solve an important problem of implementation the loan's capital creation function.**

Figure 16. Structure of self-financing funding the innovation development®



Source: compiled by the author

The structure of innovation development funding should be based on innovation cycle structure and innovation funding model which is reflected most functional financial factors in implementing innovative dynamics (see fig. 16). Therefore to design a system of innovation financial sources should be identified such general structural units:

- self-financing mechanism, which includes profit, depreciation fund, prepaid expenses for funding R & D;

- innovation investment mechanism, which includes innovative venture mechanism, the support lending mechanism: innovation loan and permanent provision of lending;
- government investments mechanism implemented through innovative public credit.

**The innovation development funding mechanism**

The enterprises innovation development is limited by the volume of industries innovation growth, which is mediated by consistent innovative cycles implementation. These limits are objective and logical for competitive environment (oligopoly) and it is transformed in the result of monopolizing markets.

Discreteness of the process is overcome by a continuous dynamics of innovative growth factors. The capital transformation type "reproduction↔utilization" is a method and technology of innovation development. The development quality and volume are defined by frequency and direction (vectors) of innovation factors transformational dynamics. The development volume is implemented through full capital innovation reproduction cycle.

Full extent innovative dynamics is replaying due to dynamics of innovation profit, where profit of innovation leaders (innovative corporations) has ability to structuring.

It is a functional basis for implementation of technological innovation (IT), capital Innovation (CI) and development funding factors.

From these preconditions one may say that *innovation development funding mechanism should be based on method of implementation funding models to get innovation profit and dynamics of capital innovation reproduction, which has next view:*

(4.4.1)<sup>®</sup>  $Y = f(Ipr;T); f \Delta C(L;T)$

, It takes into account the parameters of innovative funding models (see. table. 4.2.3), and a model of technological cycle:

(4.4.2)<sup>®</sup>  $Y = f(Ipr;T); f \Delta C(L;T)$

(4.4.3)<sup>®</sup>  $Y (Pr;Q) = f(TI;CI);$

(4.4.4)<sup>®</sup>  $Y (Pr;Q) = k_1 \times k_2 \times (b_{PEX} \times PEX + b_{DepFund} \times DepFund)$

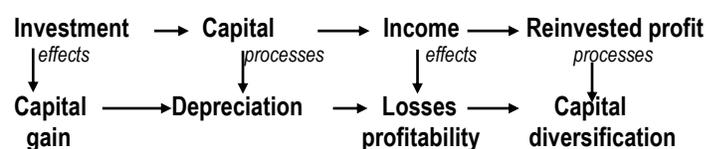
In this case the general innovative cost distribution will occur by functional purpose to innovation expenditures to development and investment costs. It allows to determine the movement of financial resources for innovation development:

Figure 17. Innovation development financial resources movement



The getting of innovative profit is considered in the context of dynamics of enterprises capital reproduction. The financial mechanism for creation and distribution capitalized values based on neoclassical production function, does not ensure the emergence of innovative enterprise development effects. It activates the accumulation of financial resources, which devoid of functional realization in innovation. Herewith, the optimization of production processes (minimizing costs to innovation) leads to losing investments profitability. This occurs due to excluding depreciation fund out off innovation production processes and through accelerated depreciation. The simultaneous increase profitability and minimizing costs at stage of innovation product introduction to market leads to concentration large diversified capital. It eventually causes decrease the innovation development financial resources. Through these processes there are some effects at the stage of forming innovation and investments profitability (see fig. 18).

Figure 18. Effects of forming the innovation and investment profitability



Source: compiled by the author

In this case, the effects of accelerated depreciation (loss investment profitability) should be substituted by compensators, namely: financial instruments (government loans, financial investment, innovative lending). These should be aimed at smoothing fluctuations capitalized cost and impact to processes of "underconsumption" (limiting development) including to prevent initialization process of diversification capital which increases the amplitude and frequency of economic crises. In other words, the future progress could be expressed through future realizing value. It also becomes the object of economic turnover and volume of future realizing demand. So, it becomes a subject to a total aggregate investments. In this case, the loss of return on capital investment effects and diversification effects (see fig 18) can be substituted by funding innovations mechanism elements. The idea for funding destructive effects of enterprises innovative development may seem paradoxical. However, in theoretical aspect the problem is solved by an innovation funding unified model (see Table. 7). Previously investigated effects of losing the essential interconnections of competitive advantages reproduction is corresponded to technological gaps. Their essential reason is the loss of the interconnection type "technological innovation→capital innovation→competencies reproductions→creation the

competitive advantages". Restoring these interdependencies initiates a searching the opportunities to innovation for enterprises. The technological gaps destructive effect is to arising deficit the innovation technological development resource of reproduction together with amplification of this effect at the stage of completion the capital reproduction cycle. In this way enterprises losing resources for reproduction technological leadership competitive advantages. Enterprises lose great part of growth if using accelerated depreciation of fixed assets. So, these doesn't use potential of last tact of innovation dynamics and these can't transform the innovative technologies productivity to capital innovative growth. On the other hand capital gains are the basis initialization for a new innovations cycle the creation of\* innovative technologies. It is clear from study that a reason for failure of innovation technologies productivity implementation is a lack circulating assets for funding the technological innovation and introduction the innovation technologies productivity to innovation products. In this regards enterprises can use (it's much more functional relevant operation) own depreciation fund for covering the circulating assets deficit the company.

Another reason is the pressure of competitive environment on businesses which motivates enterprises prematurely transforming innovative technologies productivity to intangible assets. Keeping the innovation leader position or innovation corporation status the firms forced to realize their intangible assets as a products at high-tech markets.

This is a fundamental problem. For its solution should introduce a mechanism ensuring / cover the deficit of working capital of the enterprise by funding 100% of depreciation fund at all stages of the innovation cycle of basic reproduction of capital.

For this let's consider the funding innovation development basic algorithm which avoids destructive effects initiated by innovative technologies extremely productivity. Also it allows to overcome the innovation cycles destructive effects (technological gaps consequences). This designed algorithm was introduced to a structural-organizational model the funding engineering company innovation development. The implementing mechanics of innovation funding through innovative investment mechanisms, lending and self-financing was reproduced in this model (see fig. 18).

The object of investment mechanism (financial investment) is an innovative development effects in a whole. This model also eliminates deformation of innovative development funding mechanisms.

It implements the innovative profit concept, which may be allied to overcome technological gaps destructive effects of technological gaps through synchronizing different funding mechanisms.

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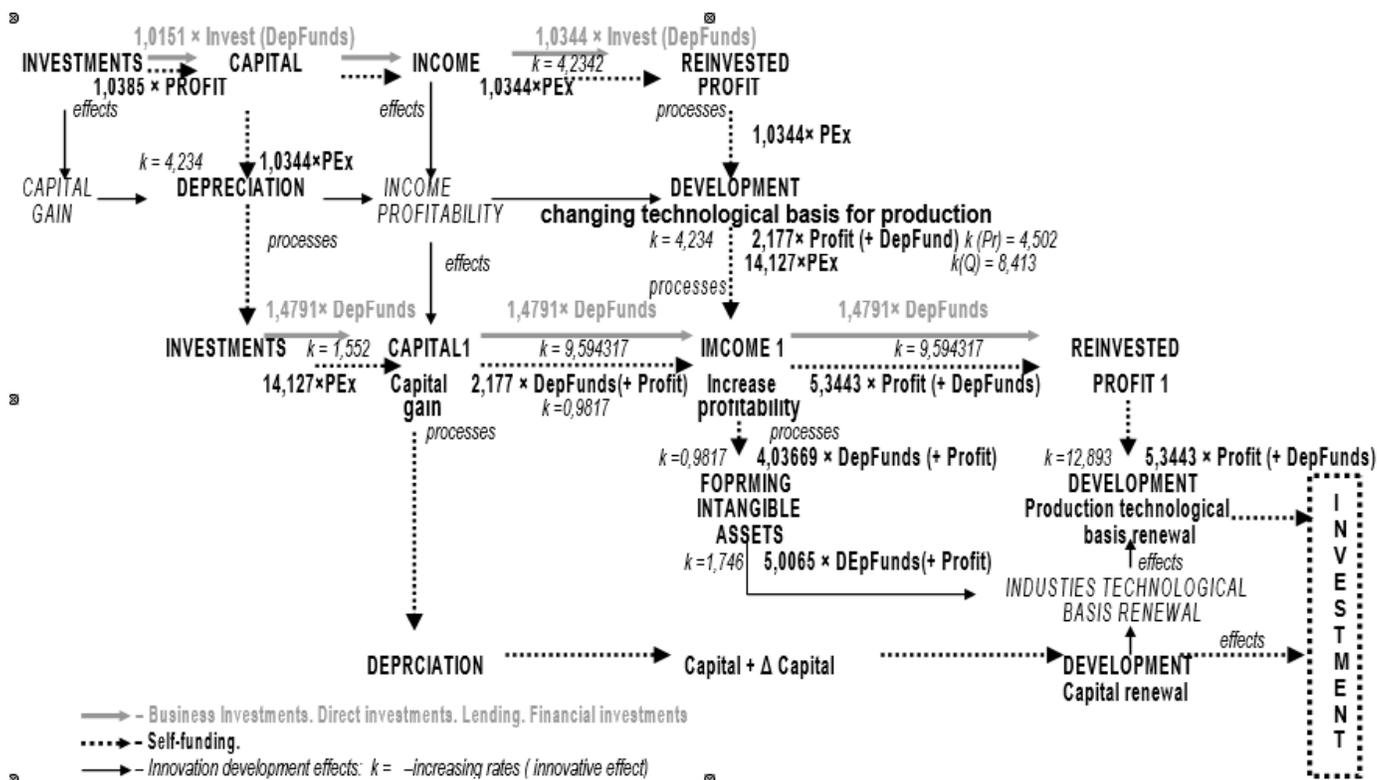
Accordingly, this model reproduces the economic-organizing mechanism of interaction different funding mechanisms to the dynamics of capital reproduction innovation cycle.

To begin with, innovation cycle is launched by investment innovation due to increasing enterprises profitability at the stage of capital innovation implementation. In the cycle "reinvested profit→development" (changing technological basis for production) we can see drop in profitability, so it must be supported (see fig. 18).

At this stage the investment, depreciation (100% funding) or loan will have a functional implementation by short-term funding form (in amount of calculated efficiency of technological innovation (45 - 55%) in total innovation expenditures). In this case it is necessary to support the enterprises working capital liquidity to finance technological innovation, R&D, where credit is the most functional method of financing. Herewith, temporary loss of loans income will cover by growth enterprises profitability in range to 350% through technological cycle implementation in future.

It motivates by growth manufacturing productivity up to 740% (total funding cumulative innovation effect is  $k = 4,234$ ). Therefore, lending income will rise to 117% at investment profitability to 48%.

Figure 18. Structural-organizational model of the funding mechanism of innovative development engineering corporation®



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The tact "depreciation→technological innovations→capital innovations" (see. table. 4.2.3) in model "capital→profit→reinvested profit" (see. fig. 4.4.4) in complex with funding efficiency ( $k = 1,0344$ ) reflects the general structure of distribution through diversificational capital forming, which clearly demonstrates generating the innovative growth synergies ( $k = 4,2342$  for basic cycle "investment→capital→income→reinvested profit→change technological basis of production", see fig. 4.4.3).

At this stage there is a loss linearity realization of innovation factors in tacts "technological innovation→intangible assets" and "capital innovation→technological innovation→depreciation". The innovative elements interconnections getting own functional form. Therefore, financial and innovation factors are differentiated along trajectory of formation the intangible assets and depreciation fund. As a result, there are two general directions of innovative development which implementation must be synchronized. Namely double-cycle synchronization based on algorithms of technological innovation development and innovation capital renewal is a task for innovation management of economic systems at any level aggregation: economic system of enterprises, multinationals, industry, national economy and global economic.

All innovation factors and financial factors lost own functionality in tact "technological innovation→intangible assets" (see fig 4.4.3: tact "Capital 1→Income1→ FORMATION OF INTANGIBLES"). It is clear that intangible assets creation is unprofitable for enterprises because efficiency of innovations implementation coefficient is  $k = 0,98 < 1$ , despite a great efficiency self-funding, where funding innovation efficiency coefficient is  $k = 4,03669$ . In this time, the intangible assets realization to economic turnover provides an additional level of profitability up to 74% at high-tech markets. It leads to increasing self-funding efficiency to 500,65%. Herewith, there are two relevant funding models with high efficiency for the innovation cycle "technological innovations→Intangible Assets". But these are not models of choice for innovative strategies. However, there is a significant structural synergies which is accompanied by increasing the efficiency from  $k = 0,9817$  to  $k = 1,746$ .

*This effect should be considered as the basis for the complex of efficiency strategies n of intangible assets capitalization for restructuring the technological base of production to next "technological leap".*

**So, it's relevant:** *forming their own financial resources to fundamental basic industry innovations is a significant competitive advantage which characterizes the company as an innovative leader.*

### **IMPORTANT!**

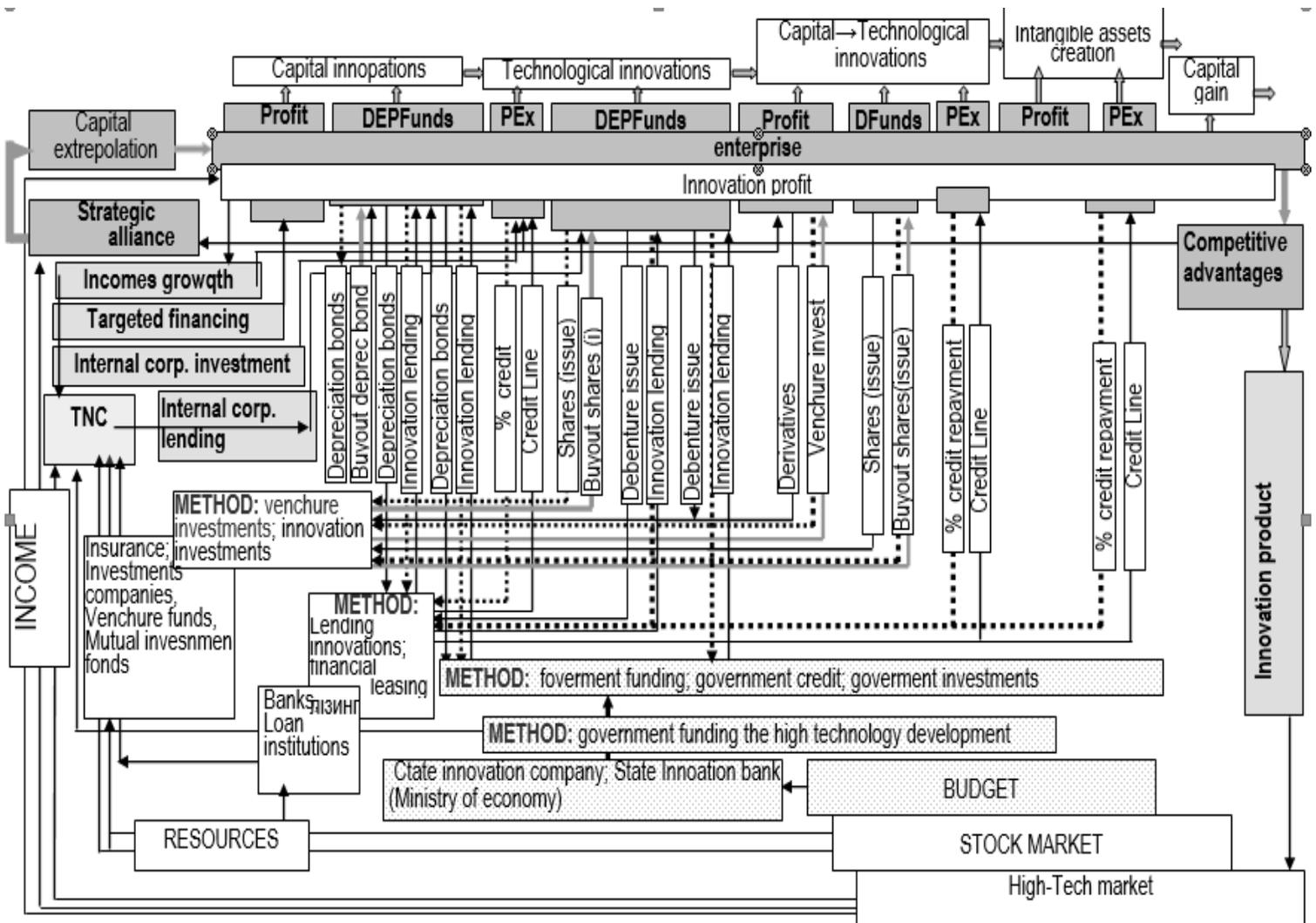
*The synergy innovative factors and funding factors is clear identified (arising) at the level of implementation capital renewal innovation cycle. This identifies and proves that the system approach is a single effective for managing innovation. Therefore, we should see the innovative development as a system which generates prospective technology platforms for socio-economic and humanitarian progress.*

Today, corporations are investing not only separate financial resources. These invest formed capital together with costs, production process and technology. It providing effective innovative reproduction. Therefore, it allows to avoid "vacuum" effect for local markets, that should be considered a factor of growth of innovative enterprises in corporations environment. By this way the financial resources won't "escape" to other markets through diversification (because it need for insurance of loss corporation's investment). Capital creates capital without transformation and movement through the financial markets. But, it can not be called horizontal integration process. It is rather a process of extrapolation the capital. Namely, high-tech corporations transnational capital movement organizing structure creates opportunities for economic integration the industrial type economic systems into the technological leaders innovative environment. The generating a new economic mechanisms reproduction resources "conflict-free distribution" for establishing the innovative type national economic systems provides increasing scale of reproduction. Smoothing the devastating effects of global economic crisis is explained by permanent reproduction the competitive advantages together with creating the accumulation competencies systems for technological leadership. Actually it should be regarded as objectively formed evolution mechanism of economic systems in global economy. In this case, it is necessary to accent, that dynamics of progress the innovation systems is provided by the intellectual activity priority.

Thus, all structural elements of an effective mechanism for financing innovative development of economic systems were represented to financing model of enterprise innovation development (see fig. 19). These should be regarded follows:

- the time series model to determine the productive and financial factors of innovative development based on capital reproduction innovation cycle;
- method the capital and technological innovations distribution which is based on financial instruments movement;
- model for synchronizing the innovation production cycle and cycle of innovation and research financing;
- the structural funding model based on effective function;
- support tools of synergy market communications between the government funding research and innovations, lending and investments.

Figure 19. The enterprise innovative development funding mechanism®



- ⇒ - enterprises innovations funding
- - enterprises innovation development funding (financial relations)
- ....▶ - enterprises innovation development funding profitability

Source: compiled by the author

Enterprise was represented by the movement financial tools in this model. Therefore, opportunities their turnover are solely provided by innovation profitability. Movement the financial instruments is determined by profit dynamics. Profit reveals an exceptional characteristics source for innovations reproduction. It dynamics determines the structure of financial resources for economic system innovation development.

As there are two phases of capital renewal through innovation cycle, the most effective financial tools to be considered are:

- depreciation fund shares or other equity securities with equal yield which total emission is equivalent to amount the enterprise innovation profit. It must correspond to amount capital reproduction for innovation of a new technologies production in amount of 100% future replacement cost for company's capital;
- additional issue shares at the end of first stage of innovation reproduction cycle when companies need an additional funding the technological innovation to complete the innovation cycle and concentration the financial resources to invest future development;
- emission of various intangible assets derivatives at the final stage of innovation cycle to create the basic technological innovation and formation of intangible assets when it is possible to involve venture innovation investments. Such opportunities are raised by taking advantage the organizing structure of innovative associations: strategic alliance, TNC, network enterprises.

This model (see. fig. 4.4.4) has implement a dual purpose of funding: funding enterprise innovation production and external innovation investment profitability through funding enterprises innovation profit. Herewith, main target of external funding at the level enterprises innovations is transformed to providing the sufficient investment profitability and risk insurance associated with large innovation projects implementation. In practice this problem is resolved by solidarization and insurance risks for funding long-term innovations projects. Systematic approach allows to create a credit-investment balance into the trends of forming funds for innovation development. This creates a similar stabilizing effect to economic crisis through national innovation systems intersystem interactions. Such stabilizing effect is providing by functionality of investment, while lending creates the credit-investments balance provision subsystem for funding mechanism of economic system innovation development. Investing is more mobile, that's why investment resources concentration creates bigger advantages on the level of intersystem interactions. Credit is not such mobilizing. Therefore, it is necessary to

attract additional funding to innovation based on depreciation fund shares additional emission after the capital innovation implementation complete. The mechanism of credit-investment balance (see fig. 19) implementation fully corrects deformations of funding mechanism under the innovation development funds formation. Such deformations are taking place as a result of technological gaps. The overcoming destructive effects of innovation growth is a most relevant aspect to use the developed innovative development funding mechanism. These effects should be regarded as loss innovation reproduction possibilities for enterprise caused by technological gaps, synchronization of increasing the external innovation environment and technological cycles of reproduction innovation in the enterprise. These effects cause loss the investment potential and therefore opportunities to attract additional funding to innovations for the companies. Arising "vacuum" of financial resources leads to loss the reproduction innovation businesses productivity to a new technological base. As a result there is a curtailment innovation productivity through refusal of creating a new technologies and restructuring the innovative environment. Technological gaps in the innovation process combined with gaps in funding innovation process causes a systemic impact to industries and economy in the whole.

The funding mechanism implementation (see. Fig. 19) provides synchronization dynamics of external funding at it's maximum functional implementation and determining influence to synchronization of internal transformational dynamics the innovation factors technological innovations, capital innovations and intangibles. In this case depreciation fund directed to capital innovations becomes the financial basis for technological innovations reproduction and so for enterprises innovative development. Herewith, there is a significant synergy increasing the national economic system within the innovation reproduction cycle.

In this way the important methodological problem of differentiation the innovation process to accumulation depreciation fund as innovation development factor and using enterprises depreciation fund as funding factor of innovation development was resolved. This mechanism is based on the principle of a real opportunity to differentiate the enterprises innovation profit and allocation their reproductive parts. it's functionally integrated to reproduction values process at the production factors markets: capital, labor and commodity markets. This principle is implemented to using credit-investment balance funding mechanism. It provides the opportunities to attract additional funding at all stages of innovation development for any level aggregation economic systems.

## SUMMARY ON THE ISSUE

In modeling the innovation development we should proceed from the general regularity of innovation factors linearity the enterprises innovation development. It manifests itself as a long

term growth of innovative environment during period their technological development. This approach allows to build the unified mechanism for synchronous implementing funding innovations and dynamics of innovative development factors reproduction.

The reason of cyclicity the innovation dynamics is regularity of cause interactions the innovation cycles development. More aggregated innovation cycles has decisive impact to creating boundaries their own smaller cycles implementation. This is a main characteristic of cyclicity dynamics. Therefore the innovation development volume is limited by implementation the technological innovation productivity to economic turnover within each technological cycle. The technological productivity is reflected by ratio of total amount the technological innovations and innovation profit share in structure of total profit. It is a basic principle of mechanism for implementing technological innovation in capital innovation growth.

The dynamics of innovation development of economic systems is determined relative to the total dynamics of scientific progress. It was researched limitation relatively larger aggregation cycle dynamics in this study. This explains the uneven development. Stochasticity and uneven development in the field of innovation is manifested under arising technological gaps within innovation cycle of reproduction. Technological gaps should be regarded as loss causation functional interconnections the innovation factor implementation to enterprises development keeping the possibility to compensate economic waster due to total innovation dynamics in industries or national economic system. The technological gaps reason is an absence synchronization between technological reproduction cycle and capital reproduction cycle due to arising lack financial resources on the verge of launching a new technological cycle of productivity reproduction into innovative products.

For practical implementation of innovation funding concepts it need to expand and change the content of depreciation policy from politics of extended replacement into development policies. The policy of funding innovation development implementation by costs provision method is an objective basis for strengthening cyclical of economic processes. It leads to arising the technological gaps in industries and, consequently, the loss of opportunities for innovation development. The intensity of technological innovation outstrips product innovations therefore it leads to asynchronous dynamics technological cycle and capital reproduction cycle. This creates a vacuum of economic environment development. It can be methodologically compensated through involving depreciation fund to financial turnover. Depreciation fund which is aimed at industrial innovation (capital innovations) can be consider as basis reproduction the technological innovation and the funding mechanism of capital's innovative reproduction.

It must be start from this.

## AFTERWORD

What are the most important theoretical principles stemming from the study? Consequently, the author believes there are some most important achievement for the development of innovation economics, and, most importantly, it, also, may serve as a methodological basis for further research.

The nature of innovation is the nature of dynamics the reproduction processes. Innovation is transformation reproducing factors of any level structure the economic systems. Innovations is essence of scientific progress, these implementation exclusively in economic relations. Innovations takes physical form as innovative product for commercialization to economic turnover. These are also realizing the potential of economy's reproduction itself through innovation development of enterprises.

The enterprises total profitability trajectory is determined by technological factors productivity. Dynamics of innovative products is substantiated by technological innovation factor. It determine the rationale for dual unified definition of innovation as the producing and reproducing the innovation development competitive advantages that is grounded on two innovations forms: physical, as a product and dynamic, as enterprise innovation development. Therefore, we should regedered the *innovative development like a competitive advantage permanent reproduction, which is characterized by the growth of firm's competencies and following transformation them into a product as experience, technologies, licenses, patents, methods and models, services, products, etc. with target to commercial realization (implementation and use) them into economic turnover.*

The innovation development methodology must be based on objective regularity of objective unification all reproduction elements with following transformation their reproductive properties to a top-level synthesis categories. An innovative type economic development is characterized by of synchronization and functional unity the internal dynamic characteristics such categories as production, exchange and distribution based on money's internal functional implementation dynamics.

The basis the innovative type of reproduction is movement of values. The values accumulation there is in first quarter reproduction cycle and it is his first tact. Accumulation suspends the reproduction. The accumulation is the function of development and original function (base) for investment. The accumulation effect - is implemented in the growth of innovative environment at the macro level. It is also occurred at micro level where there is technological gaps of microeconomic development functions. Therefore, the intangible assets value and the "recycling" of innovative technologies into enterprises intangible assets are the accumulation's resources and element of economic system innovation development.

In the process of economic growth there are transformation all economic components as a result of increasing/expansion the values economic turnover. Such transformations are tending to synchronize. There are nothing constant proportions in dynamics such changes. The focus of these transformations is functionalization the static categories and acquiring them the dynamic characteristics. This leads to utilizing the static characteristics and as the result it approximates and increases the tact of economic cycles. This opens up the possibility of more in-depth functional-dynamic analysis the economic processes. It also allows to create a relevant models of economic behavior and innovation development models in long term. It also enables to resolve the Foresight innovation development on adequate methodological basis.

Money was undergone the most functionalization in structural transformation. Cash flow is periodically autonomized. This is the moment of loss functional connections in money's structure. So, money's functionality is concentrated to purchasing power of money. It means depression the economy. There is value's transformation to reproductive resources based on not devalued values i.e. it is land's reproductive ability. The values transformed in this way "increases" (displaces) money supply through the market prices mechanism and increases the amount liquidity of money supply. The money supply growth changes the functional dependences in money and creates the monetary pressure to transformed (accumulated) values (base of development). In practice there is increasing prices to final consumption. The money's functionality is structured so that it allows to renew interconnections between accumulation and exchange/turnover. This point is accompanied by an aggravation depreciation the economic system type "debt crisis → solve the debt crisis". It leads to transformation the accumulated values (it causes to increasing purchasing power of money) to financial instruments (values's movement) type "turnover intensification (investment power of money realization) → investments (transformation the values into reproductive resources). This process is the establishment of functional interconnections in money's circulation and so reproduction in the whole.

The innovation cycle the reproductive factors in production is about 3-4 years and it model has a view "capital innovations→ technological innovation→ depreciation". The cycle of implementation innovations into innovation product is about 7 - 10 years. It reflects the structure of innovation cycle of capital reproduction "capital innovation→ depreciation→ technological innovations→intangible assets". The mechanics of innovative development is a cyclical innovation development factors transformation "TI↔IA" (technological innovation - intangible assets) and CI↔Dep (innovation capital - depreciation). Technological innovations encourage to accelerate the depreciation fund formation. These leads to accelerate the capital utilization with following transformation it into funding forms. The profitability of technological factors

determines the trajectory of enterprises total profitability. Dynamics of innovative products is caused (initiated) by technological innovation factor. This may be functional impact allowing to consider the technology as an argument of the production function, along with capital (C) and labor (L).

The deterministic nature the intangible assets formation is an objective basis for amplification the economic cycles amplitude and duration the recession of innovation entrepreneurship. The intangible assets (IA) productivity can not be estimated based on a linear function, in terms of value. The amplitude of intangibles values fluctuations in innovation cycle reflects the values amount the technological factor influence, which is counted for its economic (market) value. Dynamics of intangible assets reflects the movement capitalized value of fixed assets. But it is based on dynamics of technological factor within the dynamics of capital innovation reproduction and the development and implementation of innovative products as it innovative sense. It is necessary to transform value of intangible assets in liquid form through the mechanism of amortization or placing on the market in the early wave of technological growth cycle. It need to do because this assets is a ballast at this stage and it subject to mandatory utilization (transformation their value) to monetary funds. Otherwise intangible assets lowers the enterprise's profitability and therefore slows their development.

Financial factors are the innovation process autonomous elements. Its implementation has a functional nature, which is mediated by the self-funding mechanism and investments. There is an autonomous function for innovation development funding mechanism implementation for each phase of innovation cycle "technological innovations $\leftrightarrow$ capital innovations". The funding function will not depend from characteristics of innovation processes in the enterprise within the capital reproduction innovation cycle.

The innovation dynamic in the whole is reproduced into profitability dynamics, where innovation corporations profit detects ability to structuring. It is a nonantagonistic unity reproduction's elements for all complex economic basis for development. Innovation profit is the basis for reproduction the innovation factors and therefore it is the basis for innovation reproduction the economies. The innovation profit does not depend on the dynamics of cost production and it is an autonomous function for innovation development the industrial corporations. Such innovational profit functional nature requires to search a new method to funding it's reproduction as a factor of development.

The enterprises innovation development is integrated into macroeconomic dynamics. It is functionally closely related to capital market dynamics and technological dynamics that should be regarded as labor market element. Therefore the implementation of economic interaction between factor markets should be considered as the basis for innovations systemic

reproduction. This is a basis for public finances participation in economic systems innovation growth. In this case, the creation preconditions for factors markets interconnections effective implementation is the main function of government policy. But general paradigm should be become the management functional interactions of macroeconomic indicators due to function of innovation investment. In this case, it is necessary to see that total investments established indirectly through the concentration of total innovation profit to high-tech markets.