Administrative and Legal Arrangements for Scientific and Technological Development in Space: the EU's Pattern

Kseniia Kurkova

Ph.D. in Law, Senior Researche, Scientific Institute of Public Law (Kyiv, Ukraine)
E-mail: kurkova_ksenya@ukr.net
https://orcid.org/0000-0002-4259-5511

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The article analyses the traditional model of scientific and technological development in space. The analysis enables to identify of the main regulatory actors and their key instruments, both economic and administrative, applied in their activities to encourage scientific and technological development in the space sector towards long-term and sustainable development.

Keywords: space activities, scientific and technological development, administrative arrangements, subjects, commercialization, know-how.

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Introduction

Global problems and processes, space travel, derive from the socio-economic and technological development of civilization. They can be successfully solved through the interaction of all forces and factors working for the transition to sustainable development. Space activities are of particular importance in this process: it expands the boundaries of our civilization, brings the activities of civilization beyond the globe, as well as a number of worldwide, global problems and processes. If some of them are not solved on Earth, they will continue their cosmic reality. Thereby, globalization will complete its "geocentric existence," and universal problems will find their extra-terrestrial existence (Ursul, 2013; 152).

Technological spin-offs derived from space exploration are important to socio-economic development, technological progress, and humankind's overall benefit. Innovation is, however, not limited to technical fields. Furthermore, new business models and legal innovations are

significant. Investments in innovation are also central to Sustainable Development Goal 9 on industry, innovation and infrastructure (Space, 2020).

Therefore, the right choice of administrative and legal instruments and arrangements that will be applied for scientific and technological development, focus on space knowledge, will help develop a long-term strategy aimed at forming and improving the legal framework that promotes this development, encouraging demand for innovation, strengthening interaction between all entities related to the national scientific and technological field.

Description of the traditional model of scientific and technological development

The traditional model of scientific and technological development (also called the "Euro-Atlantic" model) (Davydenko, 2014) is typical of EU countries, and it is characterized by the application and combination of basic instruments, both economic and administrative, which include:

a) support (grants, investment incentives, tax benefits, funding from the EU budget for innovation programs and projects, etc.);
b) diffusion (technology transfer, commercialization of scientific and technological results, public procurement program, etc.);
c) infrastructure (business incubators, technology parks, innovation centres, providing conditions for the activities of entrepreneurs-innovators, licensing, patenting, copyright protection);
d) institutional (both supranational and national regulators);
e) legal (programmes, projects, strategies, public policies).

These arrangements and instruments are used by three key groups of actors: the public sector, involving actors at two levels — the EU, as a supranational entity, and the public administration of Member States; scientific and education sector (leading universities and research centres) and the commercial sector.

Evidently, each actor chooses their own unique instruments. However, regardless of what forms and methods are chosen, they should be as effective as possible and lead to sustainable scientific and technological development. The activities of public sector entities will be briefly analysed with an emphasis on the specific instruments and arrangements inherent in each of them.

Over the last decade, the EU has faced a number of challenges due to the financial crisis. The effects of the recent crisis, related to the pandemic and the introduction of various restrictions, cannot be yet assessed, as no country in the world has stopped the quarantine measures. Therefore, it is evident that sustainable economic growth is not easy today or in the future.

As early as the 1990s, the world order changed from bipolar to multipolar. And East Asian countries — Korea, Japan, China, and India — have become EU competitors, except the US, which had an absolute competitive advantage in knowledge-based industries. Therefore, the EU leadership has decided on the need to develop and adopt policy documents which provide for the updated science and technology policy, which will address the current economic downturn and create economic opportunities for the future, through various legal and administrative (institutional, financial, fiscal, regulatory) arrangements.

The European Commission proposed the ten-year strategy "Europe 2020" (Europe, 2010), adopted in 2010, and created the Innovation Union (IU) (Innovation, 2020). Already in 2014, "Horizon 2020" programme was adopted and became one of the biggest programs in the world in the field of science, technology and innovation with nearly €80 billions of funding, which the EU has created to support and promote research for scientific and technological development (What, 2020).

Compared to the previous programs, these are revolutionary due to the introduction of the theory of "open innovation." Open innovation is a broad term that encompasses several different nuances and approaches. Further focus is on two key elements of the latest concept of open innovation, entitled by scientists as "open innovation 2.02":

1. The users are under focus: invention becomes innovation in case of users' involvement in its development, particularly important sources of in the early phases of industry development, while firm involvement is typically needed for the and scaling up in the industry. The terms such as "user-centric," exemplified by von Hippel, underline the role of citizens and users in innovation processes as the "distributed" sources of knowledge. This participation of the public is one of the program goals of responsible research and innovation in Horizon 2020. In this context, the term "open" has been used as a synonym for "user-centric" (Chesbrough & Bogers, 2014).
2. Creation of a well-functioning ecosystem that allows collaborative creativity becomes important for open innovation. In this ecosystem, relevant stakeholders are collaborating along and across industry and sector-specific value chains to co-create solutions for grand socio-economic and business challenges. This co-creation process should join forces at the EU, the Member States and regional level (Boosting, 2014).

According to statistics, as of the end of 2019, China and the United States were two economic leaders in the world that also used the concept of "open innovation" through an effective patenting system, an effective platform for technological cooperation. In addition, due to licensing trade and commercialization of inventions, they would make big profits. For example, the United States, using an effective system of protection of intellectual property rights and commercialization of inventions, annually receives 75-80 billion dollars income; this is the most powerful source of investment in the future (Ukraine, 2017).

Moreover, this concept "open innovations 2.02" defined the entire EU policy for the next decades. It was most actively implemented in the strategy "Horizon 2020." Its primary goal is the same as the core science and technology policy of the Innovation Union, is to invest approximately 3% of the EU's GDP into science and technology innovation, improve the competitiveness of science and technology research in Europe, and boost research and development to withstand the competitive pressures of the global market (Junic & Jaewook, 2019).

In view of current world trends (cosmization, globalization, and digitization), the European Commission, in order to promote the creation of an ecosystem of open innovation in Europe, has developed the following ways to encourage scientific and technological development in space:

a) to join the ideas, knowledge and efforts of different actors (private, public or civil institutions) to create cooperatively new products and find solutions to meet social needs;
b) to create shared economic and social values, including a user-centric approach;
c) to benefit from existing trends, such as digitalization, international cooperation and cooperation.

An analysis of European legislation on the activities of various EU institutions that contribute to scientific and technological development in the field of space enables to conclude that:

a) the EU legal framework requires systemic reform to create a regulatory environment that removes barriers to innovation and encourages entrepreneurial innovators, while rules and standards should keep pace with rapidly changing technologies. Fewer regulatory barriers will promote space science and technology development and increase investment in innovation;
b) private investment increases, that is, comparing the innovative ecosystems of the EU and the US, there is an impressive difference in the amount of venture capital available. In 2016, venture capitalists invested about 6.5 billion euros in the EU (Cherowbrier, 2020) against 39,4 billion euros in the US (Rudden, 2020). The absence of sufficient venture capital prevents funds from keeping pace with the investment needs of firms as they increase. Europe has fewer "unicorns" with rapid growth (start-ups that have reached a market value of more than $1 billion) than the United States and China have. In 2017, there were 26 in Europe compared to 109 in the US and 59 in China (Science, 2020). European venture capital funds are not large enough to attract large institutional and private investors, nor are they large enough to finance companies as they grow: venture capital funds in Europe average about 56 million euros (2016 European, 2017), while in the US, they average three times more. In addition, 90% of EU venture capital transfers are concentrated in only eight Member States, and cross-border investments are insignificant: this fragmentation hinders the attraction of more funds. Another problem is the sources of venture capital financing: compared to the US, the EU venture capital receives much more public funding and much less private investment;
c) the innovative impact of Horizon 2020 strengthens, including through improving synergies with structural funds.

Let us briefly review all three areas and highlight the arrangements and instruments applied by the EU leadership to promote scientific and technological development in space.

The areas of scientific and technological development in space

With regard to the reform of the EU's legal and regulatory framework, the Community's leadership intends to use the following:

1. Scientific advice prior to political decision-making. The mechanism should provide timely independent, high-quality scientific advice prior to the adoption of a legal regulation and its introduction into policymaking. This will enable to improve of

the quality of EU legislation in line with the agenda for better administrative and legal regulation. To do this, in the EU, the group of 7 Chief Scientific Advisors was appointed in November 2015 after an open competition. The ultimate goal of SAM is to develop for Europe a better policy based on scientific facts that will contribute to solving global problems by consensus (How, 2018).

2. Using "innovative agreements" The mechanism implies that due to the rapid growth in scientific and technological development, under which the legal and regulatory framework has not been updated and implemented, innovations with valuable social and economic or environmental potential may be delayed or difficult to realize. To avoid such unintended regulatory effects, the EU has come up with the idea of allowing innovators to question EU rules, which have been identified as obstacles to innovation. This will be done jointly with the competent EU authorities and possibly also with the authorities of the EU Member States through "innovation agreements," which will be a new way to address in a pragmatic, open and transparent manner. Innovative agreements will take the form of voluntary cooperation between innovators, national, regional and local authorities, and the EU Commission. The idea brings together innovators and regulators to agree on how specific innovations can be embedded in an existing regulatory framework.

The instruments and arrangements applied to increase private investment in science and technology are, as follows:

1. Analytical and advisory, for example, in March 2015, the Horizon 2020 Policy Support Facility (PSF) was established to give the Member States and countries associated practical support to design, implement and evaluate reforms that enhance the quality of their research and innovation investments in national systems. Within the framework of the Fund, pilot projects have been launched, for example, in Bulgaria, Hungary and Latvia. For example, the study in Latvia enables to conclude that despite evidence of progress and strong political will, Latvia's research, innovation and higher education system remains connected to EU funding cycles, making longer-term planning difficult (Research, 2020).
2. Financial, through venture capital funds and other financial institutions, for example, InnovFin, financing tools thereof are loans, guarantees and equity-type funding, which can be tailored to innovators' needs. Financing is either provided directly or via a financial intermediary, most usually a bank or a fund. InnovFin is available across all eligible sectors in the EU Member States and Associated Countries, under the EU Research and Innovation programme Horizon 2020 (InnovFin, 2020).

The maximum effect of EU policies, research and innovation programmes (including Horizon 2020) and other sources of public funding requires to simplify and design synergies between them so that the best projects can easily access financing from different sources. Moreover, identifying the best innovations for financing is one of the challenges that the EU Commission intends to address, including through the following instruments:

1. The "Seal of Excellence," initiated by Commissioners Moedas and Creţu at the end of 2015, is a quality label, awarded to an innovation project as one of the project proposals submitted for funding under Horizon 2020 the EU's Framework Programme for Research and Innovation and which succeeded in passing all the

selection and award criteria but could not be funded under the available budget (New, 2015).

2. Synergies, that is, the greatest impact of investments in research and innovation, can be achieved by combining Horizon 2020 with European structural investment funds (ESI Funds). In other words, the research and business communities will work together with national and regional policymakers and governing bodies to ensure the best quantity and quality of the tools available. Synergies will contribute to the implementation of the Strategies for Smart Specialisation that is necessary for investment in research and innovation within the European Regional Development Fund. Smart Specialization gives priority to investment in research and innovation that exposes the strengths of the regions and thus ensures more efficient use of public funds while encouraging private investment. For example, the Horizon 2020 PSF Peer Review took place from May 2016 to December 2016 in Ukraine. The Peer Review report contains seven headline policy messages to inspire the design and implementation of reforms. The report explains the rationale for each policy message and contains thirty more detailed recommendations on the reforms to be achieved (Commission, 2016).
3. Digitization — EU science, research and innovation policies play an important role in bridging the physical and digital worlds by harnessing the potential of digital and space technologies, such as big data analysis and the Internet, to address social problems through innovative solutions in the fields of health, energy and nutrition, and water. These four fields are priorities. Digitization should also facilitate the creation of new business models and the adjustment of existing ones because "physical and digital" innovations often entail new solutions that blur the boundaries between products and services, consumption and production, online and offline.
4. The balance between minimizing bureaucratic arrangements for participants and effective control over taxpayers' funds invested. Horizon 2020 was designed to facilitate access to funding and reduce the administrative burden on project participants. This resulted in significant facilitations compared to the previous frameworks, including a very simple cost-recovery model, streamlined examinations and audits, and entirely electronic management of grants through the participant portal.

Therefore, EU policy aims to go beyond traditional thinking in order to support a political environment and ecosystem conducive to scientific and technological development in the space sector, which should unleash the strengths of the regions and, hence, ensure more efficient use of public funds while encouraging private investment.

EU member states' policy for encouraging scientific and technological development in space

The analysis of the various EU Member States' policy documents involved in space science and technology enables to identify common instruments and arrangements, which they use at different stages and which are characteristic of most of the States. These are legislation (including intellectual property protection), financial and fiscal measures to encourage scientific and technological development and innovation. Various innovative structures are particularly popular, such as:

1. Business incubators, technology parks, innovation centres, start-up centres and the like. Despite the wide variation in terminology, the main content of these structures is to seek, select, promote and support entrepreneurial initiatives. The aim is not only to encourage potential founders to set up companies but above all, to improve the success of newly formed companies. The founders should be assisted in transforming their innovative ideas into market-based products, processes, or services. As a regional policy instrument for economic development, these structures are intended to promote the creation of skilled jobs and thus also enhance the attractiveness of the place in order to preserve the existing know-how in the region. The exchange of knowledge, information and technology between science and practice is gradually enhanced through start-up centres. For example, in Germany, there are many new start-ups, such as DueDash (Welcome, 2020), fulfillmenttools (We Enable, 2020), helpcity (Wir, 2020), and Steereon (Steereon, 2020).

Thus, the main instruments for designing various innovative structures of the EU Members States: public relations (seminars, training or contact fairs); competitions with prize funds; assistance in opening and further accompanying; the use of infrastructure (conference rooms, computers, faxes, utilities), advisory services (on business plans or financial matters and, if necessary, referrals to specialized advisors);

2. The status of a young innovation company. In France, for example, this status is granted to small and medium-sized companies operating in the sector for less than 8 years. Scientific and technological activities thereof account for at least 15 percent of total expenditures. This status provides the company with a range of research benefits (Davydenko, 2014).

3. Public and private venture capital funds. For example, in the EU, VentureEU is encouraging capital investment in innovative start-up companies and scale-ups, leading to boosting venture capital available in Europe. VentureEU provides cornerstone investments of €410 million in independently managed venture capital Funds-of-Funds, including €200 million directly derived from Horizon 2020 (the EU investment is capped at 25%) (VentureEU, 2020).

4. Financial benefits. For example, France provides a tax rebate of up to 80%, depending on the company's spending on scientific and technological development (Davydenko, 2014).

Therefore, the EU public sector plays a central role in scientific and technological development and the promotion of open innovation in space by creating a regulatory environment in which all other actors operate: by establishing rules and instruments that can encourage open knowledge flow and cooperation between different actors to commercialize the results of scientific and technological activities; through the creation of a demand for the results of science and technological activities, both through the above-mentioned regulatory means and through public procurement of the above-mentioned results.

Role of international scientific and technical cooperation in promoting scientific and technological development in space

International scientific and technological cooperation is an increasingly important and effective form of contemporary international relations. Considering the high scientific and technological progress in space, no country, no matter how significant its potential in science and technology is, can fully meet its needs for advanced science and technology to produce the full range of its products, constantly changing and improving. It is cooperation in the

development of high-tech products that are an essential part of contemporary international relations in space (Soroka, 2020).

International scientific and technological cooperation is increasingly important both in enhancing the competitiveness of research and innovation systems and in facilitating the production of new knowledge worldwide. In addition, the increasing global challenges require, more than ever, increased international scientific and technical cooperation among actors and sectors to address challenges such as climate change, resource constraints or countering infectious diseases.

In 2016, the Committee on Peaceful Use of Outer Space approved seven thematic priorities in the context of preparing for the Fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE+50), the first of them was a global partnership in space exploration and innovation. The Committee established the Action Team as a mechanism to launch the topic. The Twenty-two States and seven permanent observer organizations joined the Action Team on Exploration and Innovation, producing a report including a series of recommendations (A / AC.105 / 1168, 2018; Space, 2020).

In 2018, on the basis of the Action Team recommendation, the Committee added "Space exploration and innovation" as an item on its agenda (A/73/20, 2018). This document was first considered at the Committee session in 2019, and then States became to share information on, among other things: astronaut programmes; a space exploration innovation hub centre; activities of the International Space Station and the China Space Station; various missions to the Moon, Mars, Venus, Jupiter and asteroids; the planned Lunar Orbital Platform-Gateway and others (Space, 2020). It is important that in support of the idea of open innovations and science, much of this information is available in technical presentations.

The European "Horizon 2020" program is also open for the participation of actors from all over the world. At present, 13 non-EU countries (Iceland, Norway, Albania, Bosnia and Herzegovina, Russia), Montenegro, Serbia, the former Yugoslav Republic of Macedonia, Turkey, Israel, Moldova, Switzerland (partial association), Faroe Islands, Ukraine) are linked to the Horizon 2020, that is, legal entities from these countries participate under the same terms and conditions as EU Member States, including eligibility for funding (Open, 2017). In addition, legal entities from approximately 130 countries (mostly developing countries (Horizon, 2020) are automatically eligible to contribute to funding their projects through the "Horizon 2020" programme. Moreover, organizations from other countries are eligible to participate in the programme if they meet the specified conditions, but they cannot automatically receive funding.

Therefore, openness and interaction with the world (Open Innovation, Open Science, and Open to the World) is a strategic priority for Europe — to create know-how with their subsequent commercialization, to design an appropriate ecosystem for industries involved in scientific and technological development, to address global public challenges and to generate global policies in this field.

Conclusions

The study and analysis of the current administrative and legal arrangements for implementing the traditional model of scientific and technological development in space enable to conclude that:

1. For the traditional model of scientific and technological development in space is typical to apply and combine basic instruments, both economic and administrative, which include: a) support (grants, investment incentives, tax benefits, funding from the EU budget for innovation programmes and projects, etc.); b) diffusion (technology transfer, commercialization of scientific and technological results, public procurement program, etc.); c) infrastructure (business incubators, technology parks, innovation centres, providing conditions for the activities of entrepreneurs-innovators, licensing, patenting, copyright protection); d) institutional (both supranational and national regulators); e) legal (programmes, projects, strategies, public policies).
2. Arrangements and instruments of the administrative and legal framework are used by three key groups of actors: the public sector, involving actors at two level — the EU, as a supranational actor, and the public administration of Member States; scientific and education sector (leading universities and research centres) and the commercial sector.

Therefore, the legal and administrative arrangements for the implementation of the traditional model of scientific and technological development in the space sector requires a three-block system of research regulators (public sector, scientific and educational sector, the commercial sector). The instruments thereof are based on the principles of openness to innovation, science and global integration. Nowadays, evidently, the outdated paradigm of the regulatory process of scientific and technological development in space undergoes changes with emphasis on the needs, interests, and demands of citizens and civil society that is central to the choice of regulators for funding socially valuable projects, both from regional budgets and from the EU budget. At present, a strategic priority for Europe is to encourage know-how with their subsequent commercialization, to design an appropriate ecosystem for space activities as one of the breakthrough economic sectors, to address global public challenges and to generate global space policies.

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