European Economic Letters
ISSN 2323-5233
Vol 13, Issue 4 (2023)
http://eelet.org.uk

A Study on Demand and Supply side forces of Global Space Economy and its various determinants.

Gaganpreet Kaur Ahluwalia[1], Vidya Nakhate[2], Dhirendra Kumar[3], Ragini S. Bhat[4], Samrat Ray[5]

[1]Associate Professor, ISBS PGDM, higaganpreet@gmail.com

[2]Director, SIBACA, Lonawala, vidya.nakhate10@gmail.com

[3]Associate Professor, SBIIMS, Pune, India;dhirendra1908@yahoo.com

[4]Assistant Professor, SIBMT, Pune, India, raginis.bhat@gmail.com

[5]Dean, IIMS, Pune, samratray@rocketmail.com

*Corresponding Author: dhirendra1908@yahoo.com

Abstract

Purpose: The Space sector and space economy continues to be the new and emerging sector which has attracted attentions of all the countries and institutions. There has been lot of initiatives both by private space agencies and public funded agencies in order to understand the wide horizon of the sector as well as its functioning. However, still lot of things remains unexplored about this sector and the size of its economy. The author in this chapter investigates the various dimensions of space economy, its economic forces of demand and supply, the various sectors it influences and various initiatives taken by countries in order to explore the sector.

Design/Methodology/Approach: The Research design selected for the study is exploratory as the researchers have just begin to investigate about the topic and wish to understand the different dimensions of global space economy. There are very few research works being conducted on the topic and still many things remain unexplored.

Limitations/Implications: The limitation of the study is that the researchers have studied the subject of space economy considering only the selected dimensions. The space sector in itself is in a state of continuous exploration and thus the researcher's viewpoint and observations during the period of study and findings thereafter may vary. It may happen that many subsectors and variables which will impact the space sector and its economy may not be touched by the researcher because these areas of space are at its nascent stage of exploration.

Originality/Value: First and foremost is that there are only few research papers based on the subject of study. The existing literature and research papers have only considered limited dimensions of the subject. Besides there are only few research papers which have done a comparative analysis of initiatives taken by countries, try to understand the size of economy and various sectors which directly or indirectly becomes influences space economy. Thus the researchers will try to assess the economic size and different economic variables which become part of larger space economy.

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 4 (2023)
http://eelet.org.uk

Type of Research Paper: Conceptual Paper

Keywords: **Space, Global, Economic size, Demand, Supply, Country**

I. Introduction

The Bureau of Industry and Security (2013, 5) defines "Space-related goods and services as any product, service, or object that is used in or launched into space or used to directly or indirectly support space applications from Earth and used to manufacture any product that is used in space or directly supports space applications".

The Congressional Research Service (2012, 1) defines the space industry "as set of economic activities related to the manufacture and delivery of components that go into Earth's orbit or beyond".

According to OECD (2012, 20) "The Space Economy includes all the set of activities and use of resources that add provides value to the human beings in exploring, understanding and utilizing the various resources directly and indirectly linked to space. Thus, it involves all the public and private players involved in developing, providing and using space related products and services, research and development, manufacture and use of space infrastructure such as ground stations, launch vehicles, and space enabled applications. Besides, it also includes values driven knowledge related to space related activities".

The White House (2010, 10) refers the term commercial space as "goods, services, or activities provided by enterprises which takes the larger responsibility for the investment risk, tries to minimize the cost, optimize the return and have the power to provide these goods and services to existing or prospect customers".

The Harvard Business Review defines "Space Economy to the goods and services produced in space for use in space such as mining the moon or asteroids for material".

Thus, based on the above definitions, the researcher is of the view that the definition given by OECD is comprehensive and it involves and includes all the goods and services related to space exploration, utilizing various space related infrastructure, and its influence on economic activities on the earth.

II. Objectives of the Study

a) To study the various demand and supply side forces of Space economy..

b) To study the various dimensions of global space economy based on existing literatures.

c) To do a cross country analysis of various players (countries) in the sector.

d) To study the initiatives taken by selected countries in order to explore the space sector.

III. Research Methodology

The Research design selected for the study is exploratory as the researchers have just begin to investigate about the topic and wish to understand the different dimensions of global space economy. There are very few research works being conducted on the topic and still many things remain unexplored. The

researchers will try to derive conclusions based on existing literatures and further try to investigate and explore the subject of global space economy, its dimensions, forces which influence demand and supply in the space sector and different emerging issues.

IV. Economic Analysis

IV.1. Economic Forces of Demand and Supply in the Indian Space Sector

With the success of exploratory missions in space, the government and the policymakers around the world are in race for developing space-based tools which can have wider commercial applications influencing beyond sky to earth and oceans. The Space Economy has directly and indirectly involves and influences different sectors and sub sectors of the economy. The important sectors such as transportation and logistics, oil and gas, internet, meteorology, finance, telecommunication, maritime, urban development, education, health and medicine largely gets influenced by the space related activities. Thus, the overall size of space economy becomes very difficult to imagine considering its vast length and breadth and related sectors which it influences. Thus, this sector is not only considered to be a growth sector but influences growth in other sectors as well.

The Space economy is classified into two heads i.e. Space for Earth Economy and Space for Space Economy. The Space for Earth Economy relates to goods and services produced in space for use on earth. It includes telecommunications and internet infrastructure, earth observation capabilities, national security satellites, health services and more. In the recent years, due to decrease in costs for launch and space hardware, this sector has the potential to grow at a much higher level. The Space for Space Economy relates to goods and services produced in space for use in space such as mining the moon or other asteroids for material in order to build in space habitats and fuelling stations (Sarang M, Weinzierl Matthew). However, this is the segment which is least explored but the initiatives by public and private space agencies may initiate the production of goods and services made in space. The increase in space tourism may require service stations, fueling stations in space. According to a report by Morgan Stanley, the global space industry can cross over to 1 trillion $ by 2040.

	2016		2040	
Internet	-	-	412 bn $	39.13%
Ground Equipment	113 bn $	33.33%	196 bn $	18.61%
Government	84 bn $	24.78%	181 bn $	17.19%
Consumer TV	98 bn $	28.91%	117 bn $	11.11%
Consumer Broadband	-	-	95 bn $	9.02%
Other	44 bn $	12.98%	52 bn $	4.94%

Table no.1: Size of Global Space Economy, Source: Satellite Industry Research, Morgan Stanley

a) Demand Side Forces

The overall demand related to space activities is mainly derived. It includes the manufacture of launch vehicles and the provision of a variety of launch-related services ranging from vehicle integration, spaceport activities to insurance and financing services. In addition, there is ground station equipment, software support, and satellite operations and control facilities that would not exist if there were no economic uses for space assets. At the consumer end, examples of products that are derived from the uses of space include the demand for satellite broadcasting receivers and decoders, satellite radios, and navigation (GPS) equipment. The different sectors of the economy such as telecommunication, meteorology, space tourism, health and medicine, education, information technology, finance, aviation is based on space sector and hence derives demand from these sectors.

b) Supply Side Forces

The supply-side forces consist of those firms that manufacture space equipment, provide space services and operations, and market those services to end consumers. This will also involve services related to these activities such as service distribution and other space services. Besides, there will be manufactures who deals in consumer and capital equipment related to use of space information. The overall supply side forces include companies involved in manufacture of space equipment, telecom and IT and IT enabled services providing companies, financial institutions, educational institutions, satellites manufacturing companies, companies entering space tourism etc.

IV.2. Space Economy and its Multiplier Effects

The Space economy and its variables have a multiplier effect on the global economy touching almost all the economic activities, sectors and planets from earth to space. The economic activities pertain to different aspects right from defence, infrastructure, meteorology, climate change, and telecommunication, education to even land and water management. Besides, its impact is far reaching on employment, revenues, productivity efficiency gains, food safety, cost avoidances, technology transfer, national security, international cooperation, pollution abatement etc.

The multiplier effects of space economy can be justified by the fact that it has influenced many sectors and activities related to it. The various **upstream activities** as part of space economy are manufacturing of launchers, satellites etc. As on date, the economic cost of small satellites has been reduced and that is playing a vital role in transforming the industry. There is a need to build global collaborations consisting of different economies, private agencies and technocrats to build capabilities in order to design and manufacture customized products in order to explore the unexplored. This will induce synergetic impact and will be revolutionary in the future course. Further, there will also be increased demand for servicing and fueling stations in space. According to a report by National Sky Research, the total market size of in orbit servicing will be USD 4.5 bn. by 2028. Besides according to a report by Euro consult, the launch and manufacture of small satellites together can increase up to USD 42.8 bn. by 2028. Thus, there is going to be thriving demand which will encourage economies to invest more in this sector.

European Economic Letters
ISSN 2323-5233
Vol 13, Issue 4 (2023)
http://eelet.org.uk

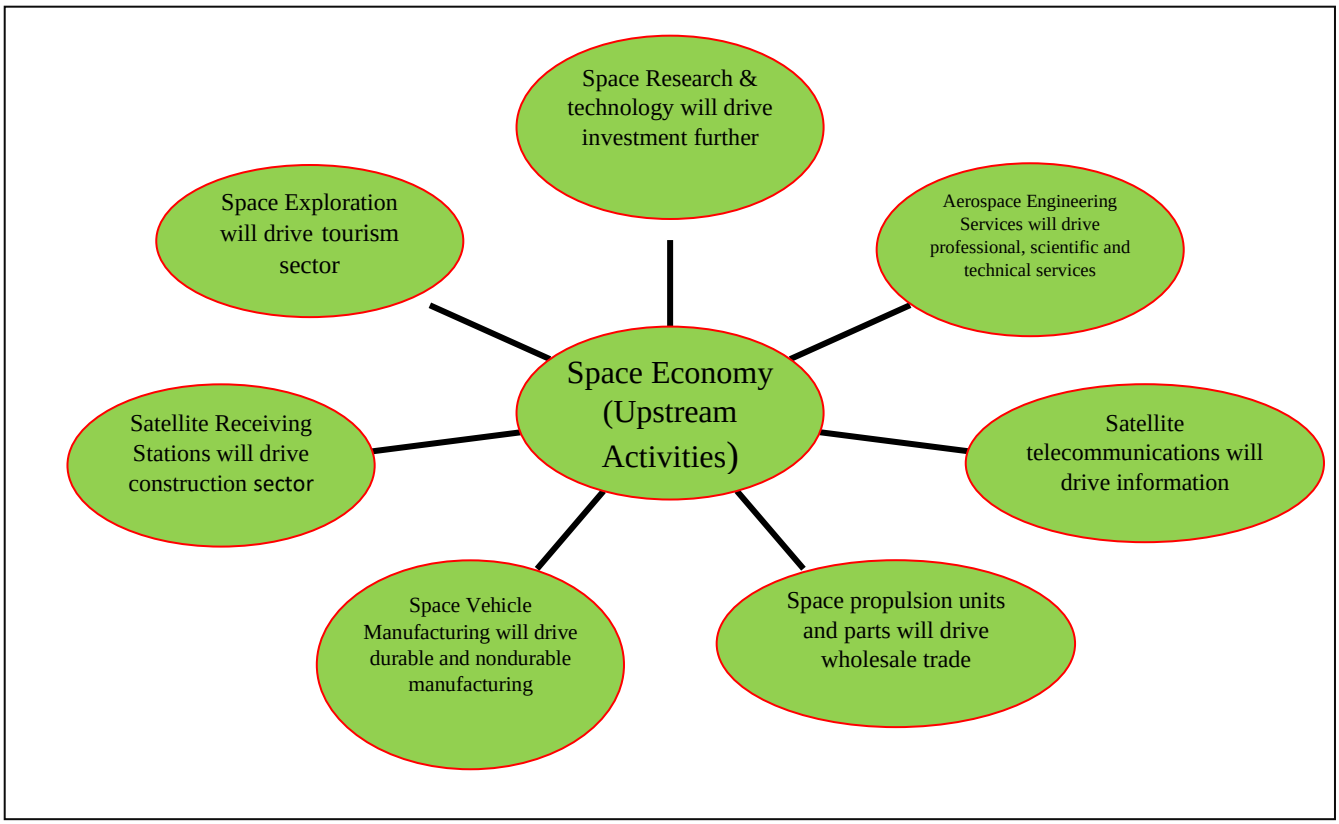


Fig.1. Space Sector: Upstream Activities influencing other activities, Source: OECD

There are various **downstream** activities which are the outcomes of space economy/sector. The various economic activities on the earth today are largely dependent and controlled from space. The technology transfers from the space have far reaching applications in automotive, educational, medical and other sectors. This will create wide horizons of services right from IT and IT enabled, artificial intelligence, data analytics and other services having larger commercial values and applications. The demand for earth observation satellites, meteorological and communication satellites will grow not because of only advanced economies but also by newly emerging developing economies from Asia and Africa. The earth observation satellites has far reaching applications right from urban and rural infrastructure development, geographical information, coastal land use regulation, road network monitoring, environmental conservation, disaster management, defense etc. These satellites help the companies to track the consignments, people thus helping in the supply chain management. The meteorological satellites help in monitoring of weather and climatic conditions by forecasting temperature, humidity, disaster warning etc. The communication satellites have completely changed and revolutionized the various activities on earth such as television and DTH (Direct to Home) services, radio networking, telemedicine, tele education. The various online courses introduced by universities across the globe is an example to showcase the importance of communication satellites.

Thus, concluding the researcher is of the view that the overall space ecosystem will be driven by space tourism, satellites manufacturing, earth observation, meteorological and communication satellites, space adventures, satellite launch pads etc.

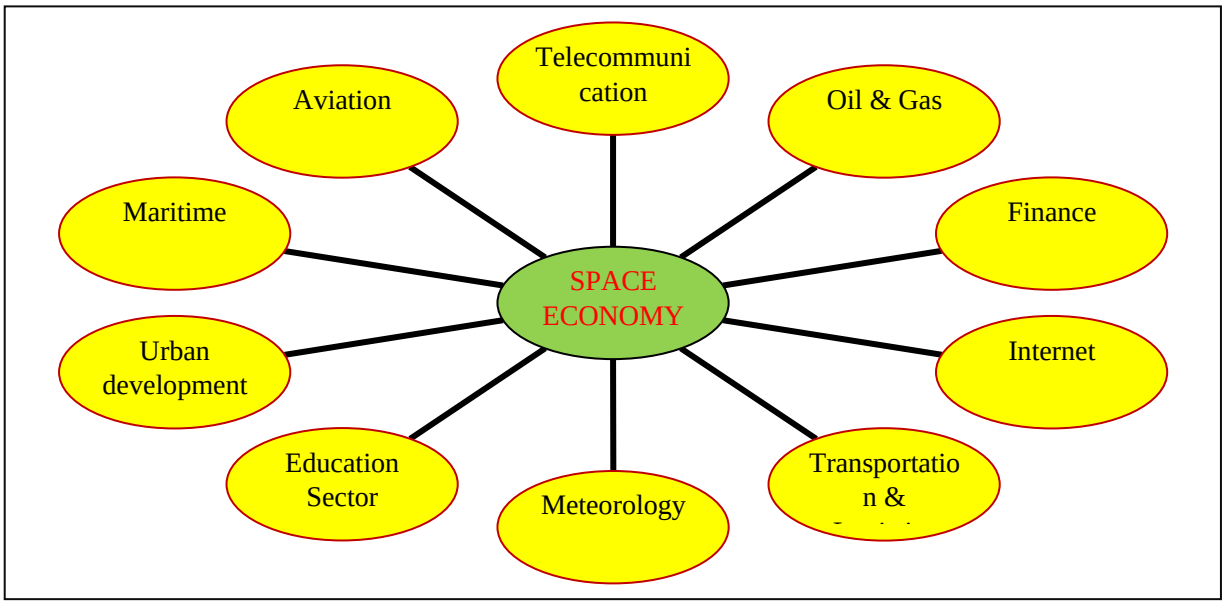


Fig. 2: Space Sector driving other sectors of the Economy/Downstream

Growth in the space sector has centrifugal effect on other sectors of economy through better productivity and efficiency gains. The new remote and extreme environment medicine techniques can assist rural medical practices; robotics can manage agricultural activities, helping farmers manage their land. However, it is very difficult to quantify the exact benefits stemming from the space sector.

V. Cross Country Analysis

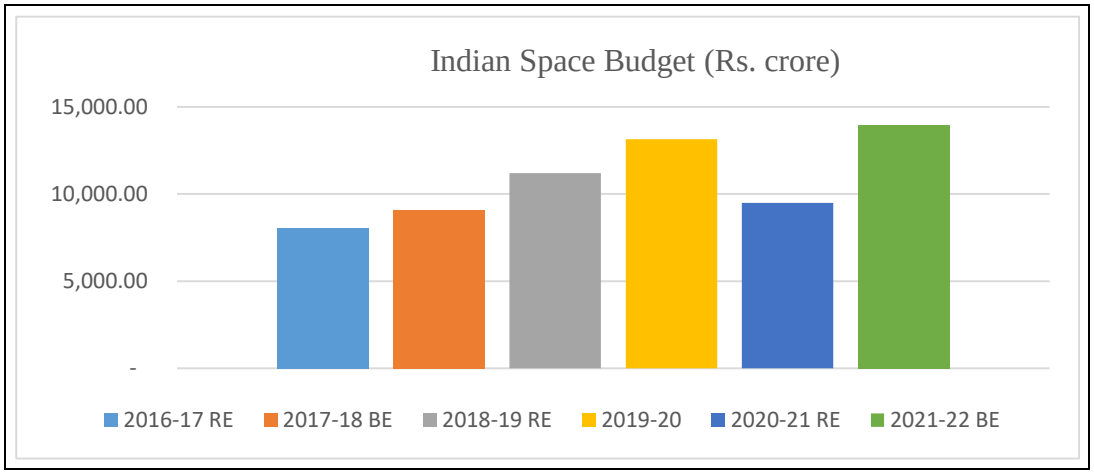
a. Indian Space Sector

In India, Indian Space Research Organization (ISRO) is responsible for driving the space activities. Although several private sector companies have engaged with ISRO as suppliers and component manufacturers, they have never been vested with the responsibility of end-to-end manufacturing of space systems. With the advent of New Space, many start-ups who are looking to exploit the opportunities in the growing global and Indian space markets have emerged within the Indian space domain. The various startups are coming with new technologies directly or indirectly in upstream as well as downstream space activities. The Indian space economy is valued at USD 7 billion which is 2% of the global space economy.

India's Space Budget (Rs. Crore)

2016-17 RE	2017-18 BE	2018-19 RE	2019-20	2020-21 RE	2021-22 BE
8045.28	9093.71	11200	13139.26	9500	13949

Table no. 2: India's Space Budget



Source: ISRO Annual Reports, Figure no.3: India's Space Budget

Challenges

a) There is no legislation in India in order to regulate the commercial activities in the space sector. There is lack of clarity which may lead to multiple risks to businesses. The Government needs to clarify its stand on space related activities which can create conducive business environment in the sector.

b) There is still lack of awareness about the global space industry and technical know-how amongst larger population base. There is a need for more research and development in this sector which will help in exploring the sector further.

c) The regulatory guidelines will no doubt induce private investment in this sector and well also revive the spirit of entrepreneurship.

b. USA

The National Aeronautics and Space Administration (NASA) is America's civil space program and is one of the pioneers in global space exploration. The overall annual budget of NASA is 23.2 billion $ in fiscal year 2021 which is approximately 0.05% of the overall US Federal budget. The agency supports employment to more than 3 lakhs of people and contributing to about 64.3 billion $. The scope of its work includes studies about earth, sun, moon and other planets including Mars. The agency focuses on human explorations and operations, space technology, earth science, aeronautics research, safety, security and mission services, construction and environmental restoration.

US Space Economy Gross Output by Industry (billion $)

	2013	2014	2015	2016	2017	2018	2019
Total Space Economy	181.9	184.4	190.4	190.5	190.4	192.4	194.5
Manufacturing	55.2	53.04	52.08	51.40	49.72	50.56	51.15
Wholesale Trade	25.03	26.45	29.33	31.0	31.6	33.5	31.5

Information	60.4	63.18	65.5	64.06	63.57	60.68	59.70

Source: US Bureau of Economic Analysis, Table no.3

Note: The space economy includes space related goods and services both public and private which are used in space or directly support those used in space and are associated with studying space.

The above table depicts that the US Space economy has grown at an average rate of 1.5% during these years. The information sector is the largest contributor to the space economy which indicates the emphasis given to communication satellites. Manufacturing is the second largest sector followed by wholesale trade.

c. China

China National Space Administration (CNSA) is the government space agency of China. The agency is responsible for all types of space exploration, space administration and international space cooperation. According to a report by Future aerospace, the Chinese commercial space investment and financing had a total value of about 520 million $ in 2018 which is going to increase to 4.4 billion $ by 2025. The Chinese space sector includes orbital launches, satellite internet, commercial launch vehicles, satellite communications, digital transportation, ground equipment manufacturing, earth observation and navigation, heavy lift rockets etc. Besides there are many Chinese universities which are contributing to research and development in space technologies and training the required human force. The Chinese Government has already given its recommendation for private sector participation in the space industry which will lead to expansion of its space sector. The Government space budget share of GDP (in 2017) was 0.08%. In the recent years the commercialization of Chinese space sector has increased with more than 100 companies raising up to US $ 6.5 billion. Although this is only a small share of annual revenues (US $ 35 billion) of the state-owned space companies, but the silver lining is that these figures are increasing.

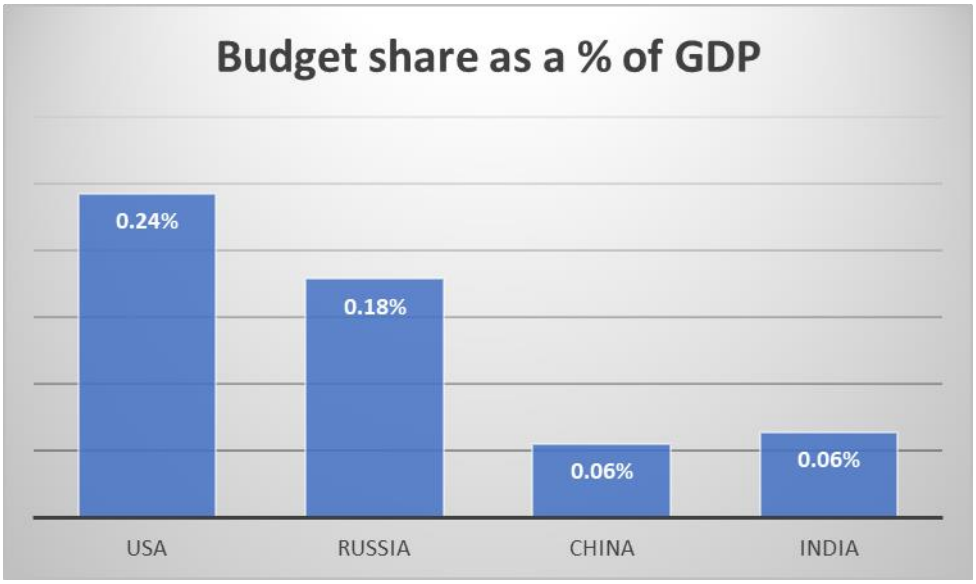
d. Russia

Roscosmos is the state space agency of Russia responsible for space flights, cosmonautics programs and aerospace research besides others. The annual budget of the agency is US $ 2.77 billion in 2020. The Soviet Union is credited with world's first satellite sputnik in 1957 followed by the first man and woman in space. However, in the recent years, the Russian space initiatives have faced different hurdles. Due to stagnation in the economy, the government has approved a budget of 17.93 billion euros from period 2016- 2025. The private investment in the sector is very low in account of low profitability. The space sector is further hit by outdated and old production infrastructure, ageing population, low productivity etc. Thus the country which was pioneer in this sector once has lagged with its peers.

f. Countries Wise -Budget Estimates (As a % share of GDP in 2019) and Expenditures

USA	**Russia**	**China**	**India**
0.243%	**0.179 %**	**0.055%**	**0.064%**

Table no.4: Budget estimates as % of GDP

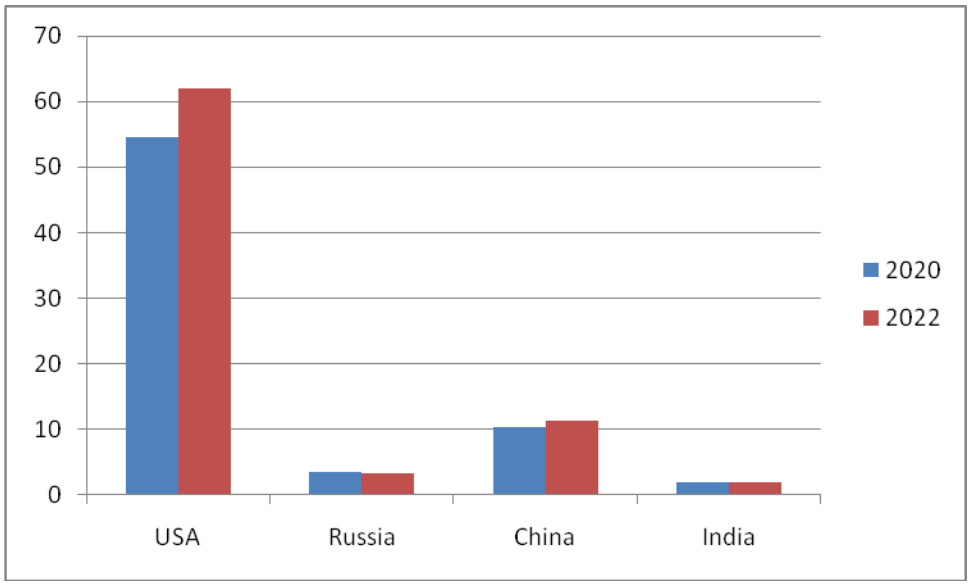


Source: Government Budget Sources and OECD database, Figure no. 4: Budget share as % of GDP

Govt. Expenditures on space programs (US $ bn)

	USA	**Russia**	**China**	**India**
2020	54.59	3.57	10.29	1.96
2022	61.97	3.42	11.34	1.93

Source: Statista, Table no. 5: Government Expenditures



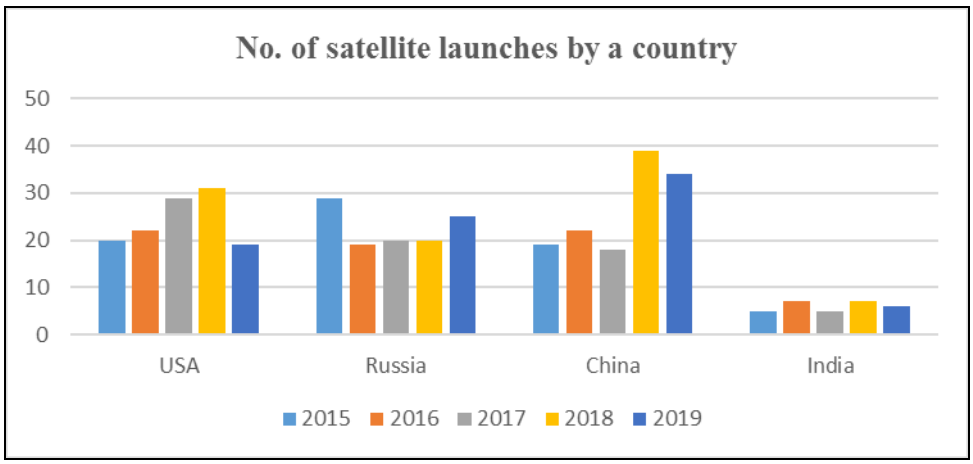
Source: Statista, Figure no. 5: Government Expenditures

Interpretation: Based on the above tables, US is the largest spending country both in terms of total expenditure and as a share of its GDP. The overall expenditures in case of USA and China seem to be increasing while in case of India and Russia seems to be stagnating. Considering the state of Indian economy, this magnitude of expenditure may not be considered to less but given the vast opportunities in the space sector, India needs to step in order to catch up its competitors.

g. Number of satellites launches by country

Country	2015	2016	2017	2018	2019
USA	20	22	29	31	19
Russia	29	19	20	20	25
China	19	22	18	39	34
India	5	7	5	7	6

Table no. 6: No. of Satellites



Source: ISRO, Figure no. 6: No. of Satellites

Observation: As far as satellite launching services are concerned, USA, Russia and China dominate the global world while India lags behind. This further explores another economic opportunity for the countries to launch satellites of other countries from their space stations. In the recent years, these trends have increased. Besides the costs of launching also have reduced with many countries want to launch small satellites. China has increased the pace of satellites launches in recent years racing much ahead of USA.

h) Total Turnover of the Global Space Economy (Bn. US $)

2015	2016	2017	2018	2019	2020	2021
323	329	383.5	414.75	423.8	446.88	469.3

Source: Statista 2023 Table no.7: Total turnover of the Global Space Economy

Observation: The total turnover of the global space economy has increased consistently in these years. This is an indication of the expanding horizon of global space economy and its magnitude. This also

indicates that the countries are exploring different options to ensure maximum benefits from space related activities and ensuring its larger impact on earth. The space economy is worth 469 billion US dollar (The Space foundation's The Space Report 2022).

VI. SWOT Analysis and Intervention tool of Global Space Industry

Based on the various existing research articles and literatures, the researcher has developed SWOT analysis of the global space industry.

SWOT Analysis	
Strengths	• Need to target commercial space opportunities both in the upstream and downstream sector
Weaknesses	• Inadequate private capital investment • Poor Coordination amongst existing stakeholders • Unable to leverage the synergic effect of coordinated efforts from private and public sector • Poor and unclear regulatory compliances of few countries • Unclear and uncertain horizon of space
Opportunities	• There is a larger scope to expand space services in order to attain economies of scale • Larger scope for applications in medical, weather, security and other areas for betterment of human beings. • There are many things which need to be explored regarding space debris.
Threats	• Space should not be used for military and missile testing exercise which can endanger human survival • Less insights as far as space exploration policy is concerned

Table no.8, SWOT Analysis

VII. Intervention Tools

a) The government around the world must come together with better regulations to develop a stable space economy. The governance framework of the space such as property rights over water, ice, parking slots need to be decided by countries.

b) Most of the initiatives in the space sector till now have been carried by government and its agencies. There is need of private sector participation considering their higher risk appetite. The policy makers need to encourage private sector to explore the sector.

c) There is a fear that geopolitical tensions of the earth may undermine the development of space for space economy. Thus, geopolitical rivalries of earth should not any way hinder the progress in space nor scare resources of space to be used for military capabilities.

VIII. Limitations of the Study

a) The exact magnitude of the space economy seems very difficult to measure at this stage considering the many dimensions of space being unexplored.

b) Countries have to redefine the scope of measuring GDP considering the commercial activities performed by them in space. So, economic growth will also be attained from space activities. The traditional political/geographical boundary in measuring GDP needs to be redefined.

c) The overall analysis is merely based on projections by various agencies and organizations and so there are chances of deviations in projections of the data related to global space economy.

d) The study is based on secondary sources collected from different institutions/websites which many give varied estimates, size of the overall space economy.

References

[1] Bureau of Industry and Security. 2013. "Defense Industrial Base Assessment: U.S. Space Industry 'Deep Dive." U.S. Government Survey. Retrieved November 21, 2019 from www.bis.doc.gov/index.php/documents/other-areas/561-space-deep-dive-survey-usg-pdf/file.

[2] Congressional Research Service. 2012. The Commercial Space Industry and Launch Market. April 20, 2012. R42492. Retrieved October 15, 2019 from www.everycrsreport.com/reports/R42492.html.

[3] OECD. 2012. OECD Handbook on Measuring the Space Economy, OECD Publishing. Retrieved October 15, 2019 from dx.doi.org/10.1787/9789264169166-en.

[4] White House. 2010. National space policy of the United States of America. Washington, DC, June 28, 2010. Retrieved October 15, 2019 from obamawhitehouse.archives.gov/sites/default/files/national_space_policy_6-28-10.pdf.

[5] 5.https://www.nsr.com/nsr-report-forecasts-4-5-billion-in-cumulative-revenues-from-in-orbit-satellite-services-by-2028/.

[6] https://esre-space.org/wp-content/uploads/2018/01/ESRE_Whitepaper_-2017.pdf.

[7] https://www.pwc.fr/fr/assets/files/pdf/2019/06/fr-pwc-main-trends-and-challenges-in-the-space-sector.pdf

[8] Weinzierl Matt, Sarang Mehak (2021), the commercial space age is here, Harvard Business Review.

[9] Economic Snapshot of the Australian Space Sector from 2016-17 to 2018-19 (2021), space.gov.au.

[10] Annual Report 2020-21, GOI, Department of Space.

[11] nasa.gov/about/index.html

[12] apps.bea.gov/scb/2020/12-december/1220-space-economy.htm

[13] Highfill Tina, Jouard Annabel & Franks Connor, Preliminary Estimates of the US Space Economy, 2012-2018.

[14] Jiwei Qian & Bojian Liu (2020), China's Space Industry: Background, Recent developments and Challenges.

[15] https://space-economy.esa.int/article/102/chinas-space-sector-commercialisation-with-chinese-characteristics.

[16] https://www.statista.com/statistics/946341/space-economy-global-turnover/

[17] Sarang M, Weinzierl Matthew (2021), the commercial space age is here, Harvard Business Review.

[18] https://www.thespacereport.org/

[19] https://www.statista.com/statistics/report-content/statistic/745717.