

## CHAPTER 2

RESEARCH OF IMPACT OF NANO ECONOMICS ON THE NATIONAL  
ECONOMIC SYSTEM DEVELOPMENTABSTRACT

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The diverse world is striking in the multitude of forms and types of various economic phenomena. Yes, the economy is characterized by the existence of different levels. The most decisive is the macro level, as the level of development of national economic systems. It is described by such categories as social reproduction, economic development and growth, economic balance and economic structure. All these phenomena depend to a certain extent on the economic behavior of individual economic agents that form the nanoeconomics. An analysis was made of the impact of nanoeconomics on the macroeconomics of an individual state based on the characteristics of the nature of nanoeconomics, its material and non-material forms, regularities and evolution. Separately, the system of households was characterized as a center of individual consumption. It was also noted that the structure of the national economy as part of the service sector, industry and the agro-industrial complex forms an entrepreneurial sector with active individuals. The latter are a spokesman for nanoeconomics as a kind of innovative economy, because nanoeconomics forms a high-quality system for the development and implementation of nanotechnological production solutions. The amount of research and development costs affects the volume of industrial and agricultural products sold and the number of services provided.

The distinctive features of the obtained results can be considered the approximation of the regression coefficient to unity, which indicates the presence of a close relationship between the indicators of the development of nanoeconomics on the macroeconomic situation in a particular country. Conclusions were drawn on the relevance of the individual systemic factor for the development of national economic systems.

KEYWORDS

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Nanoeconomics, baby economics, human economics, nanotechnology economics, simple social reproduction, macroeconomics.

Actualization of macroeconomic processes occurs in the vast majority of countries of the world under the influence of a subjective personal factor. Nanoeconomics is the conductor of such

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influence. Nanoeconomics has its own nature, patterns and evolution of development that affect the processes of macroeconomic reproduction.

The macroeconomic environment is measured by economic growth and the process of social reproduction. These are factors of economic development on which macroeconomic dynamics depends. The process of expanded reproduction can be supplemented by the stages of training and education of individuals who can become generators of ideas for various kinds of production processes.

The impact of nanoeconomics on the macroeconomic level of management and economic equilibrium occurs through the impact on consumption, savings and investment. Economic equilibrium is reflected through the ratio of supply and demand, production and consumption. Thus, by influencing supply, nanoeconomics becomes the determinant of the labor force, which is a factor of production. And influencing demand, nanoeconomics is an exponent of the consumer function, for which family cells, households, are responsible.

The structure of the gross domestic product implies the allocation of the service sector, industry and the agro-industrial complex. This distribution occurs at the production level and is formed as a whole due to the creation and functioning of FLP as a systemic economic phenomenon. The nanoeconomics also consistently affects these industries, as a person economically finds those industries where the income is higher and the return on investment is the highest. Nanoeconomics is an expression of the innovative economy and can be characterized through the analysis of data on the impact of costs on research and development in all areas of social production.

In this regard, this study may be relevant.

### 2.1 UPDATED STUDY OF THE IMPACT OF NANO ECONOMICS ON THE DEVELOPMENT OF THE NATIONAL ECONOMIC SYSTEM

The question of the influence of nanoeconomics on macroeconomic development is almost not considered in modern scientific literature. The first to introduce the concept of "nanoeconomics" was Kenneth Arrow [1]. However, there is a significant number of works devoted to qualitative changes in the national economy. Thus, the authors of [2] analyze the development of the national economy in the context of the COVID-19 pandemic and testify that the crisis should become a new platform for the evolution of both developed and developing economies. Of particular importance in this context is the individual factor, which implies that it depends on individuals how countries will overcome the consequences of quarantine.

A number of authors [3] note that socioeconomic development depends on the formation of a special mechanism within households. These family cells influence the intensification and optimization of economic relations in different countries. The economy of households becomes the focus and source of growth of national economic systems, however, the aspect of using households as a lever of nanoeconomics is not considered. The question of the influence of the household as a unit of the population of individuals requires further study. The cultural factor of nanoeconomics

has a significant impact on the promotion of the national economy. Thus, the authors of [4] prove that the economy, as a cultural phenomenon, has a synergistic effect on the promotion of national economies to highly developed stages, to the development of the noosphere. In particular, it is noted that intellectual capital becomes the key to the intensification of cultural phenomena at different levels of the economic system. This study does not apply the actualization of the personal development factor of the cultural factor of macrodevelopment. The impact of cultural individual factors on macroeconomic progress requires further study.

Economic growth in developed and developing countries under the influence of concentration and diversification of exports is considered in the work of scientists [5]. It is confirmed that the weighted circumstances of export concentration and diversification affect the way countries out of the crisis. Developed countries should operate with these categories to improve their own economic situation. This issue needs to be disclosed in the context of the impact of nanoeconomics on international trade conditions for development.

In the development of economic systems, the educational factor of the information economy is of particular importance [6]. Digitalization [7] is becoming a source of economic development. As it was said [8], the economics of education is a factor in the activation of economic processes and their digital aspect. It is with educational institutions that the influence of the educational process on economic development as a whole begins. To explore how the informatization of education affects macroeconomic development becomes the key to the analysis and synthesis of the synergy of education in the economic environment.

In [9], devoted to the impact of innovations on the development of national and world economies, nanoeconomics is considered as a kind of innovative economy aimed at the formation and use of high technologies and nanotechnologies in the production activities of innovative entities. The question of the impact of nanotechnology economics on macroeconomic development also needs further research.

It is noted that there are several billion inhabitants in the world and underestimation of the impact of each of them on economic development is a big problem. Therefore, the individualization of economic life within the framework of nanoeconomics should be carefully studied and the principles and trends of its influence on the development of the national economic system should be formed.

These issues require further consideration, since the economic life of a particular country must take into account the personal components of development, the works cited only touch on this aspect, and a thorough study should be carried out.

The aim of the study is to identify the impact of nanoeconomics on the development of the macroeconomic situation in a particular country. This will make it possible to take into account the individual factor as much as possible in the dynamics of the development indicators of the national economic system.

To achieve this aim will allow the following tasks:

- to define conceptual approaches to the interpretation of nanoeconomics as an economic category;
- to determine the directions of the influence of nanoeconomics on the process of social reproduction and economic growth;

- to identify the impact of nanoeconomics on the macroeconomic level of management and economic equilibrium;
- to highlight the principles of the influence of nanoeconomics on the service sector, industry and the agricultural sector of a particular country.

The object of this study has a theoretical direction. However, there is an assessment of multi-factorial regression as the quintessence of determining the impact of nanoeconomics on the development of the national economic environment. This estimate was made on the basis of statistical data from one of the countries with transition economy. These data made it possible to formulate a hypothesis about the dependence of the main indicators of the development of the national economic system on the indicators of the dynamics of the nanoeconomics based on the mathematical analysis of the correlation. The studied indicators included: GDP, GDP per capita, volumes of industrial and agricultural products. The research methods used in this article include: system analysis, structural approach, convergence and divergence, comparison, observation and generalization.

## 2.2 RESULTS OF RESEARCH ON THE IMPACT OF NANO ECONOMICS ON THE MACROECONOMIC DYNAMICS OF ONE OF THE COUNTRIES WITH TRANSITION ECONOMY

### 2.2.1 CONCEPTUAL APPROACHES TO THE EXPLANATION OF NANO ECONOMICS AS AN ECONOMIC CATEGORY

It should be noted that most researchers recognize nanoeconomics as the initial level of economic relations.

Let's define the considered nanoeconomics [8] as an integral part of social production (the economy as a whole). The productive force of the latter is individuals who, in the process of learning and activity, acquire the skills of economic behavior. They make optimal management decisions and, through the use of nanotechnologies, ensure the achievement of high levels of competitiveness and the dissemination of experience in acquiring it in the economic environment.

Let's dwell on the nature of nanoeconomics. So, nature is a set of natural conditions for the existence of human society. The second nature is the material conditions of its existence created by man. The implementation of the exchange of substances between man and nature is the law that regulates social production, the condition of human life itself. The total activity of society has an increasingly noticeable impact on nature, requiring rationalization [10] and regulation of their interaction. Thus, nature creates the conditions for the existence of nanoeconomics, which can be divided into material and non-material ones [11]. The material conditions of nanoeconomics are the totality of the materialized circumstances of human life, which is reflected in the process of social production. This is manifested in the production infrastructure, production process and production technologies (technologies-products and technologies-processes), these are also the circumstances of the management of social production. The material conditions of the nanoeconomics are individual production property, when

individuals have assets, receive income and invest in development. Owners of embodied property are subjects of nanoeconomics. Property is the socio-economic basis for the functioning of the economic system of nanoeconomics. Property in the economic sense is historically and logically determined.

But the material conditions of the nanoeconomics are wider than property relations, because they include both the regulation and management of this property. Thus, hired workers (managers) are also participants in nanorelationships, since they manage all processes within the framework of social production and it is their actions that lead to profit as the main goal of entrepreneurial activity.

The non-material conditions for the existence of nanoeconomics are the whole set of informational, ideological, cultural, mythical, philosophical, scientific and other conditions and factors of an individual's development. This is a set of traditions that form a person as an owner, producer and consumer of goods. If some national cultures have certain rules for doing business, they must be taken into account during international cooperation. The material and non-material conditions of the nanoeconomics form the patterns of its development.

The first regularity in the development of nanoeconomics assumes a combination of the following successive phenomena: baby economics, economics, and the economics of nanotechnologies. The system of nanoeconomics begins with the family, its formation and development, with the birth of children, their upbringing at home, in a preschool educational institution, school, college, university. So, the initial stage of nanoeconomics is baby economics. As a new category, it is a controversial phenomenon, approaches to the definition of which are few researchers.

Baby economics [8] is associated with the level of sociologization of the child, when a small person is already economical from birth, because an entire industry is working around the birth of a child:

- artificial methods of fertilization;
- accompanying a pregnant woman in specialized clinics (which costs significant financial costs for the family of a pregnant woman);
- the act of birth itself, paid in advance by the family;
- nursing a newborn child in a hospital;
- huge industry of children's products: from clothes to strollers;
- hiring a babysitter if needed;
- not free visits to preschool institutions;
- children's fashion industry (when leading couturiers create collections of children's clothing);
- the school and school life of the child, where, in particular, the financial behavior of the student is formed (how to manage the funds that the parents gave out on the day).

And such a separate aspect as the use of children in difficult labor positions in the criminal world. And this can be considered the second regularity. It lies in the fact that nanoeconomics begins with a baby economics, which has its own specific conditions for functioning and development.

The authors formulated the definition of baby economics [8] as an integral part of nanoeconomics. Due to the complex use of physical-natural, social, intellectual, material, financial and other resources in childhood, it leads to the formation of a personality that in adulthood produces benefits based on educated knowledge and skills.

The third pattern, according to the authors, is that the human economy is the central link in the chain of nanoeconomic processes. There is a combination of cultural, social and economic approaches. As it is known, culture is the transfer of skills, abilities and experience to future generations. These are the traditions of doing business, the traditions of using the means of labor and the production of certain goods and services. These are the conditions for cooperation within certain teams and society as a whole. The collective in which a person lives (his/her immediate environment) is the family. The economic sign of the family is the household.

Another regularity is the development of the economy of nanotechnologies within the framework of the nanoeconomics system.

The regularities of the formation of nanoeconomics affect its evolution, which is manifested in changes in the economic behavior of individuals. This evolution is the evolution of Homo sapiens in the broadest sense. Accordingly, the stages of the formation of nanoeconomics and its evolution by Rohnen, S. [12]:

- primitive era (from the appearance of commodity-money relations to the end of the 15<sup>th</sup> century) is characterized by the emergence of economic individuals;

- commercial era (begins with the time of the great geographical discoveries and ends with the middle of the 19<sup>th</sup> century). The driving force behind the behavior of entrepreneurial individuals during this period was the search for huge personal gains associated with the trade in colonial goods in Europe;

- expansion era of (1850–1914) is characterized by a massive reorientation of individual entrepreneurs to export exotic overseas goods to more profitable and economically promising business areas;

- concession era (1914–1945) is characterized by the formation of colonies at concession enterprises of a significant stratum of native mid-level managers specially trained at enterprises and educational institutions of metropolitan countries;

- nation-states era (1945–1970), having provided a powerful impetus to the development of nanoeconomics, made it the sphere of the whole world, in which systems such as "metropolis-colony" suspended their existence;

- globalization era (since the 1970s). This period of development of nanoeconomics is marked by revolutionary technological changes.

In the context of globalization, nanoeconomics is determined by certain characteristic features by Servan-Shraiber, Zh.-P. [13]:

1. Accessibility and universality. Each person goes through the conditions of self-improvement, each individual is a subject of nanoeconomics and his/her representative within certain groups (households, enterprises and state economies). Any person is a potential element of the nanoeconomics, this is its accessibility. And universality is determined by the fact that all levels of economic systems are based on the nanolevel.

2. Stepwise development of nanoeconomics. When an individual, after graduation, gets a position in a certain company, gains experience and decides to create his/her own business, first as an individual, which then transforms into a family business, and then into a corporate one. It usually

starts with trading activity, continues with related productions, and then the production process based on attracting investments.

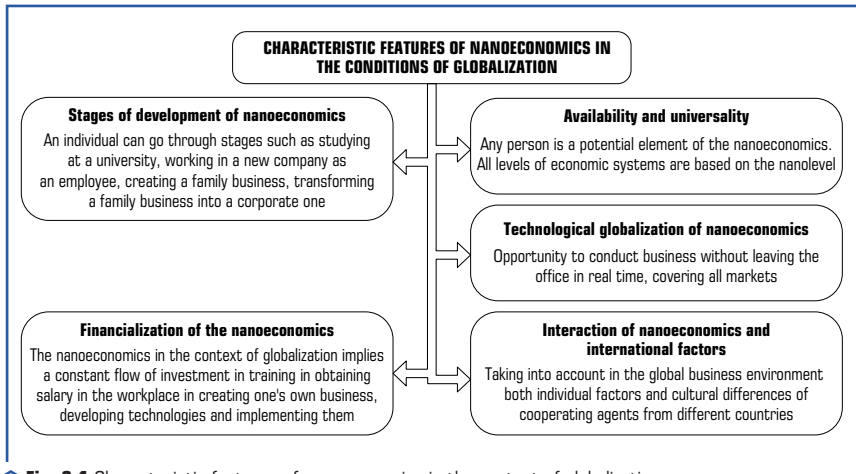
3. Technological globalization of nanoeconomics. The possibilities of computerization, informatization and telecommunications fundamentally changed the nature of the nanoeconomics, which in modern conditions has received three fundamentally new features:

- it can be effectively carried out without leaving the office;
- it can be done in real time;
- it can, with the help of telecommunications, cover all business markets for products, capital, labor, information, etc.

4. "Financialization" of nanoeconomics. Reflects the financial content of all economic transactions. Even if we are talking about barter, it is still based on the conditions for financing the supply of goods through the counter delivery of the counterparty's products. In addition, the whole process of using nanoeconomics in the development of globalization involves a financial component. The latter includes: investment in training, receiving wages at the workplace, own business, development of nanotechnologies and their implementation in their own production.

5. Complex interaction of nanoeconomic and international. When it comes to the influence of an individualized factor on global processes in the world. Nanoeconomics is represented in the global environment by individual individuals entering into a dispute for resources to improve the efficiency of their activities. Global business takes into account the cultural differences of collaborating agents from different countries of the world.

Schematically, all the distinctive features of nanoeconomics in the context of globalization are shown in **Fig. 2.1**.



**Fig. 2.1** Characteristic features of nanoeconomics in the context of globalization

Thus, the nature of nanoeconomics implies material and non-material components that define an individual as an owner, producer and consumer. Patterns define the nanoeconomics with its three components – the baby economics, the human economy and the economy of nanotechnology. The evolution of nanoeconomics conditionally begins from the era of great geographical discoveries to the modern development of mankind. The era of globalization, determined by certain special characteristics of the development of the nanoeconomics, stands out in particular.

All these characteristics of the nanoeconomics in the context of the development of international economic relations (IER) suggest that it actively influences the development of economic systems in different countries of the world [14]. The state is the leading subject of the IER, forming their various levels, and this subject develops under the influence of an individual factor, which will be discussed in the further parts of this study.

### 2.2.2 ANALYSIS OF THE IMPACT OF NANO ECONOMICS ON THE PROCESS OF PUBLIC EDUCATION AND ECONOMIC GROWTH

Social production as production at the macro level is production to meet human needs and is in constant motion, passing through the following stages: own production, distribution, exchange and consumption of products and services [15]. Macroproduction is designed to satisfy the needs of individuals in certain goods and services. The nature of nanoeconomics provides, in addition to the production function, a consumer function, that is, social production aims to satisfy the needs of individuals. This is the connection of supply and demand through an emphasis on nanoeconomic aspects. Production as a set of separate individuals who are owners, managers and workers who produce a certain product becomes the focus of supply. On the demand side, an individual also stands out, because it depends on his/her preferences whether the demand on the supply side is satisfied.

Let's note that the process of social production, taken not as a one-time act, but in constant repetition and restoration, is social reproduction. The economic cycle also concerns nanoeconomics. When it comes to products and services, the individual changes their use throughout life: the generation born after the First World War radically changed the conditions of their existence around objects. Yes, they began to go to the cinema to watch films and news, they had a radio station to understand the processes displayed on public radio waves. Then television sets appeared, providing for the possibility of watching movies and programs at home, in the late 80s the first personal computers appeared (POISK, for example), to which this generation joined with great attempts. These items are a sign of the entry into the life of information and telecommunication technologies that continue to change and change the laying around.

Let's note that for simple reproduction, it is necessary to constantly restore all factors of production: labor, means of production, natural resources and habitat.

The factor connecting nanoeconomics with social reproduction is the labor force, because the main subject of nanoeconomics is an individual. The reproduction of the labor force is associated



with the restoration of the working capacity of workers in the broadest sense: that is, with the preparation of the next proper shift instead of workers leaving production. This can be achieved by constant restoration of items and means of personal consumption, the development of social protection systems, and the training of workers with appropriate qualifications. The labor force is a carrier of economic skills and competencies that its representatives exchange for wages spent on a decent existence. The labor force is the proposed side of the nanoeconomics. In the nanoeconomics, this aspect of supply is complemented by property, which can become property for starting one's own business and turning oneself into an entrepreneur, developing a business and hiring other labor. The consumer side of the nanoeconomics provides for the allocation of oneself and persons related in living within the household, for the implementation of active consumer actions.

Nanoeconomics can be defined as a social form of existence of reproduction. Hence, an obligatory component of the reproduction process is its common side as a form of existence of the productive forces.

Let's note that the starting point of the social product is production, the ultimate goal and driving motive is consumption.

Nanoeconomics defines a part of a separate economic individual in the process of production. If there are certain specialists who were competent and had the appropriate skills, distinguished from others, then they can invest their labor in the manufacture of this product. As the classic of scientific thought Smith, A. said, if there are natural conditions and the quality of workers, these countries can specialize in the manufacture of just such a product. So, if in Portugal there are natural conditions for the production of wine and there is a gift of winemakers, then this country will specialize in the manufacture of just such a product. If in England there are conditions for raising sheep and traditions for the production of woolen fabric, then the country should produce this particular product. Specialization is the basis for the implementation of distribution. Natural conditions dictate the direction in which production will develop, and these conditions entail the emergence of habits to produce a product in a certain way. This second component dictates the conditions for the development of nanoeconomics. Nanoeconomics is formed in such a way as to ensure the production process in a particular area. This is how technologies of a state nature are formed, and if they successfully solve problems in a certain area, they can be distributed throughout the world.

At modern enterprises, the result is achieved by joint, complementary efforts of managers, mechanics, programmers, etc., between which there is an exchange of activities [16]. Within the framework of nanoeconomics, there is an exchange of results of activities, when some specialists complement the actions of others. At modern enterprises, it is impossible to exist separately, separately performing only their own forms of labor. Engineers should link their work with economists and psychologists in order to get synergies from such joint activities. This is first. Secondly, the exchange is a stage of movement of the produced product, when goods and services are exchanged on the basis of the division of labor. Specialization requires nano-efforts, because what is given by nature requires the formation of traditions in the production of a particular product, and such isolation leads to the exchange of insufficient goods and services. And, accordingly, such a trade regime

leads to the exchange of such products. Understanding the terms of use of this product leads to the desire to create something similar and your own. Economic theorists argue that if there is a demand, then it does not matter who produces this product, the main thing is that there is a certain manufacturer that satisfies these needs. So, what a country receives as imports, it can eventually begin to produce as import substitution. Thus, there is an exchange not only of goods and services, but also the experience of individual individuals of technological processes and managerial practices within the framework of the nanoeconomics system. Thirdly, through exchange, the participant in production receives the share of the social product due to him/her in distribution. As a result of the exchange, an individual is involved in the formation of the gross domestic product. The division of GDP per inhabitant is an indicator of the importance of nanoeconomics for the development of the national economic system, as well as a general indicator of the level of socio-economic development of the country. Exchange promotes production or slows it down, speeding up or slowing down the movement of goods and services. The exchange as a whole is trade relations, which at the expense of the consumer depend on the conditions for the nanoeconomics development.

Consequently, the final stage in the movement of the social product is consumption, that is, the realization of use value. Two types of consumption should be distinguished: industrial and personal.

The labor force that consumes the means of production within the enterprise in which it works is the carrier. And this is the first side of nanoconsumption.

Personal consumption is not just a physiological or educational-cultural act. Its important social nanofunction, along with the reproduction of the labor force and the person as a whole, is the creation of certain incentives, motivations for the growth and development of the nanosubject. This is the other side of the drift.

Thus, nanoconsumption includes two forms:

1) as part of production consumption, when the labor force (nanosubject) consumes other factors of production to manufacture a product that satisfies certain needs;

2) as part of personal consumption, when a person restores and develops his/her strength and ability for highly productive work through the use of various kinds of materialized products and the receipt of various services (educational, informational, medical and recreational, entertainment, etc.).

As it is known, there are two types of playback: simple and extended.

Nanoeconomics, which characterizes simple reproduction, is determined by the physical and certain professional properties of a person, when there is a limit to professional efforts and development does not occur. Such reproduction is typical for traditional societies with a non-market economy, where the rate of expansion of production is very low, and hence the slowdown in economic and social progress.

Nanoeconomics expands the stages of conventional reproduction to extended. While simple reproduction begins with the production process, extended reproduction begins with an idea of a future manufactured product. Such an idea should appear on the basis of appropriate training of specialists – technologists or engineers. A certain person who generates ideas appears as a result of high-quality training and education in baby economics. Everything should contribute to the growth

of a specialist, from birth, a preschool institution in which emotional intelligence is formed. Then training and acquisition of competencies and skills takes place in high school and on the university bench. Thus, human capital is formed, which is used as an investment in the future.

The innovative component [17] of the process of expanded reproduction also begins with the baby economics. Quantitative and qualitative changes in the factors of production are achieved through the rationalization of their use, the development of scientific and technological progress. This type of reproduction is typical for a developed society, when considerable attention is devoted to the innovation component, from the educational process to the acquisition of practical skills in the development and implementation of the latest products and services. For the emergence of ideas for improving or updating products, it is necessary to have the appropriate conditions and basis. And the baby economics forms the basis.

Expanded reproduction of the social product is embodied in economic growth. This category is related to economic development. Economic development is a process of evolution of economic systems, and their quantitative component changes as economic growth. The increase in the scale of expanded reproduction occurs within the framework of economic growth. This growth at the macro level is helped by the development of the nanoeconomics. Strengthen the economic system can qualitative labor of individuals. An indicator of economic growth, such as annual GDP growth, reflects how creative the economy as a whole is. After all, it depends on the idea (the result of the creativity of an individual specialist) whether there will be an increase in sales indicators, whether consumption reacts positively to these innovations.

Economic growth can be exogenous and endogenous [18]. Thus, for the positive development of the country's economy, there must be endogenous growth, as caused by internal factors and impulses. The internal impetus for the development of the economic system at the macrolevel occurs as a consequence of the development of nanoeconomics. Yes, only residents who have the appropriate education and the ability to develop those options in which they are involved reproduce and grow the economy. A country with a powerful family business system [19] – Italy – is developing the household as an impetus to the formation of sectoral-territorial clusters within the national economy. Countries such as the USA or Great Britain have an individualistic approach to business, when the formation of wealth and the gross product and its increment depends on the individual worker rather than on his/her closest group.

Economic growth is manifested in the specific dynamics of the quantitative increase and qualitative improvement of the social product and its factors of production. There are two main types of economic growth – extensive and intensive – depending on how expanded reproduction is achieved.

Indicators of economic reproduction and growth are reflected in nominal gross domestic product (GDP). This indicator occupies a central place in the system of public accounts. GDP is defined as the gross value of all goods and services produced in the territory of a given country during a certain period, excluding the value of their intermediate consumption. In other words, we are talking about the elimination of double counting in the quantitative calculation of GDP, the requirement to take into account only final products and not to take into account intermediate products in the calculation.

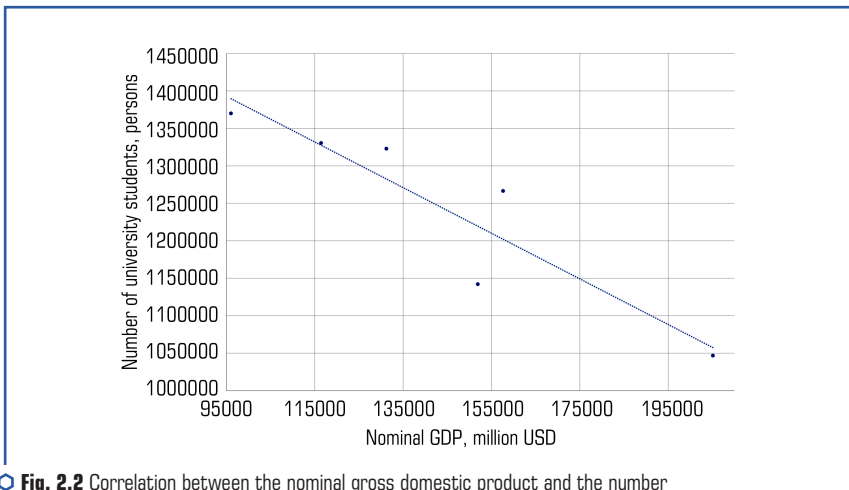
How nanoeconomics affects economic growth and reproduction can be considered using the example of correlation analysis. Yes, GDP is correlated with the number of university students. The latter reflects the state of the baby economics in the country. The initial component of nanoeconomics – the baby economics – is manifested in how many universities and their students there are in a particular country. For one of the countries with transition economy, let's calculate the correlation between nominal GDP and the number of university students. The initial data for the analysis are presented in **Table 2.1**. Let's note that all calculations of correlation coefficients are made using the Python programming language, the `pearsonr` function of the `scipy` library of the `stats` package.

● **Table 2.1** Initial data for the correlation analysis of the dependence of nominal GDP and the number of students in higher educational institutions (universities) [20]

| Index                                   | Years   |         |         |         |         |         |
|---|---------|---------|---------|---------|---------|---------|
| to study the correlation coefficient    | 2016    | 2017    | 2018    | 2019    | 2020    | 2021    |
| Nominal GDP (million USD)               | 96096   | 116520  | 131318  | 157721  | 151960  | 205247  |
| to study the correlation coefficient    | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
| Number of university students (persons) | 1369432 | 1329964 | 1322324 | 1266121 | 1141889 | 1046669 |

**Table 2.1** contains the initial data for calculating the closeness of the relationship between nominal GDP and the number of university students.

In **Fig. 2.2**, it is possible to see a graph of the correlation between the data from the **Table 2.1**. It is a downward straight line reflecting the inverse relationship between these phenomena.



● **Fig. 2.2** Correlation between the nominal gross domestic product and the number of students in higher educational institutions of one of the countries with transition economy

The correlation coefficient is 0.919, which means an inverse relationship, that is, when the number of university students decreases with GDP growth. However, this dependence is quite dense, because it approaches 1. Such analysis data can be explained by the fact that the number of universities is decreasing compared to the 1990s and early 2000s. Accordingly, the number of students is reduced due to lower quality educational services, since universities that cannot withstand competition in the education market cease to exist. In addition, the output of professionals, including professional technologists, needed to ensure the functioning of production, is growing.

### 2.2.3 IMPACT OF NANO ECONOMICS ON THE MACROECONOMIC LEVEL OF THE ECONOMY AND ECONOMIC EQUILIBRIUM

Modern Western economic thought considers the continuity of production across society due to the model of economic turnover of products and income.

The starting point in the economic turnover of goods is households offering land, labor, capital, and entrepreneurial abilities on the market. They pay direct taxes to the state, but receive from it educational and other services, transfer payments and wages (if they work in the public sector).

The economy of households as the primary link of nanoeconomics is the defining link of the country's economy. On the one hand, the country's economy includes individual consumption, which is formed within households and is the primary source of its existence. On the other hand, the future generation of economic individuals is growing in households, and how households cope with raising and educating children, such will be the next generation of consumers and producers of goods and services. As households live, so does the country.

In one of the transition economies, according to statistics, the standard of living is not high enough, but in reality, households have a fairly significant level of wealth. This can be explained by the fact that households have additional income. Thus, the rural population has food from household plots and from domestic animals, which is a significant amount of funds. In general, statistics show that the rural population has a small fortune, since additional income is not recorded by the state. In addition, there is income from agricultural shares for the lease of land by farmers. It should also be noted that the rural population is an active consumer of a variety of end products: from plumbing for home bathrooms to lawn mowers and power generators. In addition, in rural areas, residents organize sole proprietorships selling such equipment and other products, which provides them with additional income and the opportunity to have modern goods for a decent life.

Urban households also have additional wealth, say from renting out apartments for long or short periods of time. It can also be additional sources of work, when, say, teachers have income from tutoring, and doctors – from additional medical practice. It should be noted that urban residents are also trying to create sole proprietorships and have an additional share of income for their main job.

In general, in the country with the transition economy under study, private business in the form of sole proprietorship is a generator of economic impulses to heat up the entire macroeconomic

management system. Consequently, nanoeconomics and macroeconomics are quite closely intertwined. This interweaving occurs through an intermediary – the entrepreneurial system.

Enterprises pay direct and indirect taxes to the state, and receive grants, subsidies, subventions from it, if they fall under the system of benefits. Enterprises and sole proprietorships in particular are the conductors of individuals in the economic environment. They provide jobs and pay appropriate wages. Often such a wage is issued in envelopes or in half, and then taxes are paid in part. This indicates that an economical person has the ability to find additional sources of livelihood and improve his/her own quality of life.

The market economy implies coordination, balance between expenses and incomes, supply and demand both within individual industries and sectors of the economy, and across the whole society [21]. Macroeconomic equilibrium analysis requires a more careful consideration of such an economic phenomenon as aggregate demand, which takes the form of consumer (consumption spending) and investment (expenditure on capital goods).

So, consumption is the total amount of goods bought and consumed during a given period. The level of consumption depends on subjective and objective factors. The subjective factor includes the psychological inclination of people to consume; objective – the level of income, its distribution, the price level, the rate of interest, etc. It should be noted that consumption is formed at the level of nanoeconomics, when psychological and objective factors are formed within the household. The indicators of such consumption are the country's GDP and GDP per capita, since the latter is an indicator of the formation of the country's GDP depending on the population.

In the economic life of society, the phenomenon of saving is closely connected with the phenomenon of investment. Saving is the basis of investment. According to the natural-material structure, income takes the form of consumer and capital goods. The former go into non-productive consumption, and the latter into industrial consumption. In this country with transition economy, people have the means to invest as the difference between income and consumption expenditure. Since there are additional incomes that improve the quality of life, there are appropriate funds for saving and investing. The subjects of the nanoeconomics invest in capital and durable goods (cars, farm equipment, etc.), as well as in real estate. There are also funds to start your own business, which starts as an individual entrepreneur and continues in the form of Limited Liability Companies (LLCs) or Private Joint Stock Companies (PJSCs). Keynes, J. proved that if investment increases, then income increases to such an extent as to bring savings to the level of investment. Conversely, if capital investment is less than saving, then income will decrease so much that saving equals investment. This means that the economy is in equilibrium at the point where saving and investment balance. Thus, the concept of "economic equilibrium" means such a state of the economy, in which a constant balancing and mutual balancing of opposing structures (production and consumption, supply and demand) is achieved. In market systems, balancing is achieved through the market mechanism through the establishment of appropriate proportions. Equilibrium reflects the internal state of the market system, which is self-ordering. Thus, the nanoeconomics affects production and consumption through the human resources used in production processes and the

amount of funds that are spent on household needs. Equilibrium regulates the demand for human resources and their consumption of consumer and capital goods.

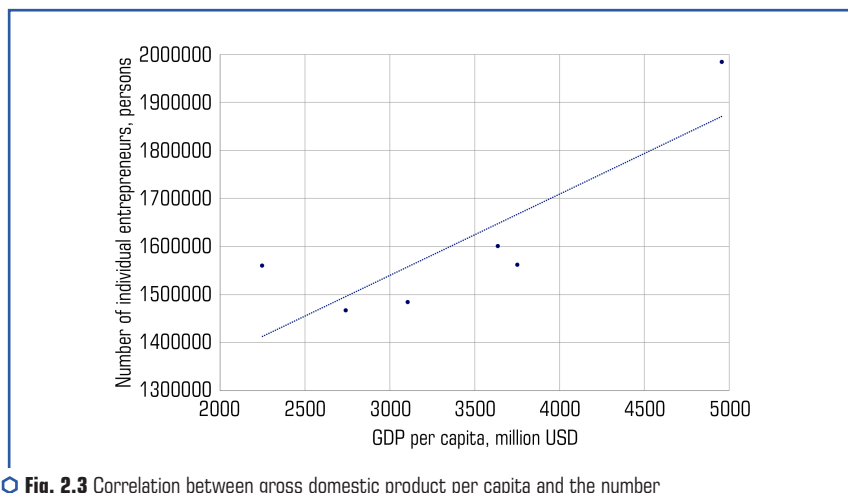
Let's calculate the correlation coefficient between GDP per capita and the number of individual entrepreneurs as a relationship between the macroeconomic state of the economy and its individual development indicator. The initial data for calculating the correlation coefficient are given in the **Table 2.2**.

● **Table 2.2** GDP per capita and number of individual entrepreneurs [20]

| Index                                | Years   |         |         |         |         |         |
|--------------------------------------|---------|---------|---------|---------|---------|---------|
| to study the correlation coefficient | 2016    | 2017    | 2018    | 2019    | 2020    | 2021    |
| GDP per inhabitant (million USD)     | 2251    | 2743    | 3107    | 3754    | 3639    | 4959    |
| to study the correlation coefficient | 2016    | 2017    | 2018    | 2019    | 2020    | 2021    |
| Number of individual entrepreneurs   | 1559161 | 1466803 | 1483716 | 1561028 | 1599755 | 1983269 |

The data given in **Table 2.2** show the growing dynamics of GDP per capita and the number of individual entrepreneurs.

The dependence graph of certain indicators is shown in **Fig. 2.3**.



○ **Fig. 2.3** Correlation between gross domestic product per capita and the number of individual entrepreneurs in one of the countries with transition economies

The correlation coefficient between GDP per capita and the number of individual entrepreneurs is 0.833. This means that the relationship between the analyzed data is quite dense and direct, when the larger the individual entrepreneurs number, the more intensively the GDP per

capita grows. These data indicate that entrepreneurs are actively developing their activities and replenishing the amount of gross domestic product produced.

Thus, it can be noted that nanoeconomics actively influences the development of the macro-economic economy.

### 2.2.4 IMPACT OF NANO ECONOMICS ON SERVICES, INDUSTRY AND AGRICULTURAL SECTOR

It should be noted that in general terms, the country's GDP has the following structure: services, industry and agriculture. The GDP of foreign countries shows that the majority in the structure of GDP falls on the service sector. The International Monetary Fund defines services as a change in the position of one institutional unit influenced by another institutional unit. This institution defines 11 types of services: from transport to government. A person living in the developed world consumes services to a greater extent than embodied products. A significant per capita income suggests that the funds are largely spent on the development of the individual, meeting the higher needs in Maslow's pyramid.

In addition, services are a type of activity that provides for a greater number of enterprises in this particular area. From 60 to 75 % of GDP falls on this area. Thus, Britain during the period of Margaret Thatcher carried out a restructuring of the national economy, encouraging laid-off miners to move into the service sector, opening their own small enterprises. In another example, the island nation of Nauru had a competitive advantage in the 1970s in the mining of phosphate rock. When these minerals dried up, the country switched to the provision of financial services on the basis of an offshore zone. This indicates that services can be the flagship of the economic development of individual countries of the world.

In some countries with economies in transition, the information technology (IT) sphere is intensively developing. IT engineers are gradually replacing process engineers working in industry. The IT sphere focuses on the use of the labor of individuals, both hired engineers and individual entrepreneurs. This segment of the economy is also focused on nanoknowledge in nanoelectronics, because the IT sector can develop only on the basis of high-quality production of electronic gadgets.

More and more traditional segments of the service sector, in which the production unit is an individual or household, are influenced by the innovation system in the country. After all, this is the most actively changing system under the influence of the quality of the process.

An illustration of the impact of the innovation system on the volume of services provided is given in **Table 2.3** and **Fig. 2.3**.

**Table 2.3** shows the volume of services provided and the cost of research and development (R&D). And these data indicate that a growing trend is being displayed.

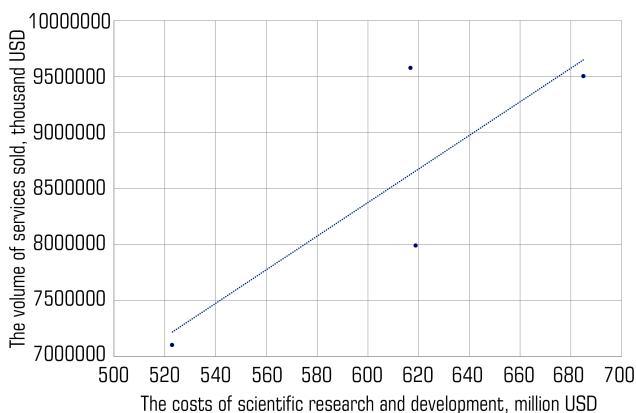
**Fig. 2.4** indicates that there is a tight relationship between the indicated data.

The correlation coefficient between the volume of services sold and the costs of research and development is 0.828. This is a significant dependence, indicating that as the cost of science increases, the volume of services provided increases.



● **Table 2.3** Initial data for correlation analysis of the impact of the innovative component of service production [20]

| Index  | Years   |         |         |         |         |          |
|--|---------|---------|---------|---------|---------|----------|
| to study the correlation coefficient                       | 2016    | 2017    | 2018    | 2019    | 2020    | 2021     |
| The cost of the volume of services provided (thousand USD) | No data | 7100128 | 7989912 | 9498686 | 9572315 | 12799667 |
| to study the correlation coefficient                       | 2016    | 2017    | 2018    | 2019    | 2020    | 2021     |
| Expenditures on R&D (million USD)                          | 465     | 523     | 619     | 685     | 617     | No data  |



○ **Fig. 2.4** Correlation between the volume of services sold and the costs of scientific research and development

Nanoeconomics as an innovative economy is determined by a significant share of research activities and its implementation in the service sector. The active use of innovation determines the research potential of this market segment.

Nanoeconomics as a human economy also affects the volume of services provided, because the individual factor should be used in the most optimal way.

Along with the service sector, industry is actively developing. In the structure of the GDP of developed countries, this segment of the national economy accounts for 20 to 30 %. And this area is under the influence of nanoeconomics. It should be noted that the level of development of such an industry as mechanical engineering, as a rule, determines the progress of the entire economy of the country. There are three countries in the world that characterize machine-building production, the USA, Germany and Japan. Twelve industrialized countries account for more than 50 % of engineering products. This is the most innovative segment of the market, in which the majority

of scientists and development engineers are involved. Most often, nanotechnologies are actively used in these industries.

It is known that the level of development of the national economy is determined by the level of clustering of economic systems. A cluster is an industry-territorial bundle in which many compatible and related manufacturers work. And it is the industry that is determined by such clustering. Countries with economies in transition had so-called production districts in Soviet times, which combined metallurgical complexes and machine-building enterprises. In these states, a chain between these basic industries should be debugged.

Other industries are also backbone. These include mining, chemical industry, mechanical engineering, industries for the production of consumer goods (furniture, textile, clothing, footwear, etc.) and others. In the conditions of the global economy, the competitiveness of enterprises in the vast majority of industries depends on the professionalism of specialists, their creativity, the ability to constantly innovate, apply nanoknowledge to create new technologies. Without the economy of nanotechnologies (as a component of nanoeconomics), in the near future, ensuring the process of expanded production reproduction will be problematic. Under the conditions of the new technological order, the formed individual (from birth to the production of nanoideas) should influence economic growth. Of particular importance in this context are society's spending on education at all levels of the educational process and R&D.

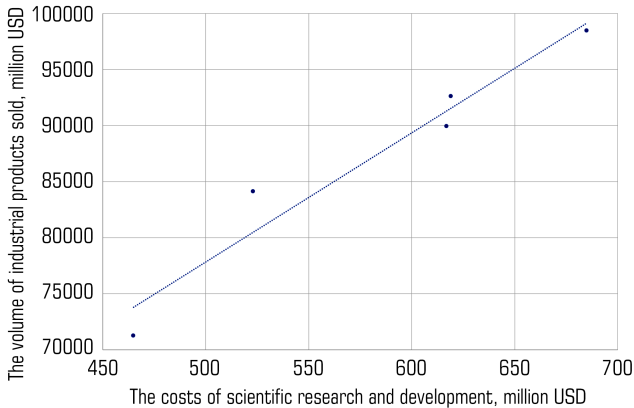
Let's calculate the correlation coefficient between the volume of industrial production and the costs of research and development in one of the countries with economies in transition, the initial data for which are shown in **Table 2.4**.

● **Table 2.4** The volume of industrial production and the volume of expenditures on research and development [20]

| Index  | Years |       |       |       |       |         |
|--|-------|-------|-------|-------|-------|---------|
| to study the correlation coefficient                 | 2016  | 2017  | 2018  | 2019  | 2020  | 2021    |
| The volume of sold industrial products (million USD) | 71254 | 84103 | 92568 | 98445 | 89897 | 134939  |
| to study the correlation coefficient                 | 2016  | 2017  | 2018  | 2019  | 2020  | 2021    |
| Expenditures on R&D (million USD)                    | 465   | 523   | 619   | 685   | 617   | No data |

Data in **Table 2.4** show that the volume of industrial production and the cost of research and development are increasing from year to year. And the correlation coefficient is 0.972, which is reflected in **Fig. 2.5**.

Such a high correlation coefficient indicates that the impact of nanoeconomics on macroeconomics is significant and direct, when with the growth of funding for science, the indicator of industrial production also grows.



**Fig. 2.5** Correlation between the volume of industrial products sold and the costs of research and development

Nanoeconomics also has an impact on the agricultural sector of the national economy. Note that in agricultural production, the economic process of reproduction, regardless of its social nature, is always intertwined with the natural. Therefore, rational management in this area requires knowledge and skillful use of not only economic laws, but also the laws of nature. The close relationship of economic processes with natural causes a significant impact of the latter on the results of economic activity, which affects the rate of reproduction.

Hence the possibility of sharper fluctuations in the rate of accumulation in comparison with other industries. If in industry a person as a subject of nanoeconomics can fully influence the production processes, then in agriculture this possibility is limited. Here the object of human activity is living organisms: plants and animals; biological processes proceed according to certain laws of nature. They objectively require the adaptation of the entire rhythm of production to the rhythm of nature: to the natural course of the production process. In agriculture, it is impossible to speed up the production process, as in industry.

A characteristic feature of the nanoeconomics of developed countries is the functioning of the agro-industrial complex (AIC) or agribusiness. This determines the essential features of social reproduction in this most important area of the economy.

In modern conditions, the clustering of the agrarian sector should take place. Thus, the production of food (grain, meat, milk, etc.) and industrial crops (cotton, flax, etc.) is based on an intersectoral production system. The latter covers agriculture and related sectors of the economy that supply it with the means of production, process and store agricultural raw materials and produce food. Their relationship can be expressed according to the scheme: production of means

of production – logistics and service – farm product – its industrial processing – sale in wholesale and retail trade. At all stages of production, supply and marketing of agricultural products, an active role belongs to economic individuals. Farms are usually sole proprietorships and their activities depend on subjective factors. This was clearly manifested during the hostilities, when farmers sowed areas and cultivated land at their own risk.

The formation and development of agribusiness is due to the transition of agriculture to the machine stage of production in the conditions of the fifth and sixth technological modes. Agribusiness is becoming more and more knowledge-intensive, and nanotechnologies are also used here, capable of growing plants with specified parameters. Agribusiness also depends on the innovation component, as discussed in the correlation study.

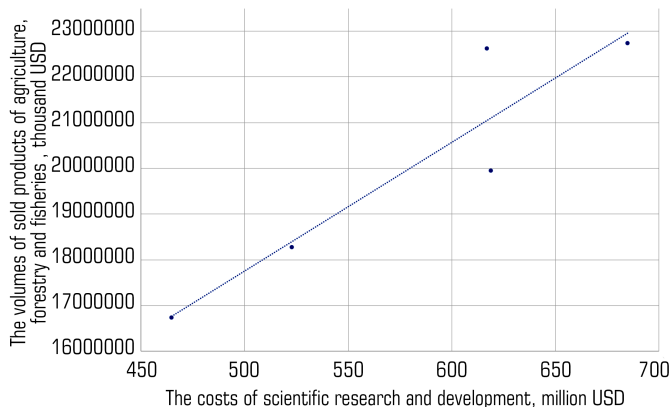
**Table 2.5** shows the initial data for such an analysis.

● **Table 2.5** Initial data on the correlation analysis between the volume of agricultural production and the volume of expenditures on research and development [20]

| Index   | Years    |          |          |          |          |          |
|---|----------|----------|----------|----------|----------|----------|
| to study the correlation coefficient  | 2016     | 2017     | 2018     | 2019     | 2020     | 2021     |
| The volume of sold products of agriculture, forestry and fishery (thousand USD) | 16725803 | 18267037 | 19944995 | 22728106 | 22611237 | 26839708 |
| to study the correlation coefficient  | 2016     | 2017     | 2018     | 2019     | 2020     | 2021     |
| Expenditures on R&D (million USD)   | 465      | 523      | 619      | 685      | 617      | No data  |

The characteristics in the **Table 2.5** indicate a growing dynamics, the correlation coefficient relative to which indicates a tight connection. The graph of the correlation dependence is shown in **Fig. 2.6**.

**Table 2.5** and **Fig. 2.6** reflect that there is a high correlation between the sales of agricultural products and the costs of science. The correlation coefficient is 0.928. Yes, the production and sale of agricultural goods grows with the growth of expenditures on science. Nano-economics as an innovative economy also influences the formation of the agricultural sector in different countries of the world. The scientific world in the agricultural sector, in particular, is more subjective in objective conditions, when an individual researcher can change the vector of development of an entire industry. The country with an economy in transition has a whole network of agricultural educational institutions, from agricultural technical schools (colleges) to agricultural academies and universities. This network is an intermediary between the AIC and individual individuals.



**Fig. 2.6** Correlation dependence between indicators of volumes of sold products of agriculture, forestry and fisheries and the volume of expenditures on research and development

The obtained results of the influence of nanoeconomics on the macroeconomic environment can be explained by the fact that:

- nanoeconomics is defined as the level of an individual within a national economic system. The nature of nanoeconomics determines how it affects the system. Yes, the nature of nanoeconomics presupposes the existence of material and non-material conditions. Material conditions actively influence the provision of macroeconomic development. Non-material conditions are factors in improving the quality of life of individuals and the quality of production processes at the macro level. Four regularities in the development of nanoeconomics were identified. All of them affect the components of the nanoeconomic system: the baby economics, the human economy and the economy of nanotechnology. It is because of these subsystems that nanoeconomics has an impact on the macroeconomic conditions for the development of certain countries. Nanoeconomics is defined by an evolutionary approach. This evolution coincides with the evolution of international business and the countries where this business developed;

- the influence of nanoeconomics on the process of social reproduction and economic growth is determined by the gradual influence on the process of social expanded reproduction. The same: production – distribution – exchange – consumption – complemented by an innovative component: idea – research – implementation and an integral part of teaching technological solutions, in particular nanotechnological ones. Yes, to the idea, there should be training and education in the family and all sorts of educational bookmarks. The correlation coefficient between GDP and the number of students is 0.919, which can be explained by the decrease in the number of privately owned universities. If in the 1990s and early 2000s universities and their students were in sufficient

numbers, today it has decreased significantly. In addition, external independent evaluation (EIE) is also a limiter for university applicants in countries;

– the influence of nanoeconomics on the macroeconomic level of management and economic equilibrium occurs through the influence on the market mechanism of the ratio of supply and demand, production and consumption. Savings, investment and consumption are expressions of the processes of individualization of market mechanisms. It is through a person that entrepreneurs influence the market equilibrium. The correlation coefficient between GDP per capita and the number of individual entrepreneurs is 0.833 and indicates that there is a direct and close relationship between these phenomena. So, private entrepreneurs are at the forefront of the business sector of the economic system of one of the countries in transition. It is individual entrepreneur that form private incomes, which become the basis for consumption and their savings provide an opportunity for investment;

– the impact of nanoeconomics on the service sector, industry and the agricultural sector is determined by the fact that recently there has been an individualization of production and management processes within the economic system. Production is increasingly moving into the service sector, offering to form a competitive advantage in its intangible part. The industry remains the flagship of economic development and technology is crucial for building a successful business here. The agrarian sphere combines natural and economic relations. For a country with a transitional economy, all these three components are decisive for building an effective national economic complex. The impact of the nanoeconomics on the production of services, industrial products and agricultural goods was reflected through the correlation coefficient: 0.828; 0.972; 0.928 respectively. These are significant indicators, indicating a close direct relationship between the development of the defining segments of the economy and nanoeconomic advancement. The latter is a kind of innovative component of macroeconomics and characterizes innovative opportunities for the macroeconomic system as a whole.

The research method used has such features as a combination of macroanalysis and nanoeconomics analysis. It is noted how the human economy affects the process of expanded reproduction, economic balance and the structure of the economy. The limitations inherent in these studies are characterized by the inability to track the impact of each individual on macrodevelopment. Aggregates such as GDP per capita can be used to generalize nanoeconomic dynamics.

The disadvantages of the study include: the lack of analysis of the activities of an individual in the macroeconomic environment, the difficulty in applying the assessment of the economic practice of an individual within an enterprise and a public institution. Such shortcomings can be addressed by using the demographics and biographies of prominent world and country-specific managers.

This study proves that there is an individualization of economic processes in the world and its individual national economies. The advantages of this study compared to similar well-known ones are that individualization should have a systematic approach, which is ensured by considering it within the framework of the nanoeconomics, which begins with the baby economics and continues with the human economy and the economy of nanotechnology.

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Correlation analysis makes it possible to determine mathematically how nanoeconomics affects the development of the national economic system. All calculated characteristics of the correlation coefficients tend to unity, which means that nanoeconomics actively influences the macroeconomic system of certain states.

## CONCLUSIONS

1. The total activity of society has an increasingly noticeable impact on nature, requiring rationalization and regulation of their interaction. Of particular importance in this context is nanoeconomics as a systemic phenomenon of a nature associated with macroeconomic systems. As a component of the country's economy, it begins its countdown from the period of extensive geographical discoveries and acquires structured features in the period of nation-states. In the context of globalization, nanoeconomics is determined by certain characteristic features: accessibility and universality, gradual development, technological globalization, "financialization", and the complex interaction of nanoeconomic and international. All these characteristics of nanoeconomics in the context of the development of international economic relations ensure its active influence on the development of economic systems in different countries of the world.

2. Simple and expanded reproduction is the initial sign of macroeconomics. Both of these forms of reproduction are based on human labor. The labor of individuals is a public form of existence of the nanoeconomics. Extended reproduction can take place even more intensively through the education and training of individuals in certain educational institutions. There they are taught how to make decisions and nurture ideas about technology and innovation in the manufacturing process. Economic growth is based on the activation of expanded reproduction at the micro- and nano-levels and receives impulses for development from specific individuals. Thus, certain countries with economies in transition base their own development on the entrepreneurial activity of specific individuals, which is confirmed by correlation analysis.

3. The economy of households, as the primary link of the nanoeconomics, is the defining element of the country's economy, since individual consumption formed within households is the primary source of its existence. In modern conditions, households largely form the macroeconomic indicators of housekeeping. Specifically, in this nanoeconomic component, dependence on indicators of the development of the state economy is formed. In one of the countries with economies in transition, the wealth of households is provided through additional items of income from ancillary activities. At the macro level, this is the total income, reflecting all the income of family cells. The difference between income and consumption is saving, which is the basis for investment. In this country, funds in business are largely invested by sole proprietorships, which are a manifestation of entrepreneurial ability. As evidenced by the correlation analysis, the relationship between GDP per capita and the number of individual entrepreneurs is quite dense, which confirms the opinion regarding the active influence of nanoeconomics on macroeconomic management.

4. The national economy includes such structural elements as industry, services and the agricultural sector. In each of these parts, the activity of economic man is actively used. The latter is a manifestation of innovative activity, when a person economically comes up with ideas for improving production processes and this is helped by state policy regarding the costs of research and development. The most significant relationship between these indicators is observed in the agricultural sector and science ( $R=0.979$ ), which indicates the possibility of an innovator's influence on the development of various sectors of the national economy.

### CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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