PART II

Chapter 5

Readiness Indicators: Inputs to the Space Economy

Chapter 5 examines the readiness factors of the space economy, i.e. different elements that are necessary for the development of space activities. These elements encompass the technical, financial and social infrastructures that enable the production of space-related hardware or the provision of services. This chapter examines the following indicators: government budgets for space activities (both for public space programmes and for R&D activities) and human capital.

Governmental budgets for space activities

National and other institutional budgets often contribute to the start-up and development of capital-intensive and high-technology sectors such as space. This section provides details on two aspects of government budgets dedicated to space activities: 1) civilian space programmes as presented annually in Government Budget Appropriations or Outlays for Research and Development (GBAORD); and 2) public institutional space budgets, covering both civilian and military budgets.

Government Budget Appropriations or Outlays for R&D (GBAORD) in civilian space programmes

Government R&D appropriations or outlays on R&D (GBAORD) data are assembled by national authorities analysing their budget for R&D content and classifying these outlays by "socio-economic objective" on the basis of the NABS 2007 (Nomenclature for the analysis and comparison of scientific programmes and budgets), (OECD, 2002). The data provided in the OECD database for GBAORD cover the period 1981-2011 (updated annually in February).

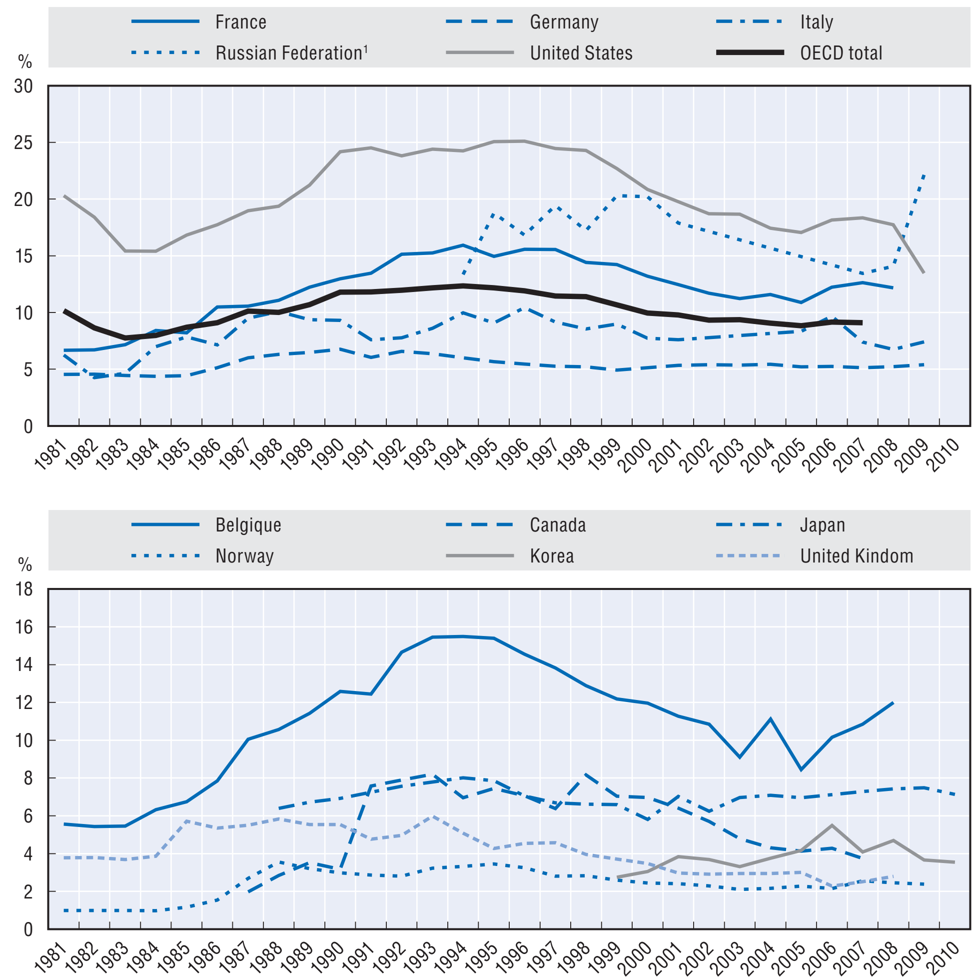
GBAORD data have the advantage of being timely and reflecting current government priorities. However, the data refer to budget provisions, not to actual expenditures, and the breakdown in socio-economic objectives brings some limitations (*i.e.* the "exploration and exploitation of space" category excludes military space programmes, which are included in a specific "defense" category). GBAORD data can provide trends, which can be usefully complemented by other data (*e.g.* institutional budgets).

The OECD recommends indices based on constant Purchasing Power Parities (PPPs) for the analysis of relative growth performance between countries and over time. Current PPPs allow useful snapshots for a given year. It is important to remember that PPPS are statistical constructs rather than precise measures, so differences between countries should be interpreted with caution (see previous chapter for more information on how to use PPPs).

When analysing GBAORD data, comparability may be affected by the fact that GBAORD tends to represent expenditures of the federal or central government only. The OECD *Frascati Manual*, which provides useful guidelines for R&D comparisons, does suggest the inclusion of provincial/state data if they are "significant" (OECD, 2002). Thus, comparability may be limited to the extent that data compilers perceive expenditures of other levels of government as significant. Also, several countries with large space programmes are usually not included, due to current lack of GBAORD data (*e.g.* Brazil, China, and India).

Figure 5.1. **Civil space programmes as a percentage of civil GBAORD for selected countries**

1981-2010 (or latest available year)



1. Non-OECD country.

Source: OECD, *Main Science and Technology Indicators database*, August 2010.

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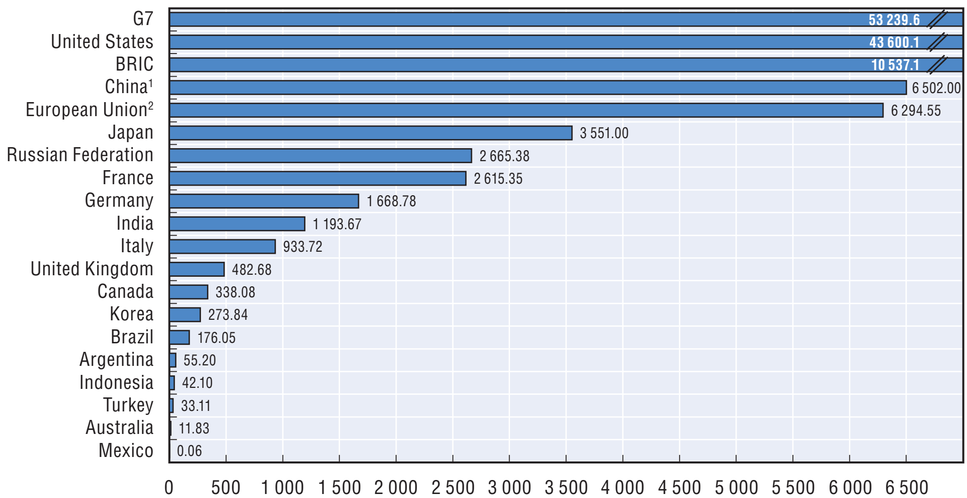
National budgets for space

Space budgets refer to the amounts that governments provide to public sector agencies or organisations to achieve space-related goals (*e.g.* better communications, security). Space budgets often serve both civilian and military objectives. In *The Space Economy at a Glance 2011*, data are derived from institutional sources and provide conservative estimates (OECD, 2011b).

Figure 5.2. **Conservative estimates of space budgets of G20 countries, 2010**

Current USD million



Note: These estimates provide orders of magnitude, as exchange rates may alter direct comparability. Figures reflect all space investments (civil and military budgets) including contributions to the European Space Agency where applicable. Data missing for Saudi Arabia and South Africa. BRIC refers to Brazil, Russia, India and China.

1. Unofficial data.
2. For the European Union, only 17 countries with national space budgets are included Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden and Switzerland.

Source: Adapted from OECD (2011), *The Space Economy at a Glance 2011*, OECD Publishing, *http://dx.doi.org/10.1787/9789264111790-en*, p. 25.

StatLink http://dx.doi.org/10.1787/888932576605

Interpreting public budgets dedicated to space activities poses several methodological challenges:

- *Budget vs. expenditures*: When they are available publicly in some details, budgets may not necessarily match current expenditures.
- *Double counting*: The risk of double counting exists too, as a number of governments provide direct and indirect funding to space-related international organizations, *e.g.* adding up France's total space budget and the budgets from the European Space Agency (which already includes France's contribution).

- *Limited data availability*:
  - Countries with very small space offices or activities often do not publish detailed budget breakdown.
  - Significant portions of military-related space budgets may not be published because of secrecy and/or may be classified under other areas of government expenditure.
  - Moreover, some civilian space-related budget lines may be classified under other areas of government expenditure, *e.g.* telecommunications or R&D, and not under "space".
- *Budgets for different space disciplines*: Although aggregate data for public budgets in science can be found for many countries, as shown in the *OECD Main Science and Technology Indicators*, very often the budgets for different scientific disciplines are not available in detail and are not comparable over time. In the case of astronomy for example, after reviewing the state of information available today on OECD countries' funding of astronomy and space sciences, it appears that there are relatively few data available that are internationally comparable (based on space agencies' and scientific groups' data) (Seth *et al.*, 2009). Even on national basis, discrepancies can be quite important (National Research Council, 2010).
- *Comparability issues:*
  - Differences in budget line definitions across countries: budgets are usually organised in different categories (science, applicative areas), according to national definitions, making data difficult to compare directly.
  - The start of the fiscal year and budget appropriation differs from country to country (*e.g.* Japan, United States, France), so that annual data are not always readily comparable.
  - Currencies and PPPs affect international comparability (see previous chapter). Expenditures in what are currently lower income countries such as China and India may have a higher purchasing power than similar expenditures in high-income countries, because the costs of labour and services are lower. The real, *i.e.* PPP-adjusted, expenditure in such countries may therefore be higher than that indicated by a comparison based solely on exchange rates.
- *Defence sector issues:* The importance of military space budgets should not be underestimated. Military budgets, dedicated to R&D programmes (*e.g.* missiles, navigation systems) or to operational programmes (*e.g.* "spy" satellites, ground-based stations for communications), represent for some countries a large part of their space investments. Space programmes are often dual use in nature, meaning the capability they provide can be used

for both civilian and military objectives. Governments may therefore fund space programmes as civilian endeavors while in fact part of the R&D is dedicated to military objectives. *A contrario*, many governments include most or a large part of the space investments in their defence budgets (China, United States). This raises issues in evaluating those budgets. The type of weapons system that should or should not be included in an overall estimate of military space programme is also not clear. For instance, should strategic ballistic missiles be included *de facto* in space programmes, if the budget information is available? The RAND Corporation measured the US federal spending within the aerospace industry from 1993 to 2003 (Hogan *et al.*, 2005). The study provides a detailed examination of the Federal Procurement Data System (FPDS), with the specific purpose of tracking all government aerospace procurement and R&D expenditures from 1993 to 2003. The results only approximate overall spending because they do not include classified military programmes, which could not be identified using the Federal Procurement Data System.

Human resources

Human capital is key to the development and sustainability of the space sector. The sector is home to highly skilled professionals (*i.e.* technicians, scientists and engineers). Existing data on space-related human capital are very fragmented. Official employment statistics on the sector are poor, lacking in both quality and detail. To some extent, the gaps can be filled by non-official statistics, mainly from industry associations, and usually focus on the space manufacturing industry while the larger services sector is often ignored.

The *Manual on the Measurement of Human Resources* or *Canberra Manual* was developed in the 1990s to provide a statistical framework for compiling data on stocks and flows of human resources in science and technology (HRST) detailing seven broad fields: natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences, humanities, and other fields (OECD, 1995). HRST are people engaged in, or who have the relevant training to be engaged in, the production, development, diffusion, application and maintenance of systematic scientific and technological (S&T) knowledge. HRST are defined by the *Canberra Manual* as people who fulfil one or other of the following conditions:

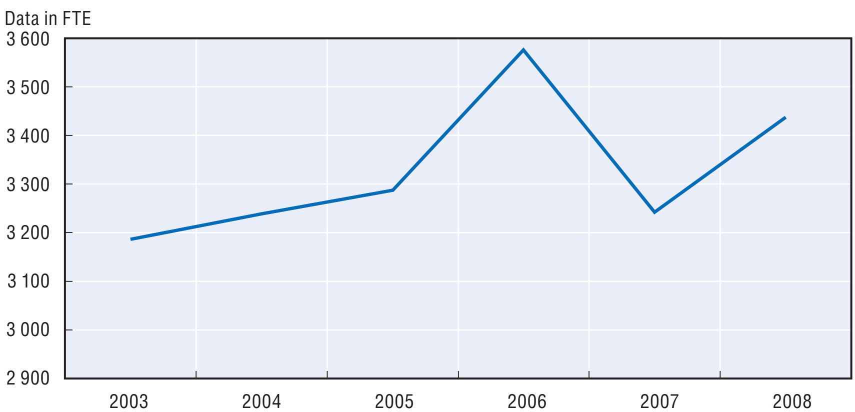
- Successfully completed education at the tertiary level in an S&T field of study (*i.e.* HRSTE).
- Not formally qualified as above, but employed in an S&T occupation where the above qualifications are normally required (*i.e.* HRSTO).

There are two harmonised standards which give definitions for education and occupations internationally: the International Standard Classification of

Education (ISCED) which provides levels of formal educational achievements and the International Standard Classification of Occupation (ISCO) detailing the type of occupation. Despite efforts to harmonise statistical information on education and employment at the international level, current data sets can still lead to conflicting interpretations (OECD, 2011a).

By way of illustration, data about the UK space workforce are examined below. The data come from two sources, using differing scope and methodologies. The figure below on space manufacturing employment uses data from the Eurospace Industry Association's annual survey. Over six years, the UK space sector employment, *i.e.* the space manufacturing sector, has ranged between 3 200 and 3 580 Full Time Equivalents.

Figure 5.3. **Space manufacturing employment in the UK (2003-08)**

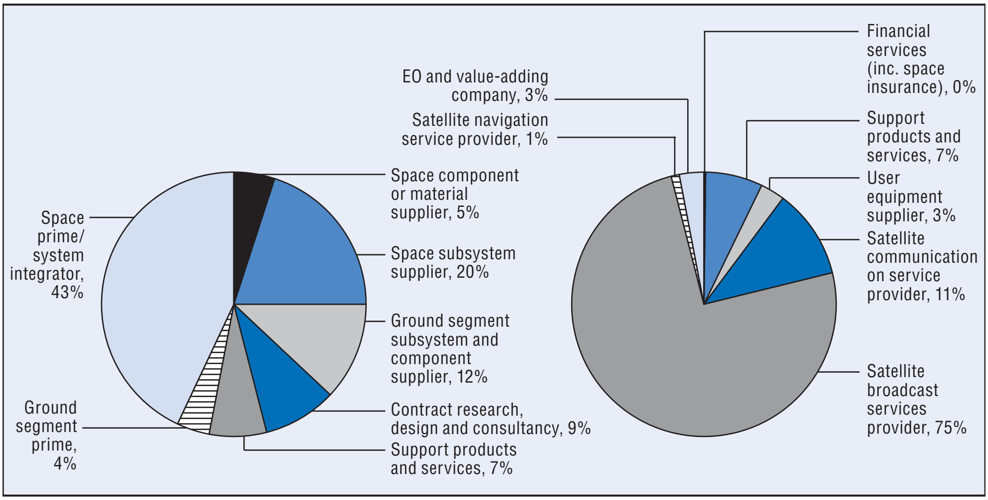


Source: Eurospace (2009), *The European Space Industry in 2008, Facts & Figures*, 12th edition, Paris.

The second source for UK space employment is the study conducted by Oxford Economics, which relied on 2006-07 data collected through surveys of the British National Space Centre (BNSC) and other consulting firms (Oxford Economics, 2009). The survey finds that in 2006-07, some 19 100 people were employed in space-related manufacturing and services jobs in the United Kingdom. The upstream space industry employs around 5 850 workers (up from just over 4 700 in 1999). Of these around 2 500 were in space prime companies, 1 200 in the subsystems suppliers, and 300 in the component or material suppliers. The downstream space industry employed around 13 250 workers. Of these around 9 700 people worked for satellite broadcast service providers and around 1 500 for satellite communication service providers. Support products and services employed almost 1 000 people, whereas earth observation and user equipment suppliers employed around 500 people each.

Figure 5.4. **Direct employment in upstream and downstream segments in the UK space industry**

(2006-07)



Note: Total: 19 100 people.
Source: BNSC/Oxford Economics (2009), *The Case for Space: The Impact of Space Derived Services and Data*, Commissioned by South East England Development Agency (SEEDA), London, UK.

As another example of existing source for space employment, the Canadian Space Agency (CSA) has collected space sector data since 1996 via its space industry survey, using a consistent set of definitions for the different sectors of activity. Based on its rather high level of responses over the years, CSA can provide breakdowns by type of position (technical vs. sales), region of the country, as well as by sector of activity (*e.g.* telecommunications vs. navigation) (CSA, 2011).

It remains that a number of key issues for the space sector include:

- *Sectors of activity:* Statistics on space activities are usually embedded in larger aerospace and defence categories, making it difficult to separate the different activities. Statistics on defence personnel are especially challenging to obtain, particularly in non-OECD countries. In the space sector itself, different specific subsectors co-exist (*e.g.* telecommunications, earth observation) with the added need to identify complex value chains.
- *Counting time or people?* Countries and industry associations may report employment in Full-Time Equivalents (FTEs) (counting shifts, not individuals) or numbers of persons employed. This is important to take into account when trying to compare data.
- *Data sources*: Official employment statistics on the space sector, when they exist, are often lacking in quality and detail. To some extent, the gaps can be

filled by non-official statistics, mainly from industry associations, which often focus on the larger aerospace sector – sometimes with a category on space manufacturing industry, but more often than not, occulting the larger services sector (*e.g.* professionals in satellite telecommunications). Increasingly private one-off surveys from consulting firms try to cover the larger field of space applications.

Based on this, one important aspect when collecting data on human resources is to characterise clearly the scope of the survey (*i.e.* identifying the segments of the value chain to be covered), and to define the categories of jobs to be surveyed.

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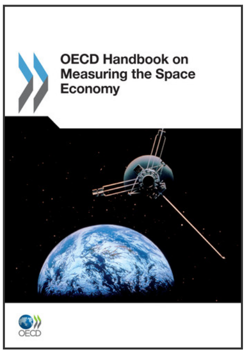

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