THE MANAGEMENT OF TECHNOLOGY TRANSFER AND ITS IMPACT ON BUSINESS ACTIVITY AND FINANCIAL SECURITY IN DEVELOPING COUNTRIES

[a]YULIIA BOCHAROVA, [b]MARIANNA KOKHAN, [c]LESYA YASTRUBETSKA, [d]IRYNA MURATOVA, [e]YULIIA ISHCHUK, [f]VIEGA KULIAVETS,

[a]Donetsk National University of Economics and Trade named after Mykhailo Tugan-Baranovsky, [b]Ivan Franko National University of Lviv, [c]Ivan Franko National University of Lviv [d]National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", [e]Vasyl' Stus Donetsk National University, [f]Vasyl Stus Donetsk National University,
email: [a]bocharova@donnuet.edu.ua, [b]marianna.kokhan@lnu.edu.ua, [c]Lesyz.yastrubetska@lnu.edu.ua, [d]irene41a@gmail.com, [e]julia_ishchuk@ukr.net, [f]v.kulyavets@vininvest.gov.ua,

Abstract: This article is devoted to assessing the impact of technology transfer on developing countries. The main purpose of the study is to determine the impact of production and technology transfer on the level of growth of developing countries. In order to achieve the goal, statistical data on research and development (R&D) expenditures, GDP, technology transfer and innovation development for 2014-2020 were analyzed. According to the results of the study, the countries investing in innovations have a great technological potential, which allows to develop the economy more rapidly, than by capital accumulation. The most influential indicator of technology development is the level of spending in R&D.

Key words: technology transfer, innovation, research and development (R&D), developing countries

1 Introduction

Technology transfer is a multifaceted process, which includes the transfer of intangible values and covers a wide range of market activities. The transfer includes migration of research results of inventions, investments in research and development (R&D), forming contractual relations between headquarters and branches of multinational firms, joint ventures or license partners, etc. Manufacturers of innovative technologies are also quite numerous. They include universities and research laboratories, private and public foundations, NGOs, start-ups and technology brokers, multinational enterprises, and R&D partners. New technologies and products are developed and transferred for various needs, ranging from expected profitability to humane purposes or often mixed motives. Increasingly in recent years, participants in this complex process have come together in global innovation and production networks, where technology transfer plays a central role.

The importance of having access to a portfolio of global technologies, of establishing relationships within the framework of international technology transfer can hardly be overestimated. This issue is doubly important for developing countries because they lag behind the technological frontier and face more severe constraints, for instance, the lack of resources and skilled personnel. Moreover, international technology transfer plays a critical role in solving social and environmental problems through technical solutions and technologies available abroad. This is most evident in medical technology, knowledge-intensive agricultural production, energy efficiency, and climate change mitigation methods. Each of these fields requires a combination of research incentives to solve socially important problems with sufficient resources. Therefore it is less costly to use off-the-shelf global technologies while adapting them to local conditions.

But technology transfer is not a concept of human assets; it is a matter of competitive advantage and the ability to generate significant revenues. Attempts to limit the diffusion of valuable technology to competing firms have been evident for centuries. Many researchers to this day have noted ongoing attempts by some states to increase intellectual property protection on a global scale to limit the leakage of technological information to developing countries because of their commercial interests (Stiglitz & Charlton, 2005; Sell, 2003).

In turn, developing countries that develop such technologies do not use them domestically but more often sell them to more developed countries to generate revenue. Thus, the trade-off between the needs of recipients for new information and the desires of technology developers has long been at the forefront of international debate. Therefore, the question of policymaking in technology markets and technology transfer for developing countries remains open. However, suppose we follow the established market order, it turns out that the developed countries buy advanced technologies to introduce them into production. In contrast, the developing countries sell the latest developments but use those technologies that are available for international trade to support their economy.

Thus, there is a problem involving developing countries' ability to participate in the international transfer of technology, relying solely on the products of developed countries. Given that technology must be constantly imported due to its obsolescence, many states become dependent on such technology, lacking domestic innovation development. In turn, those states that develop the production of innovative technologies within the country have prospects for rapid economic growth.

If we talk about the impact of technology transfer on the development of countries, we can emphasize that, in contrast to the Neoclassical Growth Model that is based on of capital accumulation as a determinant of development, even minor development of domestic R&D contributes to technological change and human capital accumulation (Lucas, 1998). Moreover, R&D-based models of growth consist of essential information about how new products embody new ideas, and trade in goods can help transfer knowledge embodied internationally.

The main purpose of the study is to determine the impact of production and technology transfer on the level of growth of developing countries.

2 Literature review

The issue of technology transfer is quite widely researched in the scientific literature, statistical and analytical companies. In particular, only the Scopus catalog (2021) counts more than 8000 publications on this topic.

A significant part of the research is devoted to studying the potential of technology transfer in the development of different countries, including the factors that affect the development of technology transfer (Singhai, 2021). In particular, Corsi *et al.* (2021), who conducted their study based on 107 thematic sources, concluded that the main obstacles to technology transfer development are resource constraints, lack of or insufficient government subsidies, and bureaucracy in transferring such technologies. These are the main problems of developing countries, which hinder technological development and the flow of foreign investment, market entry of international companies, and the overall competitiveness of the economy. Technology transfer is a consequence of public administration; in particular, for developing the technologies, a favorable environment must be created within the country for the entry of investors. Byczkowska *et al.* (2022) conducted a study evaluating technology transfer and direct investment in innovation management in Poland. The authors argue that the use of foreign technology allows the economy to develop more rapidly and gain a competitive advantage. In turn, multinational companies occupy the central place in the transfer of technology. But the process of technology transfer itself is constantly evolving, and today, it is safe to say that the importance of developed countries in the flow of innovation is gradually decreasing. If recently all the flows were directed from the Western to the Eastern countries, from the more developed

Northern countries to the Southern ones, today the crucial role is played by the countries with leapfrogging economies (Crupi, 2021). Such countries today are China, Korea, Brazil, and others. Developing countries with a fairly high level of innovative products have a huge potential both in their development and global technology development. However, detailed studies of the potential of developing countries are insufficient, which confirms the relevance of the research.

3 Research Methods

This study is based on a sample of statistical information on developing countries. Today there is no precise definition of this category of countries. However, there are several classifications of states from different organizations based on democracy, the formation of a free market economy, industrial development, availability of social programs, and human rights guarantees for their citizens (OECD Library, 2021). If we consider the classification of countries according to the UN, there are no clear criteria for classification. In UN's reports, the organization groups regions according to its methodology, where, for example, countries of Eastern Europe or the CIS do not form a list of developed or developing regions at all. On the other hand, if we talk about the IMF classification of countries, there is a clear classification of developing countries by region (IMF, 2021).

According to the IMF and the OECD, the authors have made a sample of 10 states among the developing countries, based on statistical data used for research. These states include Russia, Turkey, Romania, Ukraine, Kazakhstan, Bulgaria, Croatia, Georgia, Belarus, and Montenegro. These countries are located in the same region, they have approximately the same history of development, which allows us to generalize the study results to understand the general trend of technology development in the European region on the developing countries.

The statistical information used for carrying out research includes regular UNICTAD, UNESCO, WTO reports, and statistical information on the development of separate economies, particularly Ukraine.
Statistical data on GDP, technology transfer, and innovative development for 2014-2020 allowed conducting a horizontal, comparative analysis to determine the average values. Based on the correlation analysis, the level of technology transfer importance for developing countries was determined. For this purpose, the Pearson coefficient is used, which allows studying the patterns of influence of technology transfer and innovation on the level of GDP of the country. Graphical methods are used to present the results of the study, which allow ranking the states by technology, technology transfer, and its importance in the economy. In addition, general scientific methods of knowledge are used, such as analysis, synthesis, induction, and deduction.

4 Research results

Depending on the level of development of the countries, technology transfer can have different models. In particular, the movement of innovations of the developed countries essentially differs from the technologies of developing countries. Let us consider the features of technology transfer of developing countries in Table 1.

Tab. 1: Comparison of technology transfer of developing countries with developed countries

Comparison parameters	Developed countries	Developing countries
The movement of innovations depending on their life cycle	Technology packages in the initial stages of the life cycle	Technological packages at a mature or declining stage
Geography of the recipient of technology	Technology transfer depending on the level of technology compatibility, taking into account the competition	Technology transfer regardless of the recipient's geography
The field of investment	Possibility of transfer to industrial sectors with a branch or joint venture	All possible sectors in which it is possible to create a joint business
Strategy	Offensive, absorptive and individual strategy	Individual and offensive competitive strategies
Pricing	Market and intra-company pricing of the technology package	Market pricing of the technology package
Goal	Increasing turnover and maximizing profits	Inclusion of the country in global chains of TNCs

Source: Developed by the authors

As shown in Table 1, the approaches to technology transfer in developed countries are quite different from those in developing countries. Today there are six technological models of development, which are used in the economies of different countries. In particular, the most developed countries have the highest technological level, which includes the use of piece intelligence, biotechnology, nanotechnology and thermonuclear energy (Zakharchenko & Medvedeva, 2014). The difference in systems is explained by the fact that developed countries are currently working on the sixth technological mode, and developing countries mainly use the forth level, where the automation of production processes takes place.

According to Zakharchenko & Medvedeva (2014), in the USA and Japan, the share of the economy corresponding to the sixth pattern is up to 10%. China is also actively moving in this direction, which has allocated more than $100 billion to acquire innovative foreign technologies. If we estimate the level of economies' readiness to apply advanced technologies, we can say that the average level of readiness in the world fluctuates value of 0.45 from 1. At the same time, the average index of developed countries is at the level of 0.8, while the level of developing countries is approximately 0.3, as shown in Figure 1.

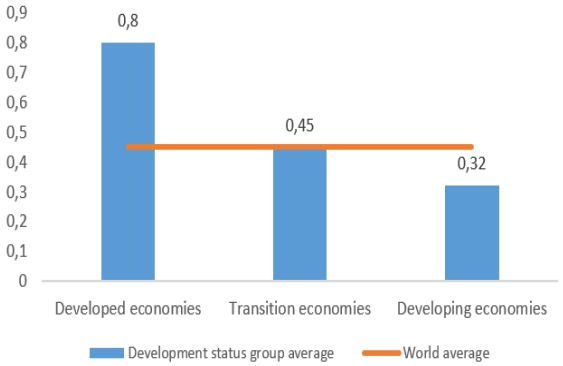

Figure 1: Average advanced technology readiness index by country development level

Source: UNICTAD, 2021

In developing countries, according to a number of scientists, the share of the fifth mode, characterized primarily by the mass transition to digital information transfer technology, the widespread use of electronics and microelectronics, nuclear energy, satellite communications, the Internet, and innovative

technologies in production does not exceed 10% (Zakharchenko, Medvedeva, 2014), which influences the low index value.
Industrial technologies and production in developing countries correspond to the fourth technological mode with elements of the fifth mode, with imported equipment and technology. Today, developing countries are only setting the fourth stage by importing technology. The future of developing countries will depend on technological readiness to use the fifth and sixth technological modes, the driving sectors of which will be nanotechnology, biotechnology, new medicine, robotics, and other technologies.

If we conduct a study of readiness to use advanced technologies for the countries included in the sample, we can see that most of them are classified as above-medium readiness levels. Only Russia has a high level, which ranks 27th in the overall readiness ranking. It is necessary to designate that the main components of the indicator are: spending on scientific and technological researches, condition of information and computer technologies in the country, level of competence and necessary knowledge for management of new technologies, level of industry and development of the financial sector. The rankings for all these indicators are shown in Table 2.

Tab. 2: Rating of developing countries on the level of readiness to use new technologies and its components

Country	R&D ranking	ICT Ranking	Skills Ranking	Industry Ranking	Finance Ranking	Total Ranking
Russian Federation	11	39	28	66	45	27
Turkey	27	75	63	78	49	55
Romania	34	44	70	38	115	45
Ukraine	39	66	84	71	13	53
Kazakhstan	56	62	42	75	114	62
Bulgaria	66	53	48	41	73	51
Croatia	76	46	39	47	66	52
Georgia	87	71	56	81	56	79
Belarus	91	45	35	63	109	59
Montenegro	111	55	37	97	78	70

Source: UNICTAD, 2021

It should be noted that in the overall rating of readiness to use advanced technologies, the first place among the sample countries is occupied by Russia, which has a large gap from the other countries. Today Russia ranks 27th in the global ranking, while Romania ranks 45th and Bulgaria, Croatia, Ukraine, Turkey and Belarus occupy 50-60th positions in the global ranking. Among the surveyed countries, Georgia, Montenegro, and Kazakhstan have the lowest score.

The most important component of the rating is the level of spending on research and technology development. Having conducted a correlation analysis, there is the highest level of correlation between the final indicator and the level of research – 0.78, while for others, it is 0.2-0.6. At the same time, if we make a rating of countries by the indicator of technology development, the situation here will be slightly different. Russia is still the leader in development, but Turkey, Ukraine, and Kazakhstan have significantly increased their positions in the rating.

The formation of the indicator of production of innovative technologies occurs mainly in the business environment at the expense of transnational corporations investing in the development of their business. Developing countries hope not only to import more efficient foreign technology through foreign direct investment (Elgin, 2021) but also to increase the productivity of local firms through technological externalities:

- demonstration effects: local firms can adopt technologies introduced by multinational firms through imitation or reverse engineering.
- labor skills dynamics: staff training or work experience in a multinational firm can transfer important information to local firms, facilitating technology diffusion.
- vertical linkages: multinationals can transfer technology to potential suppliers of intermediate goods or buyers of their products.

Global innovation networks and open innovation offer developing countries new opportunities for better access to technical information. Observations show that global innovation networks are growing in countries with strong R&D capabilities, effective funding, and strong public governance. Indeed, today's innovation network partners are predominantly located in industrialized economies, with growing participation in large emerging economies. Similarly, firms and universities with scientific and technical personnel working in existing research programs perceive the information presented through open innovation. This fact underscores the importance of investing in educational and research skills and competencies in developing countries seeking to move closer to the global technological frontier and international innovation.

According to statistics, Russia spends more than $40 billion in technology production and research, with $24 billion spent by businesses (mostly multinational companies), $12 billion by government agencies, and only $3.9 billion (9.6%) by educational institutions. Today, Russia has the greatest scientific potential among developing countries, as the number of researchers per 1 million people is 3,075 (in developed countries, the figure is from 4,000 people). Turkey is also a country that invests heavily in the development of new technologies. Turkey's expenses on R&D according to data of 2020 make up $15.9 million; thus, unlike Russia, in Turkey, much money is allocated for development in universities – $6.4 million (40.2% of the total amount), while the state uses $1.5 million. In other countries, indicators of investments in the development of technologies are much lower. However, Ukraine, which invests about $3 million in technologies, stands out from the list. At the same time, there is not enough funding for university programs of innovation development (5.7% of the total amount), businesses and government spend basic funds.

Let's consider the expenses of developing countries on R&D in Table 3.

Tab. 3: Investments of developing countries in R&D

Countries	R&D spending in $mln	R&D spending by Business, $mln	R&D spending by Government, $mln	R&D spending by universities, $mln	Number of researchers per mln inhabitants
Russian Federation	40360	24058	12302	3947	3075
Turkey	15933	7931	1544	6457	1160
Ukraine	3005	1694	1137,1	173	1023
Romania	1569	650	674	238	903
Bulgaria	1005	660	248	88	1821
Chroatia	732	353	190	188	1437

Kazakhstan	714	262	233	158	798
Belarus	907	562	239	105	n/a
Georgia	97	0	11	63	1059
Montenegro	37	13	7	13	671

Source: UNESCO, 2020

In general, it should be noted that the state can receive new technologies that are not used in other countries through investments in university development, while business accepts global technologies already used in the world (Li & Tang, 2021; Koo & Cho, 2021). Thus, those countries that invest most in the development of technology at the level of universities, laboratories, and research centers will significantly improve their competitiveness level compared to other countries. For example, today, Turkey, Georgia, and Montenegro are among the listed countries which actively invest in university developments.

Despite the fact that some countries allocate small amounts of money for technology development, it does not mean that these technologies do not affect the development of the economy. One of the main indicators, which shows the impact of new technologies on the economy is the ratio of spending in GDP of the country. Having analyzed this indicator, let us make a graph (Fig. 2).

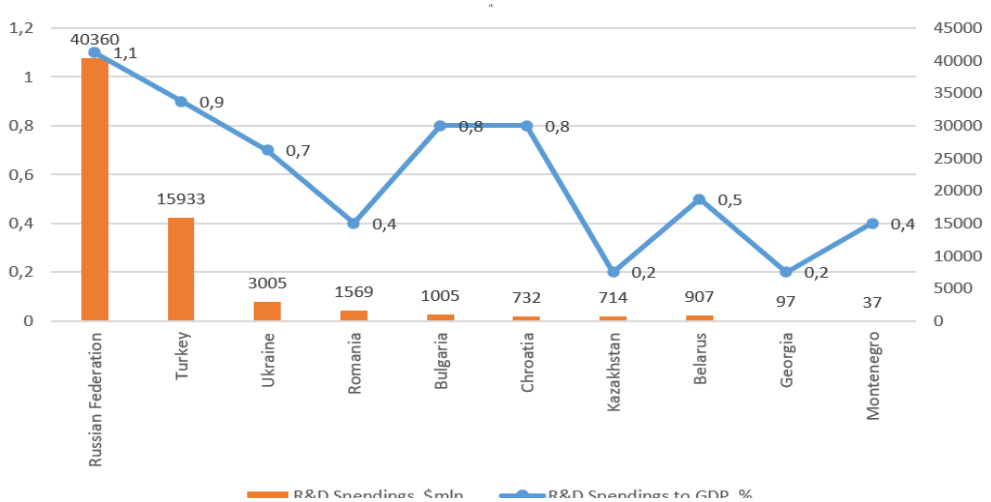

Figure 2: Comparison of R&D expenditures with their share in the country's GDP in 2020

Source: UNESCO, 2020

Figure 2 clearly shows that the size of investments in new technologies does not indicate the activity of research in the country. In particular, another ranking of countries in terms of the share of R&D expenditures in the country's GDP can be made based on the results of the study of this indicator.

According to the analysis results, we can form three groups of countries with high, medium, and low potential for developing new technologies. The countries with high potential include Russia, Turkey, Bulgaria, Croatia. The countries with an average level of potential are Ukraine, Belarus. Finally, countries with low potential include Romania, Montenegro, Georgia, and Kazakhstan.

The impact of technology transfer on the development of developing countries cannot be assessed in general terms, because here the dynamics and structure of the indicators must be studied separately for each country. Let us study the impact of technology transfer on the development of Ukraine (table 4).

Tab. 4: Dynamics of technology transfer, innovation activities and their ratio to GDP of Ukraine for 2014-2020

Indicator	2014	2015	2016	2017	2018	2019	2020
Technology transfer / GDP, %	0,004	0,004	0,004	0,004	0,003	0,003	0,005
Innovation / GDP, %	0,491	0,698	0,975	0,306	0,342	0,358	0,363
Annual growth of technology transfer, %	15,1	31,6	34,2	-15,2	12,2	74,3	15,1
Annual growth of innovations, %	79,5	68,2	-60,8	33,6	16,8	7,1	79,5
Annual growth of GDP, %	26,3	20,4	25,2	19,3	11,7	5,5	26,3

Source: Developed by the authors

Considering the dynamics of the technology transfer indicator in Ukraine, we can see its rapid positive trend except in 2018, when there was a decrease in the technology transfer activity (see. Fig. 3).

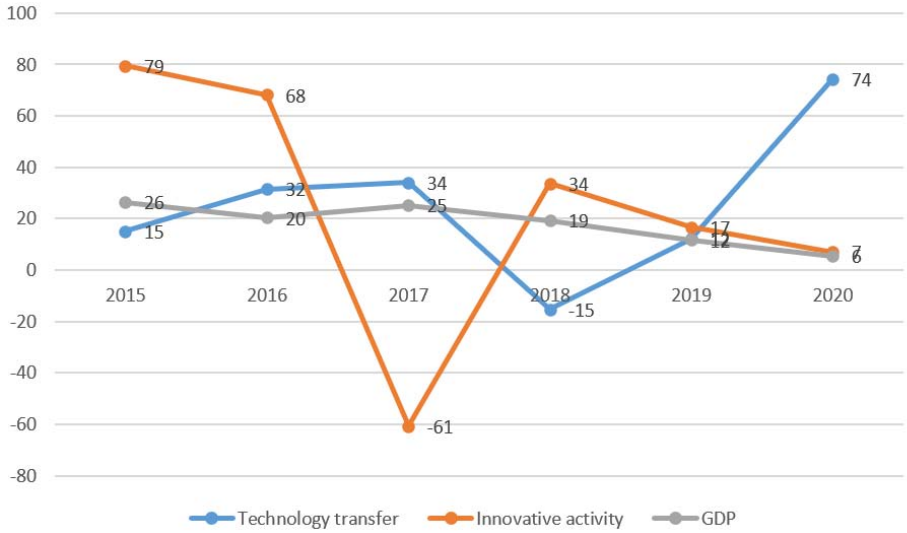

Figure 3: Annual growth of spending on R&D, innovation and GDP in 2015-2020, %

Source: UNESCO, 2020

The trend of the technology transfer indicators and innovation activity indicators during the analyzed period is quite different; the comparison of these indicators shows a weak correlation (0.14) (see Tab. 5).

Tab. 5: Result of the assessment of the relationship between indicators of technology transfer, innovation and GDP of Ukraine for 2015-2021

Indicator	2014	2015	2016	2017	2018	2019	2020	Pearson's correlation coefficient
Technology transfer, mln UAH	64,9	74,7	98,3	131,9	111,8	125,48	218,74	0,14
Innovation activity, mln UAH	7695,9	13813,7	23229,5	9117,5	12180,1	14220,9	15225	
Technology transfer, mln UAH	64,9	74,7	98,3	131,9	111,8	125,48	218,74	0,82
GDP, bln UAH	1566	1979	2383	2982	3558	3974	4194	
Technology transfer, mln UAH	x	64,9	74,7	98,3	131,9	111,8	125,48	0,92
GDP, bln UAH	x	1979	2383	2982	3558	3974	4194	

Source: Developed by the authors

The relationship between technology transfer and GDP of the country is more clearly traced; the correlation between the indicators is (0.83).

Let's take into account the fact that any introduction of technology requires a certain amount of time, which does not allow a full measure of the impact on the economy in the year of investment in advanced technology. So, we can also estimate the relationship between technology transfer and GDP obtained in the following year. This relationship is even denser, with a Pearson coefficient of (0.92).

Thus, on an example of the analysis of the influence of transfer of technologies on the economy of Ukraine, it is possible to draw a conclusion that development of the economy of the country depends on the transfer of technologies, thus more effect from the transfer of technologies the economy will be felt in the following year after investment.

5 Discussion

Recent studies of the impact of the transfer of technology on economic development in 2022 are mainly devoted to the study of the transfer of technology in different industries. In particular, the issues of technology transfer in the educational process are actively investigated. Many scientists (Mahmoud e*t al*., 2012; Kasych, 2020; Dahlman, 2007; Hoekman *et al*, 2005; Xiaokan *et al*,.2011) have studied the problem of technology transfer in developed countries. It is possible to highlight their common idea that technology transfer is crucial in developing economies, innovation, and competitiveness. Most researchers argue that universities, which were the leading suppliers of the invention in industrialized countries, are of great importance in technology production. They also have been conducted to show the effect of university developments, which is expressed by additional revenues from the acquisition of licenses and patents (Koo & Cho, 2021; Li &Tang, 2021). Today, in the period of globalization, the gap between educational programs and the technological level of the economy is very large. Therefore, the primary source of technology is its transfer from developed countries. In 2021, a new research topic emerged during a period of active coronavirus control: technology transfer in medicine (Defendi & Santiago, 2021). Given the dependence of economic processes on population activity, technology transfer for the treatment and prevention of coronavirus and future diseases is currently the most valuable compared to technological innovations.

6 Conclusion

Advanced technology is a new link in the development of economies, which can create economic and social benefits more effectively and quickly than the neoclassical theory of evolution based on the accumulation of capital. Developing countries are mainly recipients of technology from developed countries, with the consumption of technology that is at a mature and declining stage of development does not allow economies to grow more dynamically. Those developing countries which actively invest in innovative technologies have a high technological potential and, consequently, the potential for economic development.

The gap between the use of advanced technologies of developing countries and developed countries is rather large, about 0.5/1, which is explained by the different levels of the technological mode of countries. While developed countries are transitioning to artificial intelligence and nanotechnology, developing countries are still automating production processes.

The development of advanced technologies is influenced by different factors: scientific and technological research, the state of information and computer technology in the country, the level of competence and the necessary knowledge for managing new technologies, the level of the industry, and the development of the financial sector. However, the most pronounced is the influence of scientific and technological research.

The main sources of technology transfer are transnational companies that implement their know-how in the organization of production processes in their subdivisions in developing countries.Business is the main source of obtaining new technologies, but technologies obtained from universities are more effective in creating technologies, as they will be at the initial stage of their development, which will allow the country to increase its level of competitiveness.

The indicator of investment in scientific and technological research does not speak about the country's innovation potential. The ratio R&D / GDP will be more indicative. Transfer of technologies has a strong influence on the country's GDP. The effect on economic development will be stronger in the next year after investment in innovations.

The study's practical significance comes down to the provision of tools for developing countries, the main of which is primarily the production of technology and its transfer. The research will also be promising from increasing the productivity of technology in educational institutions in developing countries and the transfer of medical technology as the primary tool to support the economy in the period of quarantine restrictions.

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Primary Paper Section: A

Secondary Paper Section: AE