# **UDC 31**

# Stratification of the political field of space research application in education

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#### Abstract

From an economic point of view, space is a resource that is used for earthly needs, and the space industry is a specific industry (like aviation or geological exploration). The subject of consideration are the regularities of economic processes between the subjects of CD, flows of material values and cash. At the same time, they use different levels of consideration: macro-, meso - or microeconomic and analyze the impact of the space industry on the country's economy or the performance of individual enterprises. This article does not provide a complete overview of this issue or an exhaustive analysis of the economic component of the CD. Its focus (Why Space?) determines the priority of questions about what costs today, what gives and what can give in economic terms, space activities in terms of space prospects of Russia. Therefore, the results of various analytical works are used below to help form the basis for answers to these questions.

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#### Keywords

Politics, space, practice, structure, dynamics, development.

PhD.

### Introduction

We can also talk about the different positions from which the economy of the CD is considered. Since the beginning of the space era, calculations of the payback of space settlements, delivery of minerals to the Earth, supply of energy to the Earth have been popular. With the end of the cold war and the military-strategic confrontation between the superpowers, the problems of commercialization of space programs and technology transfer to civilian industries became urgent [Sassen, 2017]. Space agencies have special programs for the implementation of space developments

in earth technology (spin-off), as well as the use of breakthrough solutions of the earth industry for space needs (spin-in). An indispensable attribute of the management of space programs was the evaluation of their socio-economic efficiency. These trends are due to the increasing focus of programs on consumers compared to the traditional task of strategic dominance. Let us note, however, following the author [Жданов, 2005], that even today the economic aspect of space programs is not always decisive: "Physics Enables, Politics Dictates, Economics Sustains". Many programmes, as at the beginning of the space age, are politically motivated or motivated by considerations of military and strategic superiority. Nevertheless, the economic evaluation of planned missions is now a priority decision-making criterion, and the evaluation of the effectiveness of programs is carried out by authoritative research centers [Landolt, 2010].

## Main part

First, let us focus on the fundamental question of the economic impact of space programs and their prospective profitability. Objective statistics show a constant increase in the list of countries with space programs (about 40 in 2018), i.e. spending budget money on space on a permanent basis. Moreover, the space giants (USA, EU, China, Russia, Japan) maintain an almost constant high level of space spending, despite the crisis periods [Capanema Alvares, & Barbosa, 2018]. At the same time, countries with dynamic economies (India, Brazil, Israel, Argentina, Vietnam, Turkey) demonstrate a desire to steadily increase space capabilities. The tendency to invest significant funds in certain (priority) types of space technologies is also typical for countries seeking regional leadership (Turkey, Iran, Egypt, UAE). From this fact, it can be concluded that most governments attribute economic growth to the application of space technologies and therefore spend significant budgetary funds on space programmed [Fischer, 2006].

At the same time, skeptical analysts argue that space is the destiny of powers that seek global domination; flights beyond the earth's atmosphere increase the image, strategic importance, etc., but do not assume a significant economic effect. Indeed, almost all significant space programs today are not profitable and are supported by budget funding [Zhang, & Nyíri, 2014]. Those that have gone into commercial use include the huge hidden costs of past years: telecommunications and navigation projects use cold war-era technology transferred by the state to the private sector. The strategic orientation of modern international programs is aimed at the exploration and development of outer space (from earth orbit to the moon and Mars), and the thesis of the 1980s on the industrialization of space, modern space policy has postponed [Vicino, & Fahlberg, 2017]. The current discussion of commercial prospects for space exploration covers mainly two areas: space tourism and the use of small spacecraft. It is necessary to recognize that in General it is unrealistic to speak about profitability of

Astronautics soon: from possible resources of space (energy, raw materials, unique technological conditions, etc.) the person learned to use only the spatial factor. A possible breakthrough in the commercialization of CD should be associated with two conditions, the implementation of which has been outlined in recent years: a sharp decline in the cost of launch services and the arrival of private capital in space [Magin, & Gei $\beta$ , 2019].

In order to answer the question of why to develop an industry that today does not give a rapid and tangible economic effect, it is not enough to look at the current space strategies and programs (see Chapter 7 for details). Official documents provide forecast data on the introduction of new technologies and information systems, stimulation of non-space industries, solving global problems and other, mainly indirect effects. Meanwhile, if we sharpen the problem and find out whether the introduction, for example, of medical methods for diagnosing the health of astronauts will pay for the corresponding section of the lunar program, the answer will be negative [Raco, Henderson, & Bowlby, 2008]. Then why are a dozen countries investing in a long-term lunar exploration program? The answer to this question is generally known to managers who predict long-term economic prospects.

In a popular form, this problem is analyzed by E. Reipert in the economic bestseller "How rich countries became rich, and why poor countries remain poor" [Radice, 2016]. Summary of his logic, which is based, among other things, on the provisions of evolutionary economic theory. Schumpeter and the works of K. Perez (in particular), is reduced to the followin [Edwards, 2016]. The wealth of the developed countries is since for a long time (decades and centuries), the ruling elite founded, subsidized and protected dynamic industries and services, that is, the economy. production structures in areas where technological progress has been concentrated [Sassen, 2005]. Hence, economic growth was associated with certain types of economic activities in which a joint product of the division of labor can arise, increasing returns (reduction of production costs), synergies (people of different professions work together) and new knowledge [Radice, 2016]. The emergence of such a product is due to the main driving force of economic growth-innovations and inventions that create a demand for investment capital. At certain moments, large waves of innovation disrupt the homogeneity of technological development and create technological breakthroughs (they are called the change of socio-economic paradigm). In table. 4.1 the scheme of such breakthroughs in the history of mankind from the work [Жданов, 2019], in which the modern stage is associated with information and communication technologies and space, is presented. It is important to note that the paradigm shift leads not only to an explosive increase in productivity, but also to a change in society itself outside of what is called the economy. The balance of power in the world, the political system, the quality of life of citizens, the attitude to public institutions can change [Sen, 2010].

Since about 2000, there has been a landmark phenomenon in the global space economy – private sector spending has exceeded public spending. Currently, the growth of the space industry is determined mainly by the commercial sector, which has a turnover twice as large as the state. This effect is typical primarily for the United States, where satellite television, Internet services and some other services are rapidly developing, which are sold to an increasing number of ordinary consumers [Zieleniec, 2018].

According to the Directive of us President Barack Obama, the commercial sector of CD is"...space goods, services or other activities of the private sector, which carries a significant part of the investment risk, operates using typical market incentives to control costs and optimize the return on investment and has the capacity to offer these goods or services to existing or potential non-governmental clients" (CIT. according to [Dikeç, 2007]).

If we consider the space economy from the point of view of the system of national companiesleaders in the commercial sector, the picture is very different from that shown in the diagram (see Fig. 4.1). The United States in this ranking retains its place as the leader, but then the picture changes: the top five include France, Britain, Japan and Germany, China is in 10th place, and Russia drops out of the list. This is because today budget spending forms only a quarter of the market. The difference between the" old "and the" new " cosmos acquires visible features [Swerts, 2017].

In terms of investment structure, "old space" is a space industry dominated by government agencies and budget funds, and "new space" is a business that addresses the needs of consumers, in which the priority is to reduce prices and produce goods and services in an entrepreneurial spirit. During the conference on the problems of the "new space" (June 2018) [Jones, & MacLeod, 2004], a discussion was held on what sphere will be decisive in the development of the space economy. One scenario assumes the main driving factor is commercial flights into space. Another is the increase in application services such as remote sensing. And although the new cosmos is now presented as a not entirely understandable world, filled with unexpected technological startups, its future will undoubtedly affect the appearance of the CD in the coming years [Morton, 2012].

It is based on three major areas: 1) commercial orders for the creation and launch of satellites (including infrastructure maintenance); 2) commercially provided services of satellite communications and monitoring operators, as well as related user services and applications; 3) satellite navigation services and equipment. The capital intensity and complexity of the projects lead to a high level of consolidation of the commercial space sector, where large vertically integrated corporations, usually transnational, operate. Thus, the companies of the first four of the fixed satellite markets (Intelsat, SES Global, Eutelsat and Telesat) account for more than 40 % of the turnover of this industry (CIT. by [Willems, 2019]). In the sector of commercial space images, at least a third is the share of the market leader — the American company DigitalGlobe. At the same time, while in the earlier stages the development of new space companies was supported mainly by individual private investors (as in the case of Blue Origin or SpaceX) and government grants, recently venture funds have begun to play an increasingly important role. In 2011-2015, they accounted for more than a third of investments (\$2.3 billion). For comparison, over the same period, grants and investments totaled \$328 million. in 2015 alone, a record amount of funds was raised - \$1.8 billion, which is comparable to investments in the medical technology sector, which is among the 10 most attractive industries for venture investors (\$2.6 billion in 2014) [Yu, 2018].

The problem of commercialization of CD is hardly fair to consider as a gradual replacement of" old "space with"new". There is a common comparison of modern space with aviation at the beginning of the 20th century: the arrival of private capital in the organization of postal and then passenger transportation marked the birth of a new branch of the economy. In space, by many signs, this process is more complex and contradictory, with serious limitations, and public policy plays a key role [Kweya, 2017]. Let us mention the landmark government decisions that decisively stimulated commercial space. The us government's rejection of the chosen availability of GPS signals (valid until 2000) dramatically increased the number of commercial users (the approximate ratio of commercial to military users quickly turned out to be 100: 1). In 2015, ESA launched a policy of providing Santmel satellite remote sensing data free of charge; as a result, the revenues of companies (and budget allocations) providing information services based on This data to end-users have increased dramatically. Modern trends in CD commercialization are largely explained by the fact that commercialization has been beneficial to the United States, as their role in the world space markets has become dominant. Obviously, in the near

future, such a mechanism of commercialization, when States transfer technologies developed for budgetary funds to the commercial sector, will prevail [Hoekstra, & Pinkster, 2019].

The policy of commercialization of space economy meets quite understandable difficulties. The main risks of space economy development are well known high level of initial capital investments in ground infrastructure and production facilities, low or zero profitability of most projects, risks of irretrievable loss of created facilities and some others [Graziano, 2010]. There are also purely technological limitations to the development of commercial CD. Here are some of them, using the opinions of different experts. First, the existing capacity in the world can provide up to 140 launches per year, and the needs for today-almost 2 times less. Secondly, there is a critical density of low orbits: their further saturation may exceed the natural purification due to combustion in the atmosphere. Third, once space technology was used for the benefit of a wide range of consumers, competition came into play [Rees, & Lord, 2013]. For example, in telecommunications in the 1980s, satellites provided 10 times more traffic at the yen 0.1 of the cost of an underwater cable; since 2003, fiber optic cable gives the same capacity as satellite. In the field of remote sensing, the use of GPS has made aerial surveillance available, so the demand for remote sensing information is estimated to be much lower than previously. In General, if we compare the estimates of the commercial sectors of 2006 and 2017 according to the space Foundation [Boyle, & Mrozowski, 2019], we can find a significant (many times) exceeding the expected volumes of investments and realized [Elmhirst, 1999]. To this list can be added a failed program of commercialization of work on the International space station and unrealistic plans to transfer the ISS for commercial use after 2020.

However, judging by some trends (especially in the United States), the potential investment opportunities of the space economy are now beginning to exceed these risks. For example, over the period 2000-2017, more than \$16 billion was invested in space startups, and 2/3 of this amount - in the last 5 years. In 2016, Seraphim Capital, the first private venture capital Fund group, was established in the United Kingdom and invests exclusively in space ecosystem development projects. [Clarke, Jennings, Moss, & Stoker, 2017]

Summarizing the results of the development of the commercial space sector in the period 2006-2015, [Thrift, 2007] it is noted that in General it is characterized by a stable environment and growth prospects. Space Foundation [Bhimji, 2016] predicts a doubling of its volume and a further increase in its share by 2024 — up to \$516 billion and 86 %. At the same time, despite the General upward trend, the dynamics in some areas is uneven. The basic industry is fixed and mobile satellite communication systems — in 2016, they accounted for half of the current global orbital group, and more than 2/3 of this number belongs to commercial operators [Erensü, & Karaman 2017].

### Conclusion

The cost of launching payloads into space is critical to the entry of private capital into space activities. The resources of the Solar system will enter the sphere of the real economy with the provision of cheap and reliable access to space. In the US, a group of experts put forward the idea of implementing such an initiative — CRATS (Cheap & Reliable Access to Space). They believe that the way to create and implement large government programs, as well as maintaining the functioning of the free market (laissez-faire), will not solve this problem. It was proposed to support not thematic areas of activity, but an industry that can solve a technological problem: Solutions not Programs or Build an Industry, Not a Program. An example of such a problem is a system of vehicles or an aerospace aircraft.

It should be noted that the problem of commercialization occupies one of the Central places in the national space policy of the United States and Europe. There is a growing involvement of business in research and development under government programs, as well as an increase in the volume of technology transferred to the private sector. This strategy improves the efficiency of projects in breakthrough, high-risk areas, as well as, by enhancing the exchange of knowledge and resources, helps to strengthen technological capacity and accelerate the process of creating dual innovations (with high commercial potential). Reacting to changes in the internal environment of the world space activity (technological shifts, growth of potential of commercial players), the concept of commercialization in the USA and Europe evolves from vertical to more distributed, horizontal, relying on an extensive network of participants and uniting all sectors: institutional, industrial and academic.

The problem of increasing the efficiency and development of the "new space" is not limited to the involvement of private capital (it is known, for example, that the financing of space projects by E. Musk is 70% provided by the NASA budget). The main effect of the development of private initiative in space projects is the innovative development of space technologies and application in the interests of all possible consumers. There are three types of innovation that have a different impact on different sectors of the economy. First, innovations in the space sector, which fundamentally expand the capabilities of space facilities. The most typical example is the development of a system of reusable pH stages, which reduces the cost of running in the future by 10-15 %. Some organizational and management decisions are also known (application of non-space developments, new approaches to quality control). Secondly, a significant expansion of the existing fields of activity (telecommunications, meteorology, astronomy and astrophysics). Thirdly, the emergence of fundamentally new technologies and methods (space surveillance, navigation).

The main influence of space innovation on the economy is the transfer of technology or, more generally, the spin-off mechanism, which has recently been actively analyzed from the point of view of the economic efficiency of space programs. The spread of this practice through the sale of goods and services, the purchase of licenses, technical or scientific documentation forms the basis of the long-term economic impact of space programmes. In a broader sense, the term spin-off reflects all the ways in which products derived from one activity, in this case the space program, are used in another sphere. So it's not just about technology transfer; the introduction of new management methods, changing organizational structures, strengthening cooperation between firms, the use of work in space applications as marketing experience, know-how should also be considered as spin-off effects.

Commercial effects mainly take the form of increased sales of products or services that do not involve significant technological innovation. Space Agency contractors can take advantage of new markets that open up after space programs, for example at the national level (such as ground control stations). In addition, the company acquires a new image associated with space activities, which gives significant competitive opportunities. At the commercial level, ESA programs, more than other programs, allow Contracting companies to establish closer business ties, which then extend to orders outside the space agencies.

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# Стратификация политического поля применения космических исследований в образовании

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#### Аннотация

С экономической точки зрения космос – это ресурс, который используется для земных нужд, а космическая отрасль – это особая отрасль (например, авиация или геологоразведка). Предметом рассмотрения являются закономерности экономических процессов между субъектами КР, потоками материальных ценностей и денежных средств. В то же время они используют разные уровни рассмотрения: макро-, мезо- или микроэкономические и анализируют влияние космической отрасли на экономику страны или результаты деятельности отдельных предприятий. В этой статье не дается полный обзор этой проблемы или исчерпывающий анализ экономической составляющей КР. Его направленность определяет приоритетность вопросов о том, что сегодня стоит, что дает и что может дать с экономической точки зрения космическая деятельность с точки зрения космических перспектив России. Поэтому результаты различных аналитических работ используются ниже, чтобы помочь сформировать основу для ответов на эти вопросы.

#### Для цитирования в научных исследованиях

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#### Ключевые слова

Политика, пространство, практика, структура, динамика, развитие.

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