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INNOVATIONS AS A FACTOR OF INDUSTRIAL COMPETITIVENESS IN ACADEMIC RESEARCH

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ABSTRACT

Purpose – finding a general direction of academic research in comprehension of innovation's role in providing competitiveness and how.

Methodology – it is employed paper review method to highlight mainstream and general approaches, their similarities and differences in the subject of study.

Originality/value – investigating different studies on the topic gives understanding where mainstream literature develops and synthesis of various view on subject

Findings – observed two types of innovations in products and processes are possible only in industries with special characteristics. Industries contribute differently in new technologies development and consume innovations distinctively.

Keywords: development, innovations, industrial competitiveness, industrial organization, taxonomy

INTRODUCTION

In historical aspect innovations played great role in development of nations, their welfare, and economic progress. Using new technologies in producing the Great Britain increased productivity several times and became world factory in Industrialization and Global Integration period from 1750 to 1900. It was provided by development of institutes as a basis for innovative activity which was a key element of fascinating growth of all existing industries at that time.

Central Asia, where Kazakhstan and Uzbekistan are main economies, faces fierce competition from different regions. In that sense competitiveness of industries is becoming more and more dependent on innovation activities within them. However, the aspect was not studied enough and considered as a crucial. Despite any initiatives of two governments to develop their economies by strengthening of local producers competitiveness, the basis of innovations was not under the focus although some attempts were provided. As a result two mentioned states demonstrate low level of applications for registration of intellectual property (IP) rights (Table 1). And the aim to join the top 30 most competitive states must correspond to IP ranking based on average of three types of applications for IP.

Nations developed through different stages of industrial organizations and innovative approaches. All such stages were followed by establishment of strong relationship between industries and firms within them on the one hand and research centers and academic institutes on the other hand. Some companies, especially large of them, had created departments responsible for new products or innovation activities like departments of new technologies and so on. Later firms increased their investment on development due to its profitability. It could be impossible without basic research provided by academic sector and specialists trained by universities. High dependence of manufacturing from academic industry in this sense can be observed still now. When academics discover something it becomes attractive for business to adopt and to use.

But what kind of linkage does exist between science and manufacturing companies? How can be work of different actors in academic sector and manufacturing evaluated regarding innovative activities? What measures can be used to understand the degree of effectiveness of different institutes in creation of something important and beneficial for society?

Table 1 – Innovation activities of selected states

Country	World IP ranking	Dynamics of patent applications (quantity)			Rankings by type of applications		
					Patent (for invention)	Trade marks (product/service innovation)	Industrial designs (process innovation)
	2018	2018	2008	2007 (2006*)	2018	2018	2018
China	1	1 542 002	289 838	245 161	1	1	1
USA	2	597 141	456 321	456 154	2	2	4
Germany	3	67 898	62 417	60 992	5	4	2
Japan	4	313 567	391 002	396 291	3	3	6
South Korea	5	209 992	170 632	172 469	4	11	3
Singapore	29	11 845	9 692	9 951	24	32	41
Czech Republic	30	732	854	-	34	34	30
Portugal	31	690	405	-	39	31	28
Uzbekistan	59	650	448	522	60	66	70
Kazakhstan*	72	982	173	1 557	40	96	91
Note: source [1]							

Another issue is a flow of innovations from one sector to other. In other words, who is responsible for great deal of inventions and for less? Is there any consistent pattern in distribution of innovation activities within industries or not? What kind of companies do exist as producers of new technologies and consumers of new ideas and approaches?

All such questions are focused on the center task of the paper what is a general direction of academic research in comprehension of innovation's role in providing competitiveness and how? In order to find the mainstream it were evaluated different studies concerning the topic and different views of economists on development of relationship between science and different sectors of economy and on taxonomies of innovation flow influencing on competitiveness of industries. The topic is important and relevant to use in corresponding studies.

FORMATION OF LINKAGE BETWEEN SCIENCE AND INDUSTRIAL INNOVATIONS

Growth of technological capabilities of producers is a process organized internally and externally by using own resources and by protection of government. It varies from country to country. Many successful instances of technological shifts come from catching up economies in the past like Germany and the USA in the nineteenth century, Japan and Korea in the twentieth century, and others that developed their infant industries and domestic producers by instruments of domestic protection and different incentives. Governmental support included not only trade policy and fiscal measures but also expenditures in education and science even in nineteenth century due to appearance of science-based industries [2]. Pisano highlights some of science-based sectors in that period: chemical industry, electrification, mass production, and transportation [3]. They cannot grow without advances in science. In that sense governmental policy consisted of investment in research and higher education in order to train specialists more widely [2].

Companies within industries that were protected by high import tariffs, developed technology of production and capacity of equipment they used inside the environment of internal competition. Such tendency raised awareness about the role of new ideas and creativity. The strategy of Standard oil in creation of safe product by using defined technologies of production resulted in high popularity of its products and customer loyalty.

Transition from horse-drawn trams to electric trams permitted to increase productivity and income giving way to further technological advances is another example.

The relationship between business and science was strongly established in previous century. DuPont, General Electric, and AT&T and many other business giants organized corporate laboratories for research and for finding new decisions for their manufacturing process and products fostering fast development of science [3].

Innovations come from education hubs as well. The letter is a combination of education actors including students, colleges and universities, training organizations, knowledge sectors of economy, centers for science and technology development that interrelate and produce knowledge and innovation. The hubs like clusters are considered as separate industries and in many countries are highly supported by government as a direction of specialization. Therefore, some states prefer to host foreign universities and franchise programs than to develop science being based only on local resources and factors. And it is suitable for students to study at home and save money. There are six nations which demonstrate great efforts to become education hubs in 2010: Bahrain, Hong Kong, Malaysia, Qatar, Singapore, and United Arab Emirates (UAE). All these countries have small population and economic scale and aim to diversify industries from prevailed oil producing and manufacturing to knowledge and service sectors. For example, UAE accommodated more branches of foreign universities than any other state in 2009 [4].

Universities and other education organizations must be sources of innovation and knowledge production for business. A government plays central role in tendency of linkage establishment between science and business. Without enormous support of public finance the progress cannot appear. Creation of new university in 2010 in Kazakhstan which attracts foreign scientists is one of steps on the way of innovative development supported by government [5].

Regarding the case what is the role of universities in practice? Rosenberg argues that universities focus predominantly on studies in basic research and can conduct research in different spheres where industrial research is weak such as electronics. Government can define the aim of university research funding like for local industry support and not for fundamental studies that are useful in a long term. In this sense universities may have additional responsibilities for serving of industries. And need for close relationship between colleagues from universities and industries is clear. Such linkage is observed in defense technologies, agriculture and health. But it should not lead to make academics responsible for business decisions [6].

University studies will continue to play major role in electrical engineering, computer science, and materials science as a basis for high tech industries. Empirical studies signify limited number of industries where academic research play great role: agriculture, products of chemistry, electronics, and health. It is a result of long period support from government. And broadening of industry range where government supports research within universities can give the same result. Universities are capable to substitute industrial research where the latter is absent or tend to disappear. Different programs of university-business interaction are very helpful especially for firms that do not have resources to develop technologies, products, or processes. All such activities can be useful both for industries and universities. However, there must be line - division of labor between academic world and business. Any interaction of university researchers for profit generating work must be restricted and balance must be saved [6].

Important issue is evaluation of outcomes universities represent for economic growth. McKelvey adduces that some measures like number of academic patents and start-up companies established by assistance of a particular university can be used as a linear model. Since governmental investment in science must bring practical results for society in tangible studies and technical progress. However, these results take place mostly in long term and any expectation of outcomes in several years fails. Moreover, number of patents and established firms characterize relationship between academic science and economy in very weak way. University disseminates knowledge and provides education for students, who also become researchers or specialists in industry, and these two factors are not included in the linear model mentioned above. In contrast to somehow universal function of universities, managers from real sector when they are asked in surveys from where ideas come to a firm tend to place universities after suppliers, customers, and others [7]. It is an argument to prevent exaggeration of universities role.

TAXONOMY OF INNOVATIONS

Very popular taxonomy concerning innovations, which became a basis for many other studies, was represented by Pavitt in 1984. He segments innovation flow in concordance with an industry of invention, an industry of principal activity, and an industry of its use. He highlights five categories: 1. All these three characteristics are related to one industry (firm introduces new jeans, works in textile industry, and firm combines new jeans with jacket as the contents of suit), 2. All characteristics are related to different industries (textile company invents new tool for spinning and uses it for production of doors from plastic), 3. Industry of innovation production and principal of activity are the same but use is in another industry (chocolate company invents new chocolate powder to use it in cake production), 4. Industry of use and principal of activity are the same but invention is in another industry (Automobile company introduces new software for car computer), 5. Industry of primary activity is different and two others are the same (construction enterprise invents new equipment for cleaning the windows) [8].

According to Pavitt empirical survey, sources of firm innovation can be divided into three groups. So about 59% of innovations come from firms themselves, 34% from other firms, and 7% from public infrastructure (higher education, public laboratories, and research associations). The last of them is underestimated as Pavitt explains it by data collection imperfections: experts participating in the survey were from industrial sector, there was no evaluation of universities contribution and other public organizations for training and education of specialists working in research inside the companies and for basic research employed in further studies of scholars from commercial firms. It should be mentioned that contribution of manufacturing sector to all innovations of the US economy is prevailed. Nevertheless, development of technologies has two predictors: "science and technology push" and "demand pull". First of them means supply of innovations and last - need of companies that are consumers of the innovations [8].

Scherer claims that industrial expenditures to research and development (R&D) contains two directions which define productivity of a company. First of them implies improvement of existing products and creation of new one. Second direction that have straight influence on productivity, is improvement of existing production processes or formation new one. What is more that three-fourth of all industrial R&D investment are oriented for product innovation and not for productivity growth [9].

One of important aspects is related to innovation flow from industry to industry. It is observed from Britain dataset of 1945-1979 period that outflow of new technologies is considerable from Instrument engineering (93% of innovations go to other industries), Bricks, pottery, glass and cement sector (85%), Chemicals (83%), Mechanical engineering (83%), and Electrical and electronic engineering (60%). It means the impact of mentioned industries to others is crucial and innovation activities within them defines competitiveness of others. The most vulnerable industries to innovations from outside are Textiles (only 16% of innovations come from the inside), Shipbuilding (32%), Vehicles (38%), and Instrument engineering (38%). The lowest dependence on innovation from other industries is demonstrated by Electrical and electronic engineering as it produces 80% of all used new technologies by itself [8]. It can be expected industrial program failure in the case of initial development of vulnerable industries rather than sectors providing the breakthrough of innovations in higher extent.

In Pavitt's taxonomy the object of analysis is an innovating company with four categories. It can be supplier dominated (with some service sectors like education and tourism in final version), production intensive (scale intensive and specialized suppliers), science-based, and information intensive firm (also includes some of service sectors). Initially, the fourth category was called specialized equipment suppliers. And later it was added to production intensive category and replaced by information intensive category as a fourth which consists of services sector [8, 10].

Supplier dominated category is highly dependent in terms of innovations on suppliers of equipment and inventory, big buyers of their products or services, and research financed from public sources. It spends resources on product development or process innovation only at low level if it takes place. This kind of companies works mainly in agriculture, construction of small buildings, traditional manufacturing like textiles and printing, health care, retailing, and some others. It is characterized by small scale of production and little ability to invest in research. Supplier dominated firm bases its competitiveness on experience of staff, uniqueness,

image, brands. Technological progress is considered in the prism of decreasing expenditures. Part of such firms can transform to production intensive companies in the case of opening new markets and increasing the scale. Supplier dominated category initially consisted all services sector [8]. But some service companies like those who specialize on telecommunication have many characteristics far from supplier dominated firm since their significant contribution to new technologies is clear. Therefore, inclusion of all service industries to this category was criticized by researchers for a weak linkage in the first variant of the taxonomy [11].

Production intensive firms focuses on rise of production scale by selling more or producing inventory intensively in some periods of year. This category contains two highly interrelated groups: scale intensive and specialized equipment suppliers. The first of them is normally large. According to "two-thirds engineering rule" 3 percent increase in scale of production leads to 1 percent lowering of unit capacity costs. That is the basis of a scale intensive strategy. In order to organize production process and to provide innovation activities they create production engineering groups. Scale intensive establishments tend to buy equipment and tools from defined companies - specialized equipment suppliers - on long term basis and confidential relationship. Such suppliers are specialized plants that are usually not large and can provide with technical service of their products. The essence of relationship between two groups is characterized by continual service with testing new equipment, which is additional advantage for its producer, in production line and flow of technical knowledge from suppliers to scale intensive firms. As a result of such cooperation both parts benefits and their technical standards increase [8].

Third category of the taxonomy is a science-based enterprise. Traditionally it operates in chemical and electrical industries that generate large number of innovations. New technologies in production processes or transformation of products are becoming possible through R&D financing by science-based companies in a long run. It is forced to protect know-how by patents, covering information on innovations, creation of transcendence in technology that is achievable only by long development, and technological experience of a firm. The innovative contribution of this category is considerable as for principal industry as for other sectors of economy. Its relationship with specialized equipment suppliers leads to flow of technologies in two directions like cooperation between scale intensive firms and specialized equipment suppliers [8].

Table 2 – Phases of development and Pavitt's categories of firms

Age	Successive innovative approaches	Industrial organization	Typical industries	Rise of Pavitt's category of firms	Short definition
1770-1830	Early Mechanization	Growing importance of small manufacturing firms	Textiles, Potteries, Machinery	Supplier dominated (I)	Highly dependent on suppliers of equipment
1840-1880	Steam power and railway	Separation been producers of capital and consumption goods	Mechanical engineering, Steel and Coal	Specialized suppliers (II)	Small plants specialized on production of equipment and tools and their technical support
1890-1930	Opportunities associated to scientific discoveries	Emergence of large firms	Chemical, Electrical machinery, Engineering	Science based (III)	Large number of innovations, focused on long run R&D investment and tech experience
1940-1980	Fordist and Taylorist revolutions	Oligopolistic competition for mass consumption	Automobiles, Synthetic products, Consumer durables	Scale intensive (II; together with specialized suppliers)	Large and focused on rise of production scale and standardization
1990-	Information and communication	Networks of firms, strong user-produces interactions	Microelectronics Telecoms, Software	Information intensive (IV)	Design, use & improvement of large tech systems to process information
Note: source [10, 14]					

In addition Pavitt concludes positive relationship between internal innovations for producing process and size of a company. And except supplier dominated category, the more concentration of companies within sector of use the more development of in-house innovations for producing process. The taxonomy also defines technological strategy of firm that is dependent on principal industry of activity. The result of study demonstrates that diversification level in technological sense depends positively on size of a firm as well.

The taxonomy of four classes is actual still now despite some changes that was mentioned above, and critics on inclusion of services industry to one of four categories [11, 12, 13].

Archibugi makes linkage between taxonomy of Pavitt and Freeman's long waves who was a mentor of Pavitt for some time [14] - a dichotomy comparing two approach (Table 2).

According to the table 2 every new typology of innovative firms is a product of a long wave of development. And Archibugi argues that emergence of new category does not destroy existing one but forces other categories to change [14].

Lall argues that Pavitt's taxonomy is difficult to use because of absence of clear estimation of each category. And using OECD classification he proposes extended version of taxonomy regarding products. All of them are considered as technological classification of product exports. There are three categories: primary products (like coal, gas, grain, meat, oil, wood), manufactured products, and other transactions (like art, coins, electricity). Manufactured products have four subcategories: resource based manufactures (goods produced from primary products like cement, doors and windows from wood, petroleum, soy oil - simple and labor intensive products with scale and skill-intensive approach), low technology manufactures (textile products, plastic products, simple metal parts, toys and others based on well-known technologies and price competition in combination with low qualified workers for majority of goods), medium technology manufactures (automotive and engineering sectors like machinery, vessels, engines, chemicals, pipes, plastics that are skill and scale-intensive categories with considerable costs of R&D, high entry constraints, and significant role of small and medium enterprises), and high technology manufactures (electronics and electrical goods like telecommunication equipment, transistors, optical instruments, pharmaceuticals which can be characterized by advanced and sophisticated technologies with large expenditures of R&D, product innovation focus, consistent infrastructure, and deep cooperation between research centers and companies) [15]. According to the classification of Lall we can assign the level of technological achievement to every state or trajectory of development.

Guerzoni represents another taxonomy of innovation activities [16] based on type of market (Figure 1).

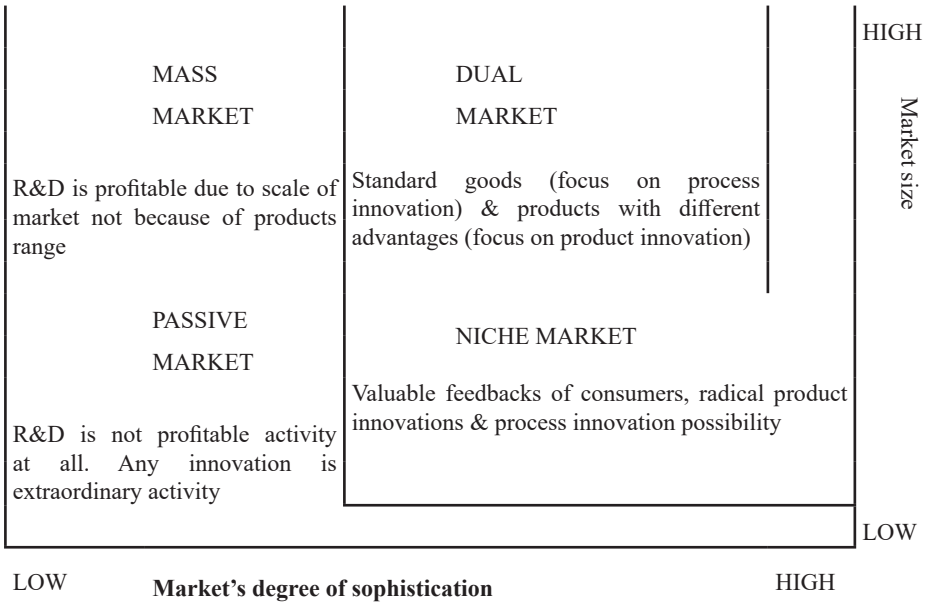

Figure 1 - Taxonomy of demand
Note: compiled by the authors with supplementation according to the source [16]

The taxonomy of Guerzoni focuses on external effects where firms work: market type and consumer sophistication. He argues that in small markets (passive markets) demand is not factor pulling innovative behaviour in contrast to all other three types mentioned above [16]. Therefore, trajectory of small economies like Central Asian Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, to niche market fits the case.

There are many other taxonomies. Within them taxonomies that are considered by Timofeev [17].

COMPETITIVENESS BASED ON SCIENCE

Economists demonstrated interest on why the US and Europe are losing their share in the international market and Japan and other Asian countries are becoming more influential in economic sense in 1980-1999. The issue is competitiveness, its essence, and relevance. Some interpret competitiveness as a comparative advantage or in other words - industrial specialization. It can be only by prevalence of country's global market share in a particular industry over its market share in all other industries and such specialization tend to be constant for a long term. The competitiveness phenomena is also associated with living standards, their stable level of increase. But this interpretation is criticized since living standards can be provided by international loans be payed later and as a result can cause lessening living standards. Another explanation is output competitiveness linked to success of a country in the factors defining the odds of output like low costs of production. However, merely technological progress is the central factor explaining long term differences in development and competitiveness [18].

What kind of companies will have more contribution to innovation in long run: small or large? The answer to the question will be basis to predict which of industries are more innovative - industries containing mainly large companies or industries that aggregate small firms [19]. The answer comes from work of Pavitt in some extent where he stressed the important role of large firms in technological development [8].

Society develops and offers new approach in standard operations, production, and research. Business interesting in competitive advantage always forces scientific and technological progress that can be provided by research centers, laboratories and universities. As a result there are a lot of ideas and innovative projects how to change a product or an operational process. The question is how to select and assess them. Mutanov and Esengalieva propose method for assessing of innovativeness and competitiveness of innovative projects [20]. Other researchers suggest indexes and instruments to evaluate an innovative process [21].

Today, when the world is changing dramatically and new companies are replacing old fashioned firms with long lasting traditions, innovations are drivers of growth and competitive odds. Therefore, great attention on the aspect is reasonable. And the most innovative industry is the most advanced and successful. Without that the growth of an economy is impossible.

CONCLUSION

The article studies different research and finds answers to posed questions. There is mainstream literature on aspect from distinctive periods especially for evaluating taxonomy of Pavitt that was investigated by so many researchers of the field. It is too important for industrial organization sphere due to its classification and division of industries by their contribution to the whole innovation process and clues on which of industries must be developed firstly as a basis for creation others.

It is found linkage between different studies of economists who had relatively close interrelation like Archibugi's comments to Pavitt's paper before its publication and his review on Pavitts research many years later. Difference in approaches on the same topic between Freeman as a mentor and Pavitt as his student was investigated and analysed by Archibugi.

As a result of the study it is observed crucial role of innovations in providing of industrial competitiveness. It is a factor of stable and permanent growth. But production of innovations, which are normally divided into two groups - innovation of products and innovation of processes, are possible only in industries with special characteristics. Forcing innovative activities in textile industry for instance leads to getting nothing. And investment in R&D in chemistry results innovations not only in principal sector but in many others. The degree of impact is also observed.

The role of academic industry is considered as underestimated by many economists. The basic research that was the fundament of applied studies in different enterprises within industries for a long period, remains driver of further development and marker for starting investment in appropriate research. But results of basic studies can be observed mainly in long run, therefore, academic sphere is under so much criticism on its today contribution to innovation process. And it is mistake to expect from academics activities like registering patents or creation of new concepts of products. Nevertheless, deep interrelation between universities and companies exist in medicine, electronics and others. Innovations can be generated by academic industry as well.

Overall, innovations play crucial role in strengthening of industrial competitiveness and their appearance is a result of appropriate organization of industries and flow of new technologies.

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ТҮЙІН

Бұл ғылыми мақала экономика салаларының бәсекеге қабілеттілігін қамтамасыз етудегі инновацияның рөлі бойынша әр түрлі әдебиеттерді талдауға және синтездеуге арналған. Бір жағынан, елдік инновациялық қорына салымда және индустрияның бәсекеге қабілеттілігін арттыруда жекелеген индустриялардың маңызды рөлі байқалады, ал екінші жағынан кейбір индустриялардың инновациялық қордың екі түріне – өнімдер мен процестерде жоғары тәуелділігі байқалады. Бәсекеге қабілеттілік факторы ретінде жаңа технологияларды құруда іргелі зерттеулермен және экономиканың басқа салалары үшін мамандар дайындаумен айналысатын академиялық секторға да маңызды рөл беріледі.

РЕЗЮМЕ

Научная статья посвящена анализу и синтезу различных источников литературы по аспекту роли инноваций в обеспечении конкурентоспособности отраслей экономики. С одной стороны наблюдается важная роль отдельных индустрий во вкладе в страновой инновационный пул и соответственно повышению конкурентоспособности индустрий, а с другой стороны высокая зависимость некоторых индустрий от наличия инновационного пула в выделяемых двух видах – продуктах и в процессах. Значительная роль в создании новых технологий как фактора конкурентоспособности отводится и

академическому сектору, который занимается в основном фундаментальными исследованиями и подготовкой специалистов для других отраслей экономики.

SUMMARY

The scientific article is devoted to the analysis and synthesis of various sources of literature on the aspect of the role of innovation in ensuring the competitiveness of economic sectors. On the one hand, there is an important role of individual industries in contributing to the country's innovation pool and, accordingly, increasing the competitiveness of industries, and on the other hand, there is a high dependence of some industries on the presence of the innovation pool in the two types identified - products and processes. A significant role in the creation of new technologies as a factor of competitiveness is also assigned to the academic sector, which is mainly engaged in basic research and training specialists for other sectors of the economy.

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FUND INDICES: ANALYSIS AND APPLICATION FEATURES

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ABSTRACT

The purpose of the study is to reveal the essence of stock indices, identify factors that influence the situation, and create effective models for forecasting stock indices.

Originality. We have identified and analyzed the quality of the stock indices necessary for the development of the Kazakhstan and Russian securities markets, also identified the factors influencing them.

Methodology. The article analyzes the dynamics of the development of indices in the Russian and Kazakhstan stock markets for 2001-2017 by applying a panel model.

Results. Based on the data obtained from the panel model, the change in stock indices depends on economic factors.

***Keywords*:** stock indices, stock market, mathematical model, investment, dividends.