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The New Opportunities in Space Economy

Uzay Ekonomisinde Yeni Fırsatlar

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Uzay Ekonomisinde Yeni Fırsatlar

Öz

Son zamanlarda, uzay faaliyetleri radikal dönüşümlere sahne olmaktadır. Küreselleşme ve gelişen teknolojiler uzay çağının başlangıcından beri sadece belirli ülkeler için stratejik bir tekel olan uzay faaliyetlerini de etkilemiştir. Uzay, artık süper güçlerin iki kutuplu politikalarının oyun alanı değildir. Uzay etkinlikleri günümüzde oyuncularının sayısı ve kalitesi günden güne artan, devletlerin ve özel girişimlerin ticari faaliyet konusu haline gelmiştir. Bu makale, kamu ve özel sektör bütçelerini, uzay ekonomisi gelirlerini ve resmi kayıtlardan elde edilen istatistikleri analiz ederek uzay faaliyetlerinin ekonomik ve sosyal etkilerine odaklanmaktadır. Uzay ekonomisinin gelecek yıllarda kaçınılmaz bir şekilde ülkelerin sosyo-ekonomik büyüme hedeflerini etkileyebileceği ve girişimlerin yatırım kalemlerini değiştirebileceği öngörülebilir.

Anahtar Kelimeler: Uzay Ekonomisi, Uzay Araştırması, Uzay Altyapısı, Uzay Aktiviteleri, Uzay Yatırımları

The New Opportunities in Space Economy

Abstract

Recently, space activities have been the scene of radical transformations. Globalization and emerging technologies have also affected space activities, which have been a strategic monopoly for certain countries since the beginning of the space age. Space is no longer the playing field of the bipolar policies of superpowers. Today, the number and quality of players increase day by day in space activities also become the subject of commercial activities of states and private enterprises. This article focuses on the economic and social impacts of space activities by analyzing public and private budgets, space economy revenues, and statistics from official records. It can be foreseen that space economy will inevitably affect the socio-economic growth targets of the countries in the coming years and that the enterprises may change the investment items.

Keywords: Space Economy, Space Research, Space Infrastructure, Space Activities, Space Investments

1. Introduction

Today, the world is in a competitive state focusing on the global economy. In such a world, the power to innovate and compete has been the key to economic growth and improvement in lifestyle quality. Space Technologies which has been an indispensable part of our daily lives thanks to its activities in fields such as weather forecast, global communication and publishing, air traffic management, agriculture, monitoring climate and environmental changes, telemedicine, bank card transaction (OECD, 2007:17) in addition to such potentially transformative areas as quantum calculation, artificial intelligence, nanotechnology, robotics and hydrogen fuel cells (OECD, 2008).

Space economy is not only about satellite television and global transportation also means of personal navigation such as GPS satellites, smartphones, GPS use and timing data for internet coordination (Jewel, 2015). In order to ensure that a sustainable space economy and relevant infrastructure should be developed, it shall be highly significant to make use of materials and energy resources of our Solar System. Space tourism will greatly benefit from space economy in terms of mining activities on asteroids and on the surface of the Moon and construction capacities for large scale areas on the surface of the Moon. Developing space infrastructure shall pave the way for various scientific activities such as the construction of large space telescopes, challenging space mission to outer Solar System (including manned missions) as well as construction of scientific research stations on the surfaces of Mars and our Moon (Crawford, 2016: 59).

In the distant future, an essential scientific application for a well- developed space infrastructure is likely to be the construction of interstellar drills which will contribute to the expeditions to the nearby stars and planets. Accordingly, private sector budget, sector incomes, exchange of space products in order to prove its financial and social effects. It is acknowledged that some space research activities in the future will take advantage of extraterrestrial gravity resources and the use of resources possibly anywhere (Crawford vd., 2016: 59). For instance, during scientific studies conducted on the surface of the Moon and Mars, local water resources will serve as drinking water, as well as a way to maintain personnel hygiene. Similarly, will also help provide such water resources hydrogen and oxygen required for the rocket fuel man will need for the expeditions to outer Solar System which will need space stations, new and improved satellites and new generation space telescopes (Spudis and Lavoie, 2011: 137).

This paper focuses on a strategic perspective based on data from official and private resources as well as matters of futuristic importance. By presenting numeric data on the financial scale of future estimates on space statistics; this work will analyze year- based global space investments in terms of public and private sector investments and enterprises.

2. Space Economy

Space industry includes all kinds of actors involved in space exploration and exploitation projects as well as the systematic applications of various scientific disciplines such as engineering (Strada and Sasanelli, 2018: 16) Global space sector is an advanced field of technology with a complex ecosystem since it is consisted of public institutions (space institutions, space departments of defense institutions and civil institutions), space services (broadcasting, datacasting) and various other members of service industry with pragmatic objectives (military robotics research, manned space flight, Earth monitoring and telecommunication) (OECD, 2012: 19).

Space economy refers to all kind of resources capable of adding value and efficacy to human lives while exploring, understanding, managing and exploiting space. Therefore, it accounts for all kinds of public and private actors from research development studies to space infrastructure (earth stations, launch vehicles, and satellites) and to developing, providing and using space products and services (navigation devices, satellite phones, meteorological services, etc.). Space economy has gone beyond the space industry itself in as much as space products, space services enhance the effects of (quantitative and qualitative) know-how on the society and the economy (OECD, 2012: 20).

Between 2012 and 2017, Global investments on space institutions were (10.238.3 million US dollars) three times more than the investments (3.688.7 million US dollars) made between 2000 and 2012. This makes it obligatory to set up a series of regulations and market configurations to encourage innovation ad competition in the market as well as to pave the way for cooperation opportunities between the industry and governments (Global Space Industry Dynamics and Bryce Space and Technology, 2017).

Nowadays, there is a new competition for space which is not on international but on the corporate scale. This trending phenomenon called "New Space" has become an area of financial growth tendency recognized by the world governments since it enables the digitalization industries with its infrastructure and thereby creating new employment opportunities (The Future of the European Space Sector, 2019). "This new space trend allows a significant decrase in costs and helps developing new products ans services in addition to expanding customer portfilio. So it can be said that space industry provides competitive advantage to other firms of contiries by decreasing average costs. Technological improvement and innovations are ultimately important for firms in competing with other firms" (Dilek, 2017:37).

Table 1. Volume and types of investment into space venture

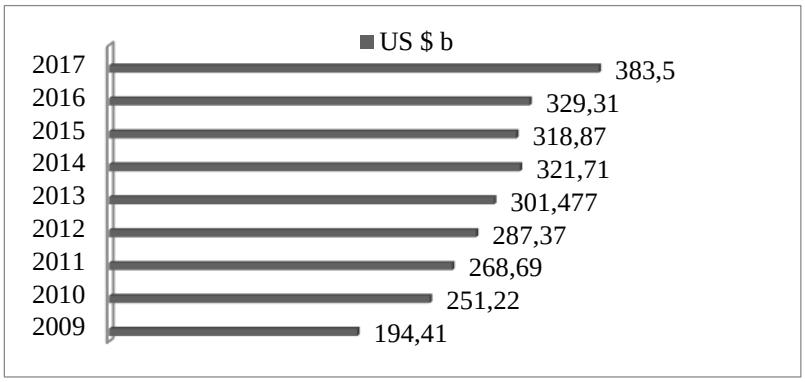
Investment into space ventures				
Investment Type	**2000-2005 (Millions)**	**2006-2011 (Millions)**	**2012-2017 (Millions)**	**Total 2000-2017 (Millions)**
Seed Prize/Grant	**$615**	**$220**	**$1.123**	**$1.957**
Venture Capital	**$228**	**$306**	**$4.680**	**$5.214**
Private Equity	**$224**	**$946**	**$185**	**$1.354**
Acquisition	**$0**	**$429**	**$2.488**	**$2.916**
Public Offering	**$0**	**$0**	**$19**	**$19**
Total Investment	**$1.067**	**$1.900**	**$8.494**	**$11.461**
Debt Financing	**$0**	**$3.007**	**$321**	**$3.328**
Total with Debt	**$1.067**	**$4.907**	**$8.815**	**$14.789**

Source: (Bryce Space and Technology, 2018).

The space sector is expected to go through a tremendous process of growth in the near future. This new space trend allows a significant decrease in costs and helps developing new products and services in addition to expanding customer portfolio. It is evident that the New Space movement is on the rise based on the data showing that there was an investment of 14.8 million Euros including a debt financing of 3.3 million Euros as of 2006 (Bryce Space and Technology, 2018).

In the future, emerging space industries might be transformed into a major part of space tourism and resource reacquisition (on planets, moon, and asteroids). Feasibility costs are based on various factors such as future regulations, international affairs, and technological developments.

Figure 1. Global turnover of the space economy (2017 prices)

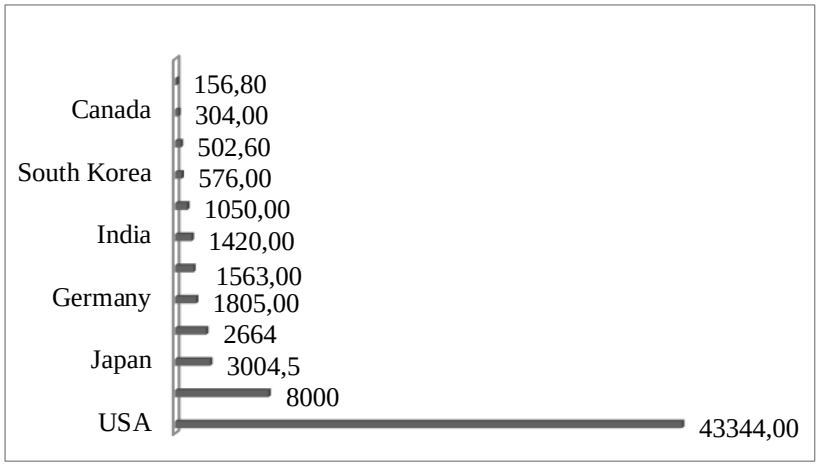


Source: (Strada and Sasanelli, 2018: 23).

Global space economy increased by 6.7% and climbed up to about 383 billion dollars in 2017. Global space economy a quarter of which is attributed to state budgets and commercial incomes between 2009 and 2017 was then influenced by the periods of recession and growth in the global economy. Between 2010 and 2014 the latest financial growth went beyond global financial growth with 6.2% (Global Space Industry Dynamics and Bryce Space and Technology, 2017).

The transformation of the space industry has been eye-catching since the 2000s with 148 billion Euro of investment. According to the data provided by the chart it can be said that total investment in space companies between 2012 and 2017 increased 3.5 times in comparison to the previous period of six months (The Future of the European Space Sector, 2019).

Figure 2. Public space budgets of major space power in 2017



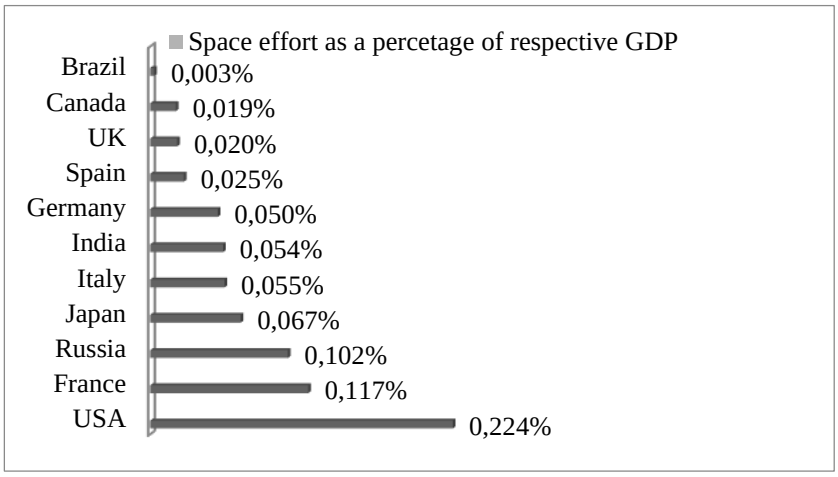
Source: (Burger and Bordacchini, 2019: 55).

Figure 2 shows us data on that the US is the country with the highest public space budget with 43.3344 billion dollars. China ranks second with 4.317

billion dollar space budget in 2016 which was later doubled with 8.000 billion dollar budget followed by an 85.4% rise (Chinese Budget Expenditures, 2017).

The fact that Japan had a space budget of 30.446 billion dollars (342.1 billion ¥) in 2017 is a direct outcome of the rising additional budget paid to JAXA. Indian experienced a growth of 870% in the commercial area with the launch of space vehicles although it had 82% share in the commercial area in 2017. While Italy had a budget of 1.05 billion dollars (from +19.4% in 2016); the United Kingdom's budget rose 4% and reached to 502.6 billion dollars including ESA budget (ESA Budget 2017, 2017).

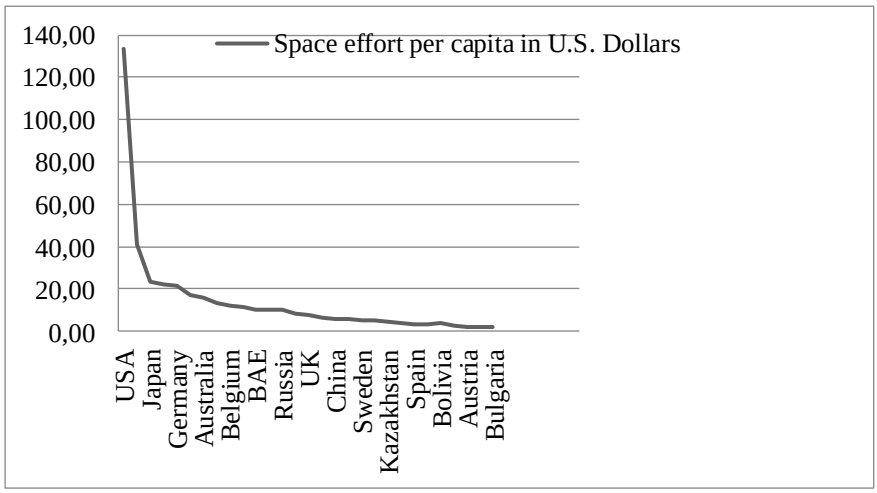
Figure 3. Public Space Budgets as a share of nom. GDP in 2017



Source: (Burger and Bordacchini, 2019:55).

Figure 3 presents data on investments in GDP in the space sector in 2017. Even if the US remains a dominant figure in the space industry; its efforts decreased to 0.224% from 0.234% in 2016. Space efforts in France slightly increased from 0.113% to 0.117%. On the other hand, Russia's efforts decreased from 0.127% to 0.102%. Japan ranks fourth at 0.067% and it is followed by Italy with 0.055%. The space efforts in the US fell dramatically by 2.5% in 2016; however, it still stands for an additional perspective with its indisputably top-ranking GDP budget of 0.050% (Bordacchini and Burger, 2018: 16).

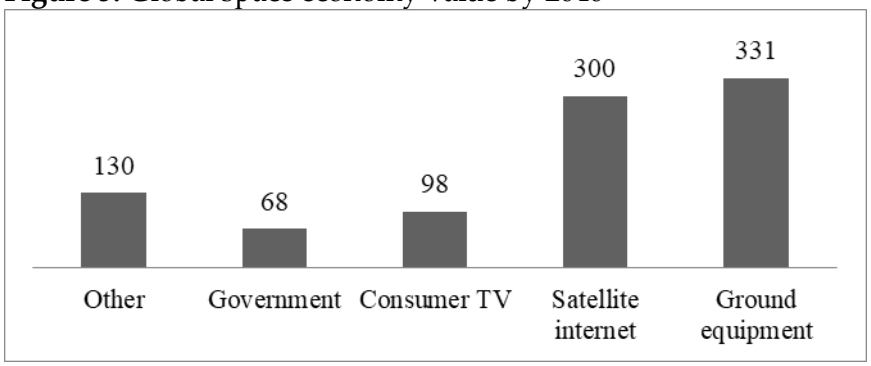
Figure 4. Public space budgets per capita (selection) in 2017



Source: (Burger and Bordacchini, 2019:56).

According to figure 4, France with a space effort of 40.98 $ per capita in 2017 did actually experience a shrinkage (43.22$). While such countries as Japan, Switzerland, China, and India are considered, it is seen that they have respectively lower figures such as 23.71$, 21.97$, 5.76$, 1.04$ (Burger and Bordacchini, 2019: 57).

Figure 5. Global space economy value by 2040



Source: (Berrisford, 2018: 6)

It is estimated that internet advertising, e-commerce and other conventional resources of internet income will have been transformed into a market of 300 billion dollars by 2040. Ground equipment markets with space observatory stations are to grow with the advent of renewable rocket technology which will lead to cheaper product launch costs and of the number of new satellites. Within the next 21 years, it is expected to have 5% of compound annual growth rate (CAGR) in annual satellite sales. It is also suggested that the earthmoving equipment market will have been 331 billion dollars by the same year (Berrisford, 2018: 6). TV market known as the clients of the satellite industry is assumed to go through a growth.

3. NASA

Following the launch of Sputnik in 1957 by the Soviet Union; an agency with the limited role and partial recognition- known as the National Advisory Committee for Aeronautics (NACA)- was transformed into the National Aeronautics and Space Administration agency in 1915. During the 1960s, the Apollo program initiated by the US government made NASA a center of attention for the next 50 years and thus the US space sector has become a strong model for the public sector ever since then (Weinzierl, 2018: 173).

Half a century ago, space represented the unknown. It was just a far-fetched science-fiction material for some minds. Nevertheless, today, it is everything that adds value to human life and this makes it more common in our daily lives and thus it has become of utmost importance. It all began when NASA initiated its first space research programs. What is being observed today is a direct outcome of that period (Griffin, 2007). New comments on the developing space economy help NASA set a route for the future of commercial manned flight along the low Earth orbit (NASA, 2019).

NASA, a center for space economy for years, has been funded by the federal reserves the US allocated from the institutions and other forms of taxes. The budget is funded as an incentive to the enterprises for collaborating with the government in space station operations, deep space researches and small groups of satellites. For instance; there is a program of $150 million just to encourage a particular growth in low Earth orbit mission. Space X and Boeing have been working on developing space capsules for the crew in order to facilitate the transfer to the space station ever since 2018. Axiom Space in Houston has been currently working on the first commercial space station in the world (Amadeo, 2019).

Table 2 below illustrates the budget to finance NASA's Moon Landing programs, as well as Mars missions, consisted of technological development and future expeditions. This table presents data on budgets for science, technology, aviation and space researches.

Table 2. FY 2019 Budget Request ($ M)

	Fiscal Year					
Budget Authority ($ in millions)	**2017**	**2018**	**2019**	**2020**	**2011**	**2022**
NASA TOTAL	**$19,653.3**	**$19,519.8**	**$19,892.2**	**$19,595.2**	**$19,592.2**	**$19,592.2**
Deep Space Exploration Systems	**$4,184.0**	**$4,222.6**	**$4,558.8**	**$4,859.1**	**$4,764.5**	**$4,752.5**
Exploration Systems	**$3,929.**		**$3,669.8**	**$3,790.5**	**$3,820.2**	**$3,707.5**

Development	**0**					
Advanced Exploration Systems	**$97.8**		**$889.0**	**$1,068.6**	**$944.3**	**$1,045.0**
Exploration Research and Development	**$157.2**		**$0.0**	**$0.0**	**$0.0**	**$0.0**
Exploration Research and Technology	**$826.5**	**$820.8**	**$1,002.7**	**$912.7**	**$912.7**	**$912.7**
LEO and Spaceflight Operations	**$4,942.5**	**$4,850.1**	**$4,624.6**	**$4,273.7**	**$4,393.3**	**$4,430.3**
International Space Station	**$1,450.9**		**$1,462.2**	**$1,453.2**	**$1,471.2**	**$1,466.2**
Space Transportation	**$2,589.0**		**$2,108.7**	**$1,829.1**	**$1,858.9**	**$1,829.2**
Space and Flight Support (SFS)	**$902.6**		**$903.7**	**$841.4**	**$888.2**	**$934.9**
Commercial LEO Development	**$0.0**		**$150.0**	**$150.0**	**$175.0**	**$200.0**
Science	**$5,762.2**	**$5,725.8**	**$5,895.0**	**$5,859.9**	**$5,841.1**	**$5,822.4**
Earth Science	**$1,907.7**		**$1,784.2**	**$1,784.2**	**$1,784.2**	**$1,784.2**
Planetary Science	**$1,827.5**		**$2,234.7**	**$2,199.6**	**$2,180.8**	**$2,162.1**
Astrophysics	**$1,352.3**		**$1,185.4**	**$1,185.4**	**$1,185.4**	**$1,185.4**
Heliophysics	**$674.7**		**$690.7**	**$690.7**	**$690.7**	**$690.7**
Aeronautics	**$656.0**	**$655.5**	**$633.9**	**$608.9**	**$608.9**	**$608.9**
Education	**$100.0**	**$99.3**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
Safety, Security and Mission Services	**$2,768.6**	**$2,749.8**	**$2,749.7**	**$2,744.8**	**$2,738.6**	**$2,732.3**

Center Management and Operations	**$1,986.5**		**$1,949.6**	**$1,945.4**	**$1,939.8**	**$1,934.1**
Agency Management and Operations	**$782.1**		**$800.1**	**$799.4**	**$798.8**	**$798.2**
Construction & Envrmtl Compl Restoration	**$375.6**	**$358.3**	**$388.2**	**$293.8**	**$293.8**	**$293.8**
Construction of Facilities	**$305.4**		**$305.3**	**$210.9**	**$210.9**	**$210.9**
Environmental Compliance and Restoration	**$70.2**		**$82.9**	**$82.9**	**$82.9**	**$82.9**
Inspector General	**$ 37.9**		**$39.3**	**$39.3**	**$39.3**	**$39.3**
NASA TOTAL	**19,653.3**	**$19519.8**	**$19,892.2**	**$19,592.2**	**$19,592.2**	**$19,592.2**

Source: (NASA, 2019: 17).[1]

4. SpaceX

SpaceX has been a milestone in the history of the space industry and thus received worldwide recognition. It is the only private company which has ever brought a space vehicle back from low Earth orbit in 2010. The company is also the first to deliver shipment to International Space Station with its Dragon Space Vehicle. Nowadays, the company has been working on flight-proven rocket technology. In 2018, SpaceX also managed to launch Falcon Heavy, the world's most powerful operational rocket. Following the success of Falcon 9 and Falcon Heavy, SpaceX has been working on the most powerful, new generation launch vehicle which has ever been built so

[1] FY 2017 reflects funding amounts specified in Public Law 115-31, Consolidated Appropriations Act, 2017. Table does not reflect emergency supplemental funds also appropriated in FY 2017, totaling $184 million. FY 2018 reflects Continuing Resolution funding as enacted under Public Law 115-56, as amended.

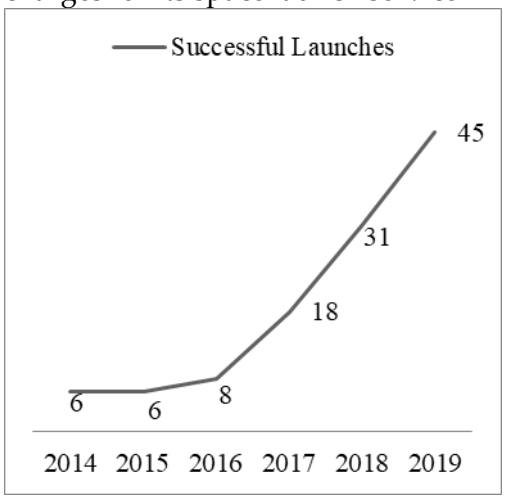
that it can transport people to Mars and other destinations in our solar system (spacex.com, 2019).

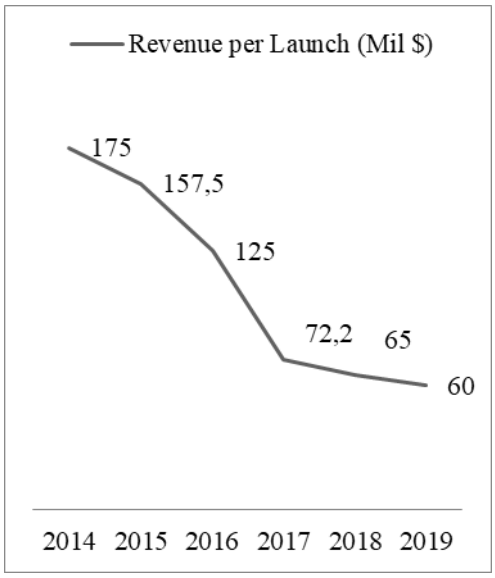
In December 2008, NASA declared that Falcon 9 launch vehicle and Dragon space shuttle of Space X was chosen to restore the space station after Space Shuttle program ended in 2011. As per CRS agreement, SpaceX thus acquired a considerable ability to purchase and return products in the US (SpaceX, 2015: 3). In January 2015, SpaceX announced that it was going to step into the industry of satellite service providers; and that it had been planning to build a satellite manufacturing facility in Seattle, Washington. It also stated that its internet service would operate on a network of 4000 satellites each of which has an orbit of 1100 km and added that the service will start to provided in 2020 (Selding, 2015). In so doing, Elon Musk aims to facilitate SpaceX to start a colony on Mars by enhancing the profit and cash flow.

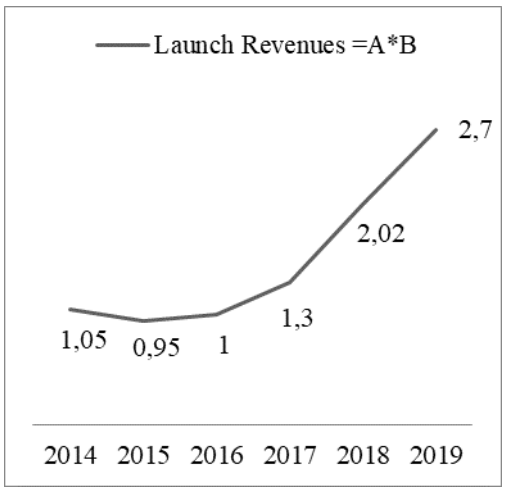
According to CrunchBase; based on the data provided by SpaceX annual financial reports, the company managed to provide a fund of 214 million dollars in a series in 2018 April, which accounts for the company's most recent funding activity and the company has also able to earn some 1,9 billion dollars in total ever since 2002 (SpaceX, 2018). The current total value of the resources varies from 33 to 35 billion dollars (Forbes, 2018; SpaceX, 2019).

SpaceX has revolutionized the space technology by manufacturing advanced rockets and space vehicles and launching them to the market. Ever since 2002, the company had some considerable breakthroughs by recycling various components of several rockets. The only source of income for SpaceX is the space launch service shipping to the International Space Station and launching satellites to the low Earth orbit. However, the increasing valuation may lead to a greater potential income in the future and its space-based global internet network and renewable rocket technology can significantly contribute to a transportation network in space (Henry, 2019).

Figure 6. Revenues for SpaceX are currently limited to the fee it charges for its space launch service



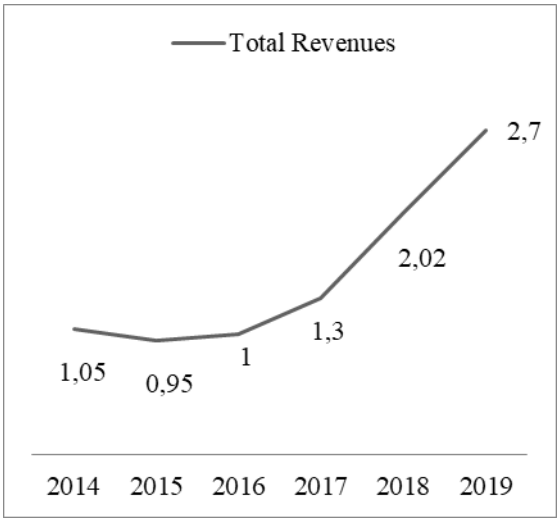


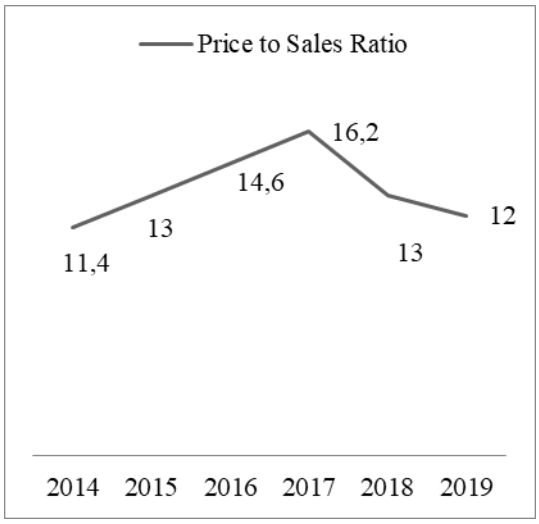


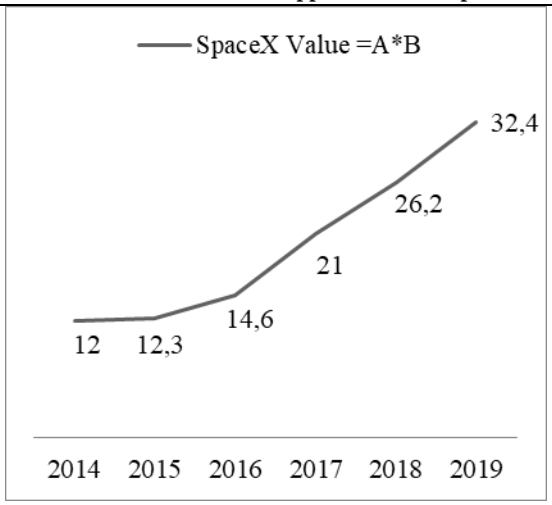
Source: (Trefis: Collaborate on Forecasts, 2019).

The number of successful launch missions increased from 6 in 2014 to 8 in 2017. However, it actually peaked in 2018 with 31. Initially, SpaceX had relatively more expenditures than expected due to long term contracts; as a result, the income per launch steadily decreased.

Figure 7. The estimated value of SpaceX was found to be approximately 27$ billion in 2018; yet it is soon to be more than $32 billion in 2019.







Source: (Trefis: Collaborate on Forecasts, 2019).

The funding which was 12 billion dollars in 2014 and later climbed up to 21 billion dollars in 2017, is expected to double in 2019. When this sales price is considered for the growth potential, it is a remarkable source for Starlink and super speed Earth travel.

5. Space Industry's Growth to 2030

OECD Space 2030 (2004) report was issued with the purpose of studying financial problems for the decision-makers in governmental and non-governmental institutions. This report studies the future development in the commercial and civil area as well as its influences on global economies and thus underlines the importance of national security and environmental problems as key future concerns. The report also focuses on how the space sector will be transformed in the next 20 years and possible scenarios for the geopolitical developments, socio-economic improvements in addition to energy, environment and technology scenarios (OECD, 2004).

In the next 20 years, the financial power shall be observed in three geographical locations: the US, Europe, and China. The financial powers of Europe and the US got weaken since China had a strong acceleration against the West. The world geopolitical power has to poles: the cooperation between the US and Europe and the cooperation between Russia and China. The competition between these two poles reflects itself in all kinds of political matters. Access to natural resources is a very competitive and strategic national problem. Dependency on fossil fuels is still on the rise an due to the minimum global cooperation for dealing with greenhouse gases and high fossil fuel consumptions; the environmental conditions are getting worse (Whealan, 2013: 11). Meanwhile, Turkey has established the Turkey Space Agency on 13.12.2018. The institution has many tasks. Commercial, scientific and research-development aimed space operations are one of these

tasks. The agency's tasks include also the development of the competitive space industry. (Resmi Gazete, 2018).

Technological developments are being restricted due to difficult financial circumstances and military inspiration should be prerequisite for technology in terms of commercial growth. Space sector shall make use of budgets for national budgets supporting military implementations. Commercial applications shall perform slower progress due to international tensions but will rise with a search for decreasing the cost for area Access and dual technologies. Civil area applications will focus on "soft national power" or the creation of national prestige and thus on local use of finances. The space sector has a nationally protective nature; this particularly enables a market sustainability thanks to advanced technology transfers. Due to financial blocs who merely care for their own strategic interests; commercial space industry develops and grows in a stronger but slower way (OECD, 2004).

So, what sort of difficulties shall mankind expect when a society is finally settled in space? The exploitation of natural resources for the development of space systems might have a significant contribution to the society and this would justify any socio-economic costs. For further analysis, environmental difficulties, exploitation of natural resources, increased mobility of men and goods and its outcomes need to be studied as well as increased security concerns and precautions.

Conclusion

In the early years of space activities, the US and the USSR had a noticeable space capacity. During the Cold War, national security and -in particular- the nuclear threat was indeed a decoy for achieving financial and technological superiority in the space race. The US might be a leader in the space technology but its dominance in various space markets is somehow limited. The space power which was once considered to be a criterion for commercial heroism is now about to be shared among countries conducting space flights. Isolation and policies to protect the intellectual property in commercial industries just allow others to develop similar products; which will eventually lead to a dead end. Therefore, policies and incentives encouraging research and development programs are an integral part of space programs as long as a bigger and stronger financial competition is desired in the market (Hertzfeld, 2007: 220).

Globalization is a natural process for space industry thanks to the development of more space programs in different states; multiplication of value chains in commercial actors; sustainable digitalization trends and new space systems in the Space Age. This work studies new and internationally comparable data and tables to explain these trends. The importance of space activities is particularly emphasized for developing countries in terms of their economic development, scientific research, and innovation as well as for social welfare. Therefore, it is recommended to make ultimate use of space investments so that sustainable socio-economic growth is achieved.

Investments in the space industry are increasing rapidly and it is a must for governments to make these investments. The space industry has the power to affect more than one industry. It also has the potential to generate high income. It is, therefore, an opportunity for private companies. Recent developments show that in the future space industry will occupy more space on the agenda of society and governments. Countries that want to increase their socio-economic growth target towards the 2030s will need to allocate more space to their space industries than their budgets.

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