Executive Summary

Space applications have the potential to provide significant contributions to society's responses to 21st century challenges, such as environmental monitoring, management of natural resources, security and safety. Key activities in everyday life – weather forecasting, global communications and broadcasting, disaster prevention and relief – depend increasingly on the unobtrusive utilisation of space technologies. Over coming decades, space-related applications, such as distance education, telemedicine, precision farming, land use management, and monitoring of various international treaties, will continue to hold great socio-economic promise.

In order to ensure that the potential of space is more fully realised, governments and space agencies need evidence-based analysis to help shape policy making. Paradoxically, despite the critical role that the space industry plays in modern society, the space sector is one of the least developed in terms of robust, internationally comparable statistics and data.

The Space Economy at a Glance responds to this growing need for metrics by assembling a basic data set that gives a quantitative picture of space-related activities in OECD countries and several major non-OECD economies. The book also offers critical insights into some of the main problems involved in deriving internationally comparable data for the industry and its downstream activities, notably the lack of detailed data, and conceptual and definitional problems.

What is the "space economy"?

In 2006, the OECD International Futures Programme launched the OECD Global Forum on Space Economics – a platform for international dialogue and research amongst participating national governments and space agencies – and set out to explore further the economic dimensions and societal impacts of space infrastructure and space-based activities. The Forum defines the emerging space economy as:

> All public and private actors involved in developing and providing space-enabled products and services. It comprises a long value-added chain, starting with research and development actors and manufacturers of space hardware (*e.g.* launch vehicles, satellites, ground stations) and ending with the providers of space-enabled products (*e.g.* navigation equipment, satellite phones) and services (*e.g.* satellite-based meteorological services or direct-to-home video services) to final users.

How is the "space economy" measured?

An increasing number of countries are developing space systems and applications, but internationally agreed definitions for statistical terminology on space activities do not yet exist. The current edition of the United Nations International Standard Industrial Classification (ISIC Revision 3.1) includes most parts of the space sector under different aggregate categories. Indeed, there is no specific "space activity" classification in the ISIC, and disentangling the space sector from the larger aerospace sector remains a challenge in most countries.

Inspired by many years of OECD work on emerging economic areas (*e.g.* the information, society, e-commerce, the bio-economy), the data and statistics on the space economy are presented here in a framework that consists of: readiness (inputs, such as financial and human resources), intensity (outputs, such as products and services), and impacts (largely qualitative, societal "value added").

This book compiles information on space-related manufacturing, goods and services, public budgets, R&D, human capital, and patents from a wide range of official and non-official sources. Official statistics come from two main sources: OECD databases and publications (such as the OECD Structural Analysis or STAN system of databases), and official government departments or national space agencies. Non-official sources are mainly industry associations and private consulting firms.

The compiled data answer questions, such as:

– Who are the main space-faring nations?

– How large are revenues and employment in the sector?

– How much R&D goes on, and where?

– What is the value of spin-offs from space spending?

Spotlights on space developments in some members of the OECD Global Forum on Space Economics provide country-specific information for the United States, France, Italy, the United Kingdom, Canada and Norway. And highlights from a recent internal OECD study of water resources management illustrates the vital role that space applications can have in providing innovative solutions.

Some statistical findings

Estimates of the size of the space economy vary widely (due to the lack of internationally comparable data). However, worldwide, institutional budgets (around USD 45 billion in 2005 for OECD countries) and new commercial revenues from space-derived products and services (around USD 110-120 billion in 2006 worldwide) indicate that the underlying trend in the space economy is one of growth.

The G7 countries dominate production in the aerospace industry, which comprises the manufacture of all aircrafts and spacecrafts. Although a key strategic sector for many countries, aerospace represents a small share of their total manufacturing value added, ranging in 2002 from below 1% in Japan to more than 3% in Canada, France, the United Kingdom (UK) and the United States (US). Business enterprise R&D expenditure in the aerospace sector totalled more than USD 19.8 billion in 2002; the US, France, the UK and Germany accounting for 84% of that total.

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Narrowing to the smaller space sector, downstream space activities (applications) are often much larger than the traditional upstream segment (manufacturing). In 2006, manufacturing revenues (*e.g.* satellites, rockets) were estimated at around USD 12 billion and space-related services (*e.g.* direct to home satellite television, GPS) were estimated at more than USD 100 billion. As for human resources in the space industry, data are very fragmented; but an estimated 120 000 people in OECD countries are employed in upstream sectors in 2006.

Capital stocks, as well as annual levels of investment, for space assets are very difficult to estimate; however focusing on satellites' values, a 2005 study estimated that the 937 satellites in the Earth's orbit at that time had a replacement value of USD 170 to 230 billion.

Finally, patent data are considered an indicator of technological innovation and the economic vigour of a given sector. Between 1990 and 2000, the number of space-related patents tripled both in Europe and the US, with the US, France, Germany and Japan accounting for a major portion.

Broad socio-economic impacts

Countries develop space activities for both political (*i.e.* international prestige) and strategic objectives (*i.e.* civilian-military utilisation of space systems). Key outputs of those activities comprise various scientific and technological developments (*e.g.* space exploration, advances in physics), even as unforeseen socio-economic impacts can increasingly be detected in the larger economy.

The many derived space-based services have positive impacts on economies and societies, although at this stage, they are more qualitative than quantitative. The ability to disseminate information over broad areas, instantaneous telecommunications, and a global vision of the world are some of the important capabilities that space assets bring. Combining terrestrial facilities with space infrastructure can provide benefits for end users such as: decreased transaction time, cost savings, cost avoidance, improved productivity, and increased efficiency.

Studies show that being able to transfer and broadcast information worldwide instantaneously has been a significant commercial revenues' multiplier since the 1980s for phone and television companies. Employment in the space sector has led to the creation of jobs in "derived" sectors, in particular telecommunications.

In Norway, the "spin-off effect" of space programmes on space firms has been measured at 4.4, that is for every million Norwegian kroner (NOK) of governmental support, space sector companies have on average attained an additional turnover of NOK 4.4 million (EUR 510 000). Although this impact measure may vary widely depending on the country and level of specialisation, it is indicative of possible increased competitiveness due to space involvement.

Benefits from space infrastructure are becoming more evident in the management of long-term and significant challenges of modern society. In the case of natural disaster management (floods, for example), remote sensing from space can provide data for the whole cycle of information for flood prevention, mitigation, pre-flood assessment, response (during the flood), recovery (post-flood) and weather newscasts. Timely satellite

imagery and communications links in hard-to-reach places can help stem catastrophic loss of lives and economic losses.

Challenges to overcome in data collection

Future space-related data collection efforts will need to overcome obstacles in order to more accurately quantify the space sector and render data and statistics comparable across countries. The challenges include:

- Disaggregating data. Disentangling space data from aircraft data in the larger aerospace sector will be essential; likewise, separating manufacturing data from services, in some instances.
- Double-counting. Production data in the sector is often subject to double-counting. Efforts to break out value added will be necessary.
- Limited international comparability. Countries are using their own methodologies, concepts, and definitions in official government data.
- Confidentiality. Much data is subject to secrecy due to dual-use military and civilian applications of space developments and/or the existence of only one or a few major space-related companies in a country.
- Non-OECD countries. As in the case of other economic sectors, obtaining official data is difficult, and purchasing power parity issues need to be taken into account.
- Employment. Data is not available split by R&D or production, for instance.
- Detailed services. Only satellite telecommunications services have been partly traced; trade in other services is poorly quantified.

Next steps

Much work remains to be done to develop universal, data-driven indicators for the emerging space economy. More efforts in that direction could benefit both decision-makers, industry and citizens, and help them have a better understanding of the significance of space activities in the larger economy.

Further actions could include international efforts to separate the statistical classifications for aircraft and spacecraft industries, as well as exercises that drill down on space-related services (such as telecoms, satellite navigation). Case studies that assess the social and economic impacts of space applications in today's world would help to better qualify and quantify the space economy. The OECD Global Forum on Space Economics could be the platform that provides the impetus for such work, while further international co-operation will be required with national statistical offices, space agencies and industry associations.

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Introduction

The Space Economy at a Glance breaks new ground in a number of ways. Prepared under the aegis of the OECD Global Forum on Space Economics, this publication constitutes a first attempt at providing a quantitative, internationally comparable view of not only the space sector itself, but also its broader role in the economy and society. It brings together data and statistics from official and unofficial sources that cover public space budgets, space sector revenues, trade in space products, and space patents, in order to illustrate the economic and societal impacts of space-based activities. While some of the statistics are drawn from traditional sources in the space community, others are drawn from OECD databases, containing in some cases previously unpublished material.

It is important to note that, as with all new emerging economic sectors, official statistics in the domain of commercial space activities are considerably underdeveloped. This is because more detailed data often require new or revised statistical definitions and classifications. In order to improve international comparability of such data, significant international co-operation will be needed. Looking to the future, the OECD Global Forum on Space Economics could provide a platform for such work.

1. Defining the space economy

Space technologies are becoming an increasingly important part of everyday life. Weather forecasting, air traffic control, global communications and broadcasting – these and many other essential activities would be almost unthinkable today without satellite technology. Although an increasing number of countries are developing space systems and applications, internationally agreed definitions for statistical terminology on space activities do not yet exist.

In broad terms, the OECD Global Forum on Space Economics defines the space economy as:

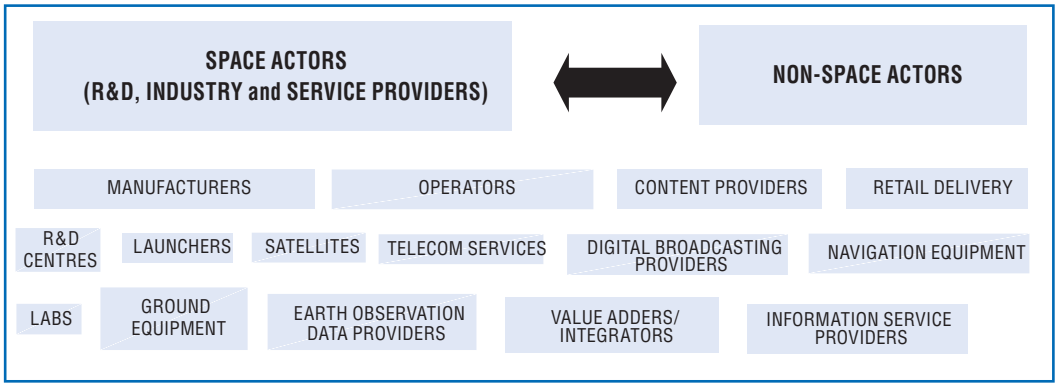
> All public and private actors involved in developing and providing space-enabled products and services. It comprises a long value-added chain, starting with research and development actors and manufacturers of space hardware (*e.g.* launch vehicles, satellites, ground stations) and ending with the providers of space-enabled products (*e.g.* navigation equipment, satellite phones) and services (*e.g.* satellite-based meteorological services or direct-to-home video services) to final users.

Thus, the space economy is larger than the traditional space sector (*e.g.* rockets and launchers); and it involves more and more new services and product providers (*e.g.* geographic information systems developers, navigation equipment sellers) who are using space systems' capacities to create new products. Figure 1 provides a simplified view of the

space economy; a public or private actor may be involved simultaneously in several space activities (*e.g.* being a manufacturer, as well as an operator and service provider).

As a first step in quantifying the space economy, this publication focuses mainly on the data available for the traditional space sector; however, throughout the document, broad indications about derived sectors of the space economy will be provided. More methodological work is needed to capture in greater detail space economy-related services.

Figure 1. **Overview of the space economy**



Source: OECD IFP (2006).

Governments play a key role in the space economy as investors, owners, operators, regulators and customers for much of space infrastructure. As in the case of other large infrastructure systems (*e.g.* water, energy), government involvement is indispensable to sustain the overall space economy and to deal with strategic implications of such complex systems. In the case of space, infrastructure can be used for both civilian and military applications as space technologies are by nature dual use, and military developments often pave the way for the development of civil and commercial applications (*i.e.* today's rockets are derived from missiles).

Estimates of the size of the space economy vary considerably, due the lack of internationally comparable data. Worldwide, institutional budgets (around USD 47 billion in 2005 for OECD countries) and new commercial revenues from space-derived products and services (around USD 110-120 billion in 2006) indicate that the underlying trend in the space economy is one of growth. And this remains true, despite the cyclical nature of commercial space activities (*e.g.* regular replacement of telecommunication satellite fleets).

2. Data sources

While focusing on OECD countries, *The Space Economy at a Glance* also looks at selected international non-OECD countries in the space economy, using both official government and private (association or industry) statistics. A major methodological challenge concerns the statistical classifications for space activities, which suffer from a lack of clear and common official definitions (see Box 1).

Box 1. **Classification issues for space activities**

The ISIC – The United Nations International Standard Industrial Classification (ISIC) system is a standard classification of economic activities arranged so that entities can be classified according to the activity they carry out. The current edition of the ISIC (Revision 3.1) includes most parts of the space sector under different aggregate categories. This will remain case in the forthcoming (2007) international ISIC (Revision 4.0).

"**Space**" **in ISIC** – There is no specific "space activity" classification in the ISIC. Most national industrial classifications (based largely on the UN ISIC system) used by statistical offices provide no breakdown for this industry. However, the US North American Industry Classification System (NAICS) and the French national statistical system (NAF) are partial exceptions. Nationally and regionally, countries have adopted the main international categories, while sometimes adding more details in how they classify industries. Three ISIC aggregate divisions cover the main space sector activities:

Division 35: Manufacture of transport equipment / Class 3530: Manufacture of aircraft and spacecraft. This class includes the manufacture of spacecraft and spacecraft launch vehicles, satellites, planetary probes, orbital stations and shuttles.

Division 62: Air transport / Class 6220: Non-scheduled air transport. This class includes the launching of satellites and space vehicles, and the space transport of physical goods and passengers.

Division 64: Post and telecommunications / Class 6420: Telecommunications. This class includes the transmission of sound, images, data or other information via satellite.

Other segments of the space sector, especially space applications and services, are even more "buried" within official statistical classifications. For example, ground equipment and communication equipment are included under broader categories in the manufacturing sector.

"**Space**" **in the next ISIC (2007)** – Overall, the space sector will not have much more visibility in the 2007 revision of the ISIC (Revision 4.0), although satellite communications activities will be better represented:

Manufacturing in the aerospace sector will still be counted as a single activity in Class 303: Manufacture of air and spacecraft and related machinery (within Section C: Manufacturing, and Division 30: Manufacture of other transport equipment).

The satellite communications domains will, however, be more precisely represented. Class 6130: Satellite telecommunications activities (within Section J: Information and communication, and Division 61: Telecommunications) will include the activities of "operating, maintaining or providing access to facilities for the transmission of voice, data, text, sound, and video using a satellite telecommunications infrastructure." This class will include the delivery of image, sound or text programming received from cable networks, local television stations, or radio networks to consumers via direct-to-home satellite systems. This class will also take into account the provision of Internet access by operators of satellite infrastructures.

Source: UN Statistics Division, http://unstats.un.org/, accessed 6 May 2006.

Official statistics in this book consist of data from two main sources, OECD databases and publications, and official government departments or national space agencies:

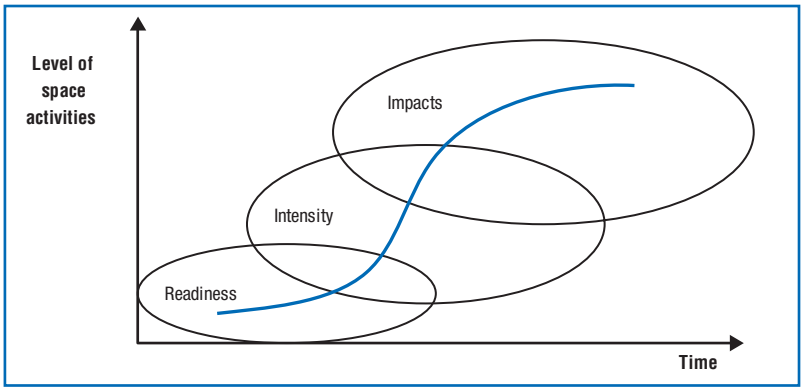
- The primary OECD source is the STAN (or "Structural Analysis") system of databases that were essential for compiling comparable official statistics for industrial and national variables. Other OECD data sources include the UN/OECD International Trade in Commodity Statistics database (ITCS), the Annual National Accounts, and selected Exchange Rates and Purchase Power Parities databases.
- Official data also include reports and documents from government departments and agencies (*e.g.* national space agencies).

Private sources of data in this book include industry associations and consulting firms. While the data from those sources are quite comprehensive, all raise questions with respect to their international comparability.

3. Structure of *The Space Economy at a Glance*

Inspired by many years of OECD work on emerging economic areas (*i.e.* the information society, e-commerce, the bio-economy), the data on the space economy are presented in a framework that consists of three stages: readiness (inputs), intensity (outputs), and impacts. Each stage provides an indication of the maturity of the sector. The diagram below (Figure 2) illustrates the different steps from readiness to impacts. This is, of course, a stylised representation, as some space applications (*e.g.* satellite telecommunications) are more developed than others and are already making a very significant impact.

Figure 2. **Development of the overall space economy**



Source: Figure adapted from the *OECD Working Party on Indicators for the Information Society, Guide to Measuring the Information Society*, Directorate for Science Technology and Industry, Committee for information, computer and communications policy, 8 November 2006, DSTI/IICP/IIS(2005)6/FINAL, p. 10.

This publication has five chapters: (1) an overview of the aerospace sector, historically the cradle for space activities; (2) the readiness (inputs) of the space economy, (3) its intensity (outputs), (4) its impacts, and (5) several spotlights on the space programmes of selected countries. The annexes provide methodological notes, tables with the underlying

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data for some OECD graphs, and information on the OECD Global Forum on Space Economics and a list of participating governments and space agencies.

1. *The background on the aerospace sector* provides the wider context from which the space economy has emerged. It also highlights the importance of future endeavours to separate the aircraft and spacecraft industry components for more meaningful official OECD data.
2. *The readiness factors (inputs) of the space economy* consist of the overall technical, commercial, and financial infrastructures necessary to engage in pertinent space activities. This chapter deals with the financial and human resources that are employed in producing space-related hardware and the provision of relevant services. It examines R&D, financial support for space programmes, and human capital.
3. *The intensity factors (outputs) of the space economy* describe the use that is made of space activities. The outputs refer to the specific space-related outcomes that are derived from the inputs. Thus, outputs may include products or services that are produced or provided in the realm of the space sector. They also include the benefits to industries/nations, including financial benefits (sales and trade revenues) and indications of future financial benefits (*i.e.* patents).
4. *The impacts of the space economy*, which are more qualitative than quantitative, consist of the "societal value-added" created by space activities. Examples provided are of benefits to society as a whole.
5. *The spotlights on selected countries* offer some insights into the space-related activities of member countries participating in the OECD Global Forum on Space Economics. Data come from their official sources (such as national space agencies or statistical offices) as well as private sources. Direct comparisons between countries are not possible due to definitional, conceptual and methodical differences.

The quality of available measures and comparable data for the space economy varies strongly for the input, output and impact stages. Some official statistical data are available for the readiness (input) factors (although not always readily comparable) and the intensity (output) factors, but these need to be supplemented by private data sources (*e.g.* industry surveys for revenues of the space sector). There are very few data on impacts. This situation is mainly due to a current lack of comparable quantitative information internationally. In order to provide a better indication of the state of the space economy, more work on the concepts and definitions for the space sector and the larger space economy will be needed. This will call for significant international co-operation. Looking to the future, the OECD Global Forum on Space Economics could provide a platform for such work.

List of Acronyms

AIA	Aerospace Industry Association of America
AIAC	Aerospace Industries Association of Canada
AIAD	Associazione delle Industrie per l'Aerospazio i Sistemi e la Difesa (Italian Industry Association for Aerospace Systems and Defence)
AIPAS	Associazione Italiana PMI per l'Aerospazio (the Association of Italian Small and Medium Aerospace Enterprises)
ANBERD	OECD Analytical Business Enterprise Research and Development database
ASAS	Associazione per i Servizi, le Applicazioni e le Tecnologie ICT per lo Spazio (Association for Space-based Applications and Services)
ASD	European AeroSpace and Defence Industries Association
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
BTD	The OECD STAN Bilateral Trade database
BERD	Business Enterprise Research and Development
BNSC	British National Space Centre
CAD	Canadian dollars (currency code)
CAST	China Academy of Space Technology
CNES	Centre National d'Études Spatiales (French Space Agency)
COMTRADE	United Nations' Commodity Trade Statistics Database
CPI	Consumer Price Index
CSA	Canadian Space Agency
CSG	Centre Spatial Guyanais (Space Centre in French Guiana)
DARS	Digital Audio Radio Services
DBS	Direct Broadcast Satellite
DTH	Direct to Home satellite
EO	Earth Observation satellite
EPO	European Patent Office
ESA	European Space Agency
ESA95	European System of Accounts 1995
ESTEC	European Space Research and Technology Centre
ESTP	European Space Technology Platform
EU	European Union
EUR	Euro (currency)
EUROSTAT	Statistical Office of the European Communities
FAA	US Federal Aviation Administration
FAI	Fédération Aéronautique Internationale (International Aeronautic Federation)
FAA/AST	US Federal Aviation Administration's Office of Commercial Space Transportation
FSS	Fixed Satellite Services

G7	Group of 7 leading industrial nations (Canada, France, Germany, Italy, Japan, United Kingdom, United States)
GBAORD	Government Budget Appropriations or Outlays for R&D
GBP	British pounds (currency code)
GDP	Gross Domestic Product
GIFAS	Groupement des Industries Françaises Aéronautiques et Spatiales (French Aerospace Industries Association)
GPS	Global Positioning System
IAF	International Aeronautic Federation
ICT	Information and Communication Technology
IFP	OECD International Futures Programmes
INSEE	Institut National de la Statistique et des Études Économiques (French National Institute for Statistics and Economic Studies)
IPC	International Patent Classification
ISIC	United Nations International Standard Industrial Classification
ISS	International Space Station
ITCS	International Trade in Commodity Statistics Database (UN/OECD)
JAXA	Japan Aerospace Exploration Agency
MSS	Mobile Satellite Services
NACE	Nomenclature d'Activité dans la Communauté Européenne (Economic Classification System in the European Community)
NAF	Nomenclature d'Activités Française (Economic Classification System in France)
NAICS	North American Industry Classification System
NASA	US National Aeronautics and Space Administration
NOAA	US National Oceanic and Atmospheric Administration
NOK	Norwegian krone (currency code)
NSC	Norwegian Space Centre (Norsk Romsenter)
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parities
R&D	Research and Development
RIMS II	Regional Input-Output Modelling System II
ROI	Return on Investment
SBAC	Society of British Aerospace Companies
SESSI	Service des études et des statistiques industrielles (French Service for Industrial Studies and Statistics)
SIA	US Satellite Industry Association
SNA	UN System of National Accounts
SOHO	Solar and Heliospheric Observatory (ESA and NASA)
SSB	Space Studies Board (US)
STAN	OECD Structural Analysis Statistics database
UK	United Kingdom
UN	United Nations
US	United States
USD	US dollars (currency)
USGS	US Geological Survey
USPTO	United States Patent and Trademark Office
VSAT	Very Small Aperture Terminals

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