Innovation in the space sector

Rationale and objectives

The space sector is experiencing a profound transformation that is being driven by developments both inside and outside the space domain.

The utilisation of space applications is growing worldwide, and satellite signals and data play an increasingly pivotal role in the efficient functioning of societies and their economic development. The efficiency and productivity gains derived are becoming more visible across very diverse sectors of the economy, although experiences in estimating impacts vary across countries. From agriculture to energy and routine surveillance, governments, firms and individuals are increasingly using satellite signals and imagery in geospatial tools (e.g. Global Positioning System – GPS). Satellites, for instance Internet broadband satellites, also play a key role in rapidly providing communications infrastructure to areas lacking any ground infrastructure, contributing to link rural and isolated areas with urbanised centres. Significant improvements have been achieved in weather forecasts over the past decade, due in part to a larger international fleet of improved meteorological satellites, bringing substantial gains in the accuracy of forecasts of large-scale weather patterns in both hemispheres. This has directly benefited early warnings of major hydrometeorological hazards, such as cyclones, thunderstorms, heavy snowfall, floods and heat waves.

Capabilities derived from satellite data and telecommunications are also increasingly being used to support more efficient policy making. The ubiquitous surveillance capability of satellites is, for instance, increasingly applied to monitor food production, international borders and transportation hubs by ministries and departments of the interior, agriculture and transport. As an illustration, the European Common Agriculture Policy provides direct aid to eight million farmers, with amounts distributed per declared square meter of land. To improve cost efficiencies, European Commission inspectors are now routinely using commercial precision farming products, GPS and satellite remote sensing data to check whether the area declared by farmers is eligible. In 2010, the programme allowed the control of 410 000 area-aid applications by European Union farmers, representing approximately 70% of the required controls for the entire EU (OECD, 2014).

The value chains of space manufacturing are becoming more international and more complex. New original industrial processes are being introduced by new actors in the sector, paving the way for higher productivity. In addition, technological breakthroughs are expected within the next decade that could have a significant impact on the sector as a whole (see also the chapter on “Future technology trends”). Increased competition in space manufacturing and synergies with other sectors and technologies are driving the development of more cost-efficient space manufacturing techniques. To lower costs in space systems, adaptations of new industrial qualification procedures are being pursued, using existing experience and data from high-volume industries to mass produce spacecraft and launchers (e.g. automobile, aeronautics). This process has been promoted by SpaceX, a California-based space manufacturing company founded in 2002 by the billionaire Elon Musk, founder of PayPal. The business model is based on vertical industrial processes (i.e. more than 70% of each Falcon launch vehicle is manufactured at the SpaceX production facility) and mass production, inspired by the automobile sector and a first for the space industry. It has also benefited from supportive US institutional contracts to develop the activity. SpaceX and other new private actors are disrupting incumbents, traditional industrial policies and the usual long-term contractual practices set up by governments.

As for new industrial processes, 3D-printing is also starting to make a difference, not only in the production of prototypes but also by enabling more lightweight and durable components (see the chapter on “Future technology trends”). A large number of space-related components have already been produced in North America and Europe with various types of 3-D printers, and these are continuing to grow in size and complexity.

The last few years have also witnessed the start of what could be a revolution in the design, manufacture and deployment of satellites (again see the chapter on "Future technology trends"). Small satellites, weighing less than 500 kg, have become very popular and cost-efficient as commercial off-the-shelf components, and consumer electronics are now commonly used to build satellite platforms and instruments at the lower end of the cost range. These smaller satellites are making space technology more affordable and accessible to new types of users. Today, more than 50 countries have satellites in orbit. Small satellites are finding uses across a wide range of applications – from earth observation and communications to scientific research, technology demonstration and education, as well as defence. Increasingly popular are also nano- and microsatellites (weighing between 1 kg and 50 kg), but these come with much more limited functionalities and a very short mission life (1-2 years). Since the first CubeSat launch in 2002, the number of very small satellites put into orbit has increased at a remarkable rate. In 2014, some 160 nano- and microsatellites were launched, an increase of 72 % over the previous year. Almost thirty countries have developed CubeSats, with the United States launching over half of them (OECD, 2014). Recent advances in miniaturisation and in satellite integration technologies may significantly increase the functionalities of nano- and microsatellites and greatly extend their possible field of application. Constellations of small and very small satellites appear to be on the verge of scaling up very significantly, although business plans may still need some elaboration.

With the multiplication of actors involved in space developments and the growing trade in space products, the space sector is experiencing globalisation like never before. Globalisation can benefit the economic development and innovation capabilities of a large number of countries, but this will increasingly come with more challenges for incumbents and newcomers alike. Furthermore, as of 2016 gaining access to space and commercial in-orbit activities was a complex undertaking, and the wealth of data coming from satellites (e.g. weather, climate) is raising new big data issues for institutional and commercial users alike. Major ongoing developments not only represent opportunities for governments but also create a growing number of challenges. Companies need long-term economic visibility as well as a stable policy environment in order to engage in and nourish innovative activities – and this is particularly important for small- and medium-sized enterprises and young companies.

This evolving situation calls for policy action to ensure that developments in the space sector benefit society at large. Despite a rising commercial space sector, the role of government remains essential as a source of initial funding for public research and development and as a major anchor customer for many space products and services. The strategic nature of space systems is still the driving force in the development of new space capabilities nationally or through international co-operation, as these systems provide unique capabilities that support a broad range of national policies, from security to economic development, often over a long-term horizon.

Major aspects and instruments

Governments are increasingly developing different types of policies in order to create adequate framework conditions for their national space industries and are encouraging the wide use of space applications. Many of these initiatives, such as policies addressing education, the research infrastructure, workforce skills, entrepreneurship and innovation, are beyond the scope of the national space agencies alone, but they are key for the space sector (see also in this the Policy profiles on "Strengthening education and skills for innovation", "Labour market policies for the highly skilled", "Public research missions and orientation", "Financing public research", "Start-ups and innovative entrepreneurship", etc.).

Some specific policy instruments aim to foster institutional demand for space technologies, with national administrations procuring R&D, services and equipment via dedicated contractual arrangements (e.g. United States, India). And to spur commercial space-related exports, specific export credits and guarantees to the buyer have been used by different governments (e.g. France, Germany, India and the United Kingdom).

In addition to these national instruments, some space agencies have set up programmes that support these policies, such as dedicated programmes related to outreach and education with funding for teacher training in schools in space-related topics (e.g. Canada, Italy and United States).

The policy instruments supporting national space programmes are therefore varied, and different policy mixes are currently being reviewed in the context of the OECD Space Forum.

Box 1. The OECD Space Forum

In co-operation with the space community, the Space Forum of the Organisation for Economic Co-operation and Development (OECD) was established to assist governments, space-related agencies and the private sector to better identify the statistical contours of the space sector, while investigating space infrastructure's economic significance, its role in innovation and its potential impact on the larger economy. This unique international platform promotes a constructive dialogue between stakeholders and the exchange of best practices. The Forum's Steering Group includes organisations from Canada, France, Germany, Italy, Korea, Mexico, Norway, Switzerland, the United Kingdom and the United States as well as the European Space Agency. For more, see https://www.innovationpolicyplatform.org/oecd-space-forum.

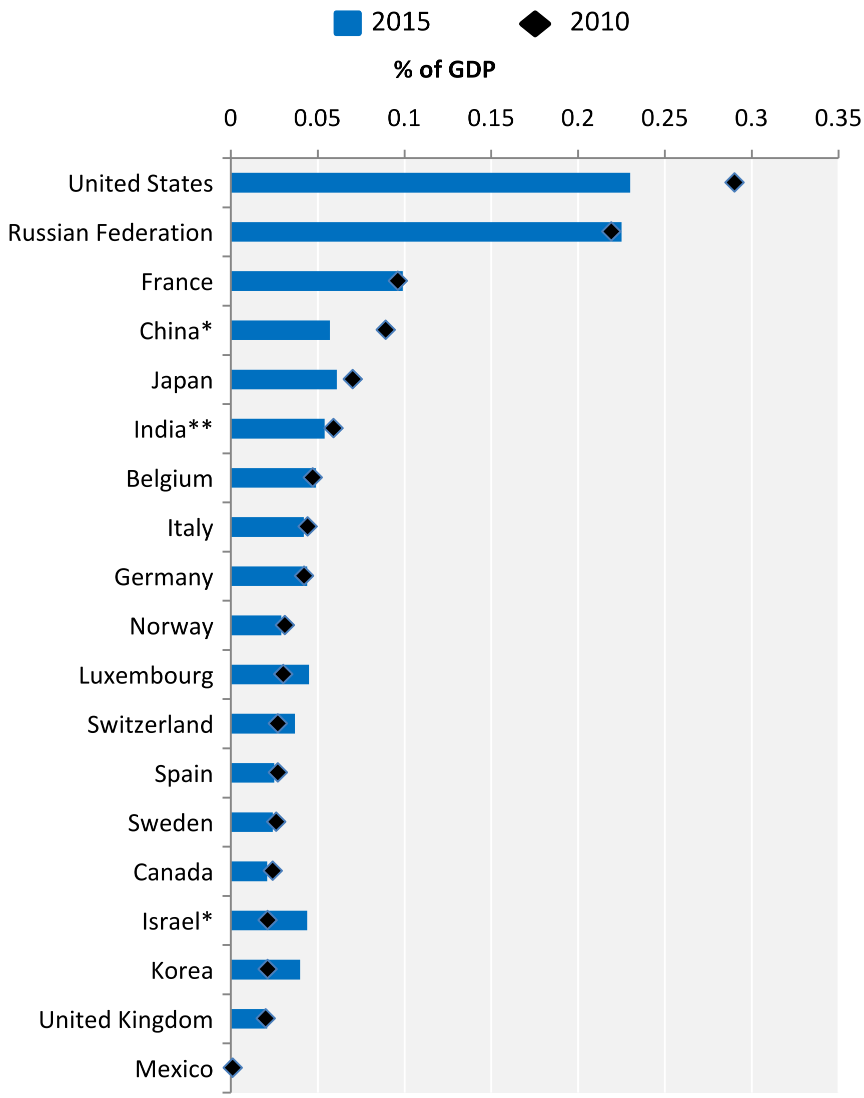
Recent policy trends

Governments today are still the main investors in space R&D and other space-related activities, through contracts and grants to public agencies, research institutes, universities and the private sector. They are also responsible for providing a level playing field and ensuring framework conditions that are conducive to the evolution of the commercial space sector.

In 2015, global institutional space budgets were still rising in real terms, and 2016-17 should see more public investment in space programmes particularly in selected OECD economies. The institutional funding of space programmes represents, therefore, an interesting although imperfect indicator of the level of intensity of space activities around the world (i.e. budget allocations often do not represent the actual annual spending). One of the most useful indicators of the intensity of space funding is the ratio of a government's space budget to GDP (Figure 1). In 2015, the budgets of the United States and the Russian Federation accounted for more than 0.2% of their GDP, followed by France at 0.1% and Japan at 0.06%. Still, the majority of OECD economies' space budgets constituted less than 0.05% of their GDP in 2015 (including civil and military space activities). Changes in a space budget's share of GDP may be affected not only by adjustments in funding levels but also by a rapid rise or fall in GDP. Illustrating this, India and China have relatively low space budget/GDP ratios, because their budget allocations have not kept pace with high GDP growth.

An ever increasing number of institutional actors are developing space programmes with long-term plans. The Austrian Space Applications Programme, for example, was initiated by the Federal Ministry for Transport, Innovation and Technology (BMVIT) in 2002 and was recently confirmed until 2020. The Strategic Vision Document of the Italian Space Agency (ASI) also clearly sets out the country's objectives in terms of developments in space science and technology until 2020. And Lithuania's recent National research programme towards future technologies (2016–21) also mentions space for the first time. Germany's current space policy describes space technologies as "enabling technologies" for services that create significant downstream markets and benefits for society. Examples are satellite communication and navigation and services derived from Earth observation or space-based scientific research. In addition to France's well established national space programme, the 2010 Investments for the Future Programme (PIA) provides a framework to allocate specific funds for the development of innovative space applications. This growing interest in space can be found also in South America, where, for example, Colombia's Space Commission was established in 2014 to optimise the contribution of space science and technologies to the country's social and economic development.

Figure 1. Selected public space budget estimates



* Estimates. **Based on preliminary budget estimates for the fiscal year 2015-16.

Source: Government estimates in national currencies, GDP retrieved from OECD (2015), *Economic Outlook* No. 98, DOI: 10.1787/eo-data-en.

StatLink http://dx.doi.org/10.1787/888933445100

As new opportunities arise in the form of technological innovation and new applications, so too do new risks – the growing vulnerability of widely stretched supply chains to various kinds of disruption is just one example. Balancing these new risks and opportunities over the next few years will prove challenging for policy makers and industry players alike. To better face these trends, two avenues could be pursued by policy makers: improving the tracking of who is doing what, and sustaining value-creating industries (OECD, 2014).

- To better track who is doing what in the space industry, a number of initiatives can be taken by national administrations. In addition to working with industry associations and promoting and conducting regular industry surveys, other official information sources in government agencies could be more thoroughly exploited to provide a clearer picture of the actors involved in space-related activities (e.g. analysing administrative data on firms, information on contracts). This would be conducive to improving the quality of evaluations of national industrial policy, with detailed information on the structure, the positioning along the value chain, and the competitiveness of the space industry and other actors involved in the larger space economy.

- As economies become more interdependent and interconnected, all countries and all firms have the opportunity to participate and benefit from global value chains in the space sector. However, this situation is putting new competitive pressures on governments to adopt reforms that enable their producers to find or to try to retain niches in which they can make the most of their capabilities. There is a need to develop complementary policies, such as those that boost education and skills, as well as to ensure long-term investments in national research and development capabilities, in order to encourage future innovation.

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