

Is finance a final frontier for space today?

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This article is about the space sector economy and related financial measurement issues. It reflects, and develops further, aspects of earlier presentations to Wyższa Szkoła Administracji i Biznesu im E Kwiatkowskiego, Gdynia on the 9th of November 2017 to Centrum Badan Kosmicznych Polska Akademia Nauk on 16-17 January 2018, and at Kozminski University, Warsaw Poland on 25 October 2018.

Introduction

For most of the past 70 years the space sector was largely the domain of governments and public space agency organisations (in the USA, Europe, Russia, China and many other countries) mainly for space exploration missions, the international cooperation space station, and for national military and security purposes. The manufacture of launch vehicles and many support services, including those for satellites, has typically been in collaboration with, and contracted out to, a few large specialist corporations, mainly private but also state companies, as in Russia and China.

In addition, the satellite industry has developed with large, private sector operators delivering services for communications, such as direct to home TV, earth observation and navigation. More recently new satellites, from public organisations such as ESA Copernicus and Galileo, and from private sector firms have been deployed into orbit. The outer space sector is also opening to new private sector business players commercially willing to launch, operate in, and explore space, such as SpaceX, Blue Origin, Virgin Galactic, and many new lower orbit small satellite service providers. There are approximately 850 space companies in Europe alone.

In step with the new space sector development, a new space economy is emerging. Today, great emphasis is being placed on developing new markets and commercialisation of some aspects of the public sector, creating new challenges in policy, scientific and business areas, and presenting us all with what is often referred to as “new frontiers”. One of these is said to be finance and the concept of financial measurement in the space sector.

Measurement and finding more accurate ways to do this, has always been one of the most fundamental challenges in science and perhaps no more so than in space. One measurement concern of scientists has always been –“How old is the universe?” Estimates made hundreds of years ago were not necessarily wrong then, we just now measure this with much greater accuracy, thanks to the work of great scientists and many technological advances.

Financial measurement in this emerging field is predominantly measurement of money and financial reporting of the results of the space sector (rather than say “socio economic measures”).

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Commercialisation involves a voluntary exchange of products and services, information and/or money. Financial measurements can cover the impact of new customer market revenues, digital technology, changes to operating costs, capital expenditure on tangible and intangible assets, public sector budgets, funding from equity and debt, profitability and cash flows. Understanding this and going beyond any finance frontiers can help existing and new players to access and unlock new space markets, deliver new digital services, raise money to create commercial and profitable returns to deliver real benefits from space to everyone on Earth.

The Market of Many - the search for new revenues

In this article, we refer to the space market in the widest context, both public sector outer space missions and research, and private sector business, covering space manufacturing activities, the satellite industry, and its related consumer services, and so called “new space” business. One definition of space market is “the full range of activities and the use of resources that create and provide value and benefits to human beings in the cause of exploring, understanding and utilizing space”.² The market covers outer space exploration and research beyond our galaxy, military services, proposed missions to planets for potential mining of valuable resources, and more recently space tourism as a potential new market. Further, the satellite industry includes a significant range of geostationary (GEO), medium earth orbit (MEO) and low earth orbit (LEO) satellite services, including military, communications and broadcasting, earth observation services, weather forecasting and navigation.

What is the financial measurement of the total space industry or market? The most widely adopted is the one expressed in global revenue terms. Estimates vary, but a recent source values the total “market revenue” at US \$339.1 billion, of which non-satellite at US \$ 78.6 billion, leaving the “satellite industry” valued at US \$ 260.5 billion. There are also a number of different “market segments”. For example, revenues can be analysed at a high level by say four main segments which comprise: Ground Equipment US \$ 113.4bn (mainly GNSS), Satellite services US \$127.7bn (mainly TV communications), Launch activities US \$ 5.5bn, Satellite manufacture US \$ 13.9bn, with the USA having 44% of the global market³

Revenues of the major manufacturers and satellite industry are large, but have shown very little growth in recent times. Greater competitive activities have played a part as well as talk of a move, within the communication sector, to wider use of local fibre access networks for the Internet and digital broadband services.

Another total market estimate of US\$ 360bn today is projected to grow at a CAGR of 5.6%, to value US\$ 558 billion by 2026,⁴ with growth likely to come from new products and services. The development and search for new revenues, and new space markets is important and often comes from new players. There is growing interest and investment in new markets’ potential, i.e. those not yet measured or reported in financial results, such as manufacturing on the Moon, mining on Mars and space tourism, but it is wise to remember the old business saying: “Turnover (revenue) is vanity, profit is sanity, but cash is reality”, meaning that commercial success of those ventures remains unclear.

²NASA 2007

³<https://www.sia.org/wp-content/uploads/2017/07/SIA-SSIR-2017.pdf>

⁴<https://www.prnewswire.com/news-releases/global-space-industry-market-and-technology-forecast-to-2026-300678748.html>

We talk of space, but a large part of “the new” relates to markets here on Earth, reflecting different characteristics per country, region, or even a location. We could say “where” is the new market? Is it Outer Space? Earth (global such as GPS)? Region? the EU? a country (Poland)? a city? a village? an individual home or route or link between two locations?

The “upstream” market is still largely occupied by the governments, military, National Space Agencies, research facilities, and some very large multi-national corporations. There are several smaller sub-contractors and specialist SMEs throughout the world. Their products and services include for example, those developed by Polish engineering firms and by public research centre such as Polska Akademia Nauk Centrum Badan Kosmicznych (PAN CBK), who design and build instruments, and develop new services for satellites and for space missions.

Should we treat the national space agencies around the world as a global market? Their estimated annual spend is US \$43.4 billion.⁵ It can be argued that national space agencies are a market for international collaboration and for revenue gains of the private sector. Annual space agency expenditure budgets are estimated at US\$43.4 billion (for example NASA \$19.5bn, ESA \$6.3bn, Russia \$3.2bn and other countries)⁶. A part of this expenditure certainly flows back to private sector, through contracts and collaboration, and to public state suppliers in different countries, for example using SpaceX rockets. Revenues will also flow through to the development of new space technologies or spin off activities.

Spending by government space agencies, academic and research institutions seems likely to continue increasing significantly and will play a fundamental role in the development of the space sector. However, the mechanics and practical ways in which the public-sector benefits from and collaborates with the private sector will challenge policy makers and business leaders keen to commercialise and take advantage of opportunities these markets present.

Quite how space markets will grow is not yet clear. Can we look at other markets to give us a clue? An interesting analogy, or parallel idea, can be drawn between the space sector and the maritime industry. In the earliest days, we had great explorers setting out in a single ship on a voyage of discovery, going where no Europeans, had been before, discovering what was new out there which might have been useful to us here, such as gold, other commodities or plants. Many of the great launch sites then were big sea ports. We later saw the expansion of many new ports, new markets and economies that developed in distant lands.

In a similar way to the space industry, the shipping industry spans several markets, and has different market segments, such as shipbuilding (and breakup), ship operations or the transport of goods, ship ownership and leasing. Approximately 90% of the worlds’ goods are transported by sea and 70% by containerised cargo (a key unit of measurement today, but not in distant past). Also of note are competition effects, where the locations for building of very large ships and the ownership of ships have changed significantly over the past fifty years. The shipping of goods markets has changed and freight rates have fallen, negatively impacting on operators’ profitability, although shippers and some retailers welcome any transportation unit cost reductions. For instance, prices for carriers

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⁶https://public.tableau.com/views/NSAB/Budgets?:embed=y&:display_count=yes&publish=yes&:showVizHome=no

between the years of 2005 and 2012 have fallen between 20%-30%, depending on the carrier size, with profitability falling from approximately 10% to 4% for the same period.⁷

Costs, Profits and Investment

Clearly the cost structure, cost drivers, scale of international operations, and profitability of the various space sector segments will vary from manufacturing for large government contracts through to direct home TV services and to new small satellite start-ups. They will all have different business models and reflect different profitability levels.

A major cost for space is the price of launch equipment and the costs of human flight are even more significant. NASA apparently pays the Russian space agency Roscosmos about US \$81 million for a round-trip ticket in a Soyuz capsule.⁸ Consequently, the industry is looking for ways to reduce their fixed costs and efforts are put into finding ways of recycling key launch materials and components.

Turning to the cost structure of private companies, it includes cost of sales, salaries and wages, SG&A and operations. Insurance can also be a significant item. Another cost item is radio spectrum, which is a topic in itself and often overlooked in debates about space, and yet it is a key resource for all endeavours in space for communications with Earth. It is not free and has become a financial issue with an impact on us all. Spectrum previously allocated to the satellite industry for relatively small amounts of money, is now being sought by others who are prepared to pay much higher prices.

Bringing revenues and costs together leads us to profitability, earnings before and after tax, cash flows, assets and investment, and the concept of financial measurements. Investors are looking for ways to safeguard their assets and recoup the funds they have invested usually within relatively short time frame. How profitable is the industry and what are the levels of risk that distinguishes it from other forms of investment? Profitability and earnings before interest and tax of existing major players in the manufacturing for space market activities is not always disclosed separately, as results are often consolidated with other services such as defence or security. Gross profit margins for satellite service companies are relatively high, but so is their cost of capital as reflected in high interest charges. Estimates for private sector investment vary somewhat, one estimate is US\$3.9 billion from private investors by some 120 venture capital firms⁹.

Further, existing companies in the space sector, including satellite operators and service firms, are making their own "capital investments", such as Iridium NEXT satellite constellation (Form 10K Iridium Communications Inc., 2017). However, these remain at relatively low levels compared with national budgets for other public services, such as health, and although investments made by very wealthy individuals such as Elon Musk continue to attract Media attention, the overall investment picture is mixed as to the amounts and locality.

Other factors that can affect costs and need to be considered carefully are local regulatory and legal issues impacting on space business but these go beyond the scope of this article.

⁷(source OECD [oecd.org/industry/\(ind\)imbalances_Shipbuilding_Industry.pdf](https://www.oecd.org/industry/(ind)imbalances_Shipbuilding_Industry.pdf))

⁸<https://www.theverge.com/2017/2/28/14763632/spacex-private-moon-flight-price-cost-estimate-nasa-space-adventures>

⁹<https://www.cnbc.com/2018/01/18/space-companies-got-3-point-9-billion-in-venture-capital-last-year-report.html>

The Future is Digital and Big?

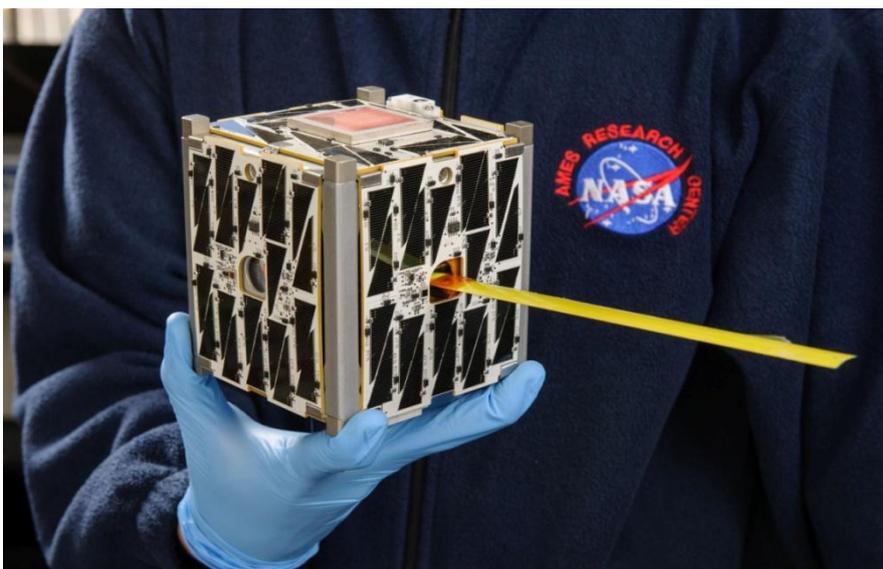
The search for new revenues is not just about finding new customers and new markets. It is also about new products and services, and enhancements to current products at affordable prices. We cannot ignore the world of digital technology, which is driving many new products and services, and has a big financial impact. Massive increases in observation data about the earth and the environment, coupled with modern telecommunications, IT systems and data analytics, all point to a new world of big data, higher volumes, and hopefully, lower unit costs and variety.

The era of “big and yet small” is upon us and a possible further example can be taken from shipping - seen from the author’s sighting of the ship in the River Thames in the UK. We might contrast some aspects of a container (a unit of capacity) business with the big data capacity business

A very big ship and a big cargo



And a very small satellite with big data to come!



Financial Measurement Issues

Financial reporting is often aggregated at a higher level so that transparency, and the visibility of business drivers and market opportunities, may be reduced. Financial reporting in the space sector is similar, in many respects, to other sectors, but techniques of measurement differ and present some difficulties for financial statements preparers where new, or different or more accurate measurement bases for revenues, costs and investment will need to be considered. Understanding and crossing these finance frontiers may help existing and new players to access and unlock new space markets, deliver new, digital services, create commercial returns and bring benefits from space to everyone on Earth.

Certainly, major space missions require a vast supply of human scientific research expertise and skills, communications technology, engineering facilities and equipment, radio spectrum management and, not least, a huge investment in financial resources and a need for measurement. Financial measurement encompasses the physical measurement of assets used, both tangible and intangible such as spectrum, and the ability to capture and record the commercial transactions that have taken place. Put simply, it involves a process of identifying the costs and benefits, both for the service provider and the consumer, typically in a very complex and long supply chain.

Measurement is a key challenge in every scientific endeavour and in business too. One possible area for further research is to think about the measurement of space financial activities in a “bottom-up” or “top down” approach. Both terms, “bottom-up” using engineering cost models and “top-down” accounting separation methods were used for costing and developing wholesale pricing methodologies within the telecommunication sector, especially as this sector moved from public to private ownership. Cost allocation methods and alternative cost standards are also being used for costing, pricing and financial and management reporting. Both approaches are needed in practice for decision making and financial reporting requirements within a varied and complex space segment market.

Financial measurement in the space sector provides some challenges for policy makers and business managers alike. Below is a summary of these.

1. Financial characteristics of the space sector. These include:
 - High market entry costs, including very high upfront costs;
 - Since space related businesses require new capabilities and new markets, the evaluation of return on investment is difficult, which will increase the risk of investment;
 - Some assets are shared, (e.g. intangible assets such as spectrum), and although sharing is often addressed in some form of legal frameworks, it goes against the concept of profit;
 - With the shared ownership of assets, commercial disagreements are likely to lead to regulators’ involvement;
 - At present, the poor transparency of the industry profitability renders investment evaluation difficult. Better segment reporting is needed for public agencies and private companies to invest in the space sector;
 - Importantly, currently access to capital and markets and know-how remains limited.
2. Similar to other industries and sectors where commercialization will involve the transfer of resources, both tangible and intangible, from a public body to a one driven by a profit motive and private ownership, which necessitates new forms of financial measurement.
3. A switch to private sector and the focus on the profit motive and more customer oriented will change the investment cycle perspective from long-term while under the control of a public

body, to medium or even short-term recognising the time value of money for institutional investors.

Non-financial measurement units are also changing in communications as we move from traditional ones such as call numbers, Erlangs and minutes to MHz and bandwidth bits per second.

Conclusions

Governments need to develop innovative policies for space and support research programmes to deliver social, environmental and economic benefits for everyone. How do academic centres and science laboratories feed into and help the space industry to grow beyond the most obvious military uses? And who will pay? Such policy questions need to be discussed and evaluated in various government and industry forums.

In theory, everyone on this planet should benefit in some way from what is done in space – Earth has a population or market of 7.6 billion people, showing a rapid growth over the past century and predicted for the future. On this planet of ours some 353,000 babies are born every day. So, what can space do, for example, for their health and development?

Space exploration and its exploitation will undoubtedly continue and gather pace in the coming years. Our sustained endeavour should, and will, push back the frontiers - this will need to involve leadership from governments and public sector agencies but will also increasingly require a more commercial approach, bringing new funding from private sector organisations. Finance must be a key enabler and needs new skills, studying not just physics, engineering or science, but understanding and learning more about finance and its impact on space activities.

Finance is perhaps a big frontier but space may have many more or at least one very big one - our understanding of it. Is availability of finance the final frontier for space? The answer is most certainly no, but finance is an enabler or resource for crossing frontiers. In practice, it is rarely easy to obtain the money needed or justify it. By viewing space from a business perspective, it becomes possible to see what are the potential rewards and benefits, both public and private. This will require financial information for the space sector to be properly reported, in a more transparent manner. With this knowledge, the real financial impact of the space sector can in future be more accurately measured allowing a full cost and benefit analysis.

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