

Spring 2021

Space Exploration: NASA Investment into the Private Space Sector and Public Opinion

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Abstract

The space exploration industry has entered a new era with companies such as SpaceX and Blue Origin leading the way to the privatization of space. This paper examines public opinion regarding the source of space exploration funding and proposes possible motivations for these sentiments. This is followed by an assessment on NASA's investment trends into the commercial space industry. Both probes review the past decade, to reveal the public-private relationship in this new era and finally, conclude whether or not public opinion plays a role in the degree of NASA investment and what that role may be.

Introduction

The dynamic, triangular relationship between scientific research, the government and private industry has always fallen under scrutiny. Scholarly analysis documents an ongoing critique regarding who is funding research, what research is supported, how much is contributed and ultimately, why people or institutions are investing (see Archibugi, Charlton, Muscio). Space exploration faces similar discussions. However, as a niche topic in the broad category of scientific research – and one that lacks saliency – there is not a significant amount of investigation regarding the relationship between public and private investment into space exploration. The National Aeronautics and Space Administration, commonly known as NASA, was formed in 1958 and public opinion regarding government funding of space exploration has fluctuated ever since. Despite the recent boom in the privatization of space, with companies like Blue Origin and SpaceX leading the charge over the past twenty years, much of the existing public opinion analysis on space exploration relates to how the people feel about government presence in the field but fails to further explore their feelings on private involvement.

This paper will first examine public opinion regarding the source of funding for space exploration and propose motivations and lenses that construct these sentiments. Then it will assess NASA's investment trends into the commercial space industry. Both probes will review only the past decade, to reveal the public-private relationship in this new era of space exploration and finally, will conclude whether or not public opinion plays a role in the degree of NASA investment and what role that may be.

Public Opinion

Methodology

The Roper Center database is rich with polls regarding government involvement in space exploration, starting as far back as the 1960s. Unfortunately, space exploration in general, and public versus private involvement in it, is a topic that lacks saliency in opinion surveys about public policy and therefore has both limited cross-sectional information and even less trend data. More recently, however, there has been an increase in the type and amount of surveys on the issue. Polls from a variety of sources such as Social Science Research Solutions, Gfk, Princeton Survey Research Center Associates International and more were utilized to examine public thought over the past decade. Following the coverage of public opinion and its evolution, is an assessment of the factors that lead the public to support one dynamic or another.

Data and Interpretation

The General Social Survey conducts surveys biennially with English or Spanish speaking adults (18+) in the United States with permanent addresses. The majority of these data are collected in face-to-face interviews¹.

The exact phrasing for the following two polls was as follows:

We are faced with many problems in this country, none of which can be solved easily or inexpensively. I'm going to name some of these problems, and for each one I'd like you to tell me whether you think we're spending too much money on it, too little money, or about the right amount. First (READ ITEM A) . . . are we spending too much, too little, or about the right amount on (ITEM)?

Item A for the two figures was “Space exploration program” and “Space exploration,” respectively.

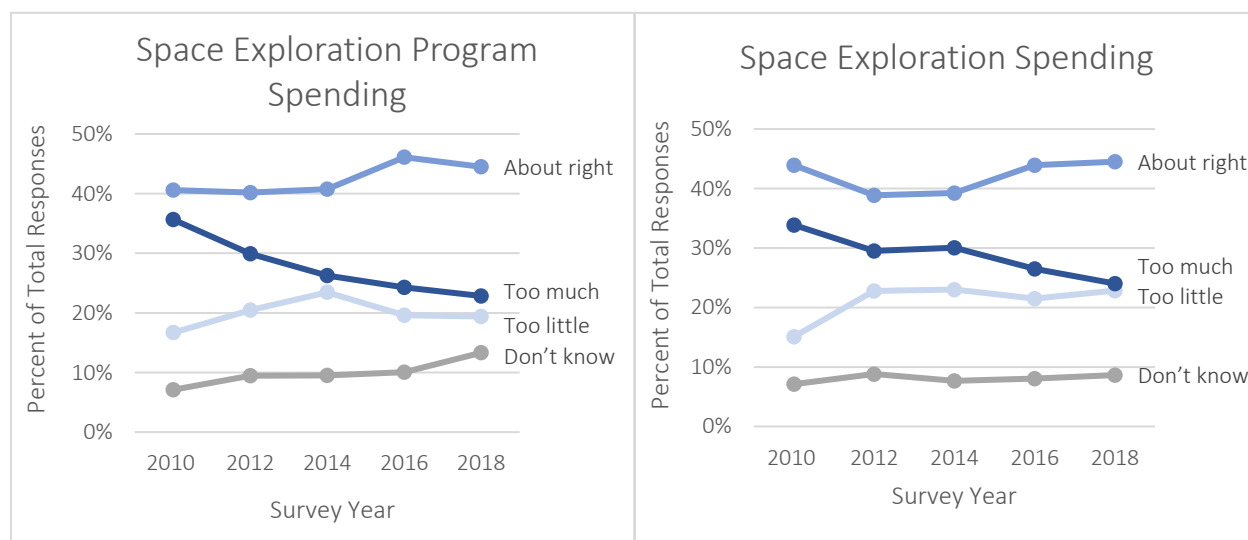


Figure 1

Note: Respondents who did not give an answer are not shown.
Source: Survey conducted by the General Social Survey with a range from 998 to 1,437 completed interviews.

Figure 2

Note: Respondents who did not give an answer are not shown.
Source: Survey conducted by the General Social Survey with a range from 976 to 1,430 completed interviews.

¹ For more complete information see <http://www.gss.norc.org/>

While the difference between the wording was minimal, the survey groups slightly varied. The sample population for both surveys marked a notable decrease in those who believed too much money is spent. Overall, the data demonstrates that the public believes the current level of spending on space exploration is consistent with the public's position, however, there is a significant trend of more support to increase funding. A shift in government spending could have led to the increase of the "too little" position. Interestingly, those who selected "Don't know" with respect to "Space exploration program" spending nearly doubled from 2010 to 2018, increasing from 7% to 13%. The plurality for both polls was "About right," but failed to reach a majority.

The next data set examines what role a sample population believes the federal government should play in advancing space exploration². It is compiled over three different surveys from three different years. The survey questions from 2015, 2017 and 2019 respectively are:

(For each of these same areas, please tell me how much of a role, if any, the federal government should play.) Should the federal government play a major role, a minor role, or no role at all...advancing space exploration?

(For each of the following areas, please tell me how much of a role, if any, the federal government should play.) Should the federal government play a major role, a minor role, or no role at all...in space exploration [NASA (National Aeronautics and Space Administration)]?

² The remaining polling data is compiled from Roper iPoll. For more complete information see <https://ropercenter.cornell.edu/ipoll/>

Thinking about advancing space exploration and research, should each of the following play a major role, a minor role, or no role?...The United States government

While it is important to note that phrasing influences poll results, these questions can establish a trend, nonetheless.

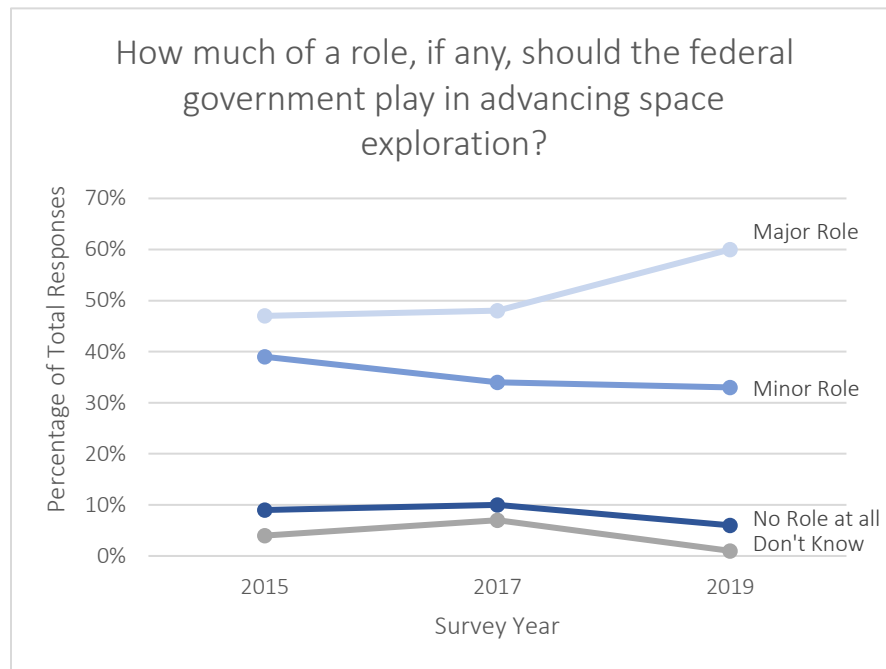


Figure 3

Note: Respondents who did not give an answer are not shown.

Source: 2015 survey conducted by Princeton Survey Research Center Associates International with 6,004 completed interviews by telephone. 2017 survey conducted by Braun Research Incorporated with 1,000 completed interviews by telephone. 2019 survey conducted by AP-NORC Center for Public Affairs Research with 1,137 completed interviews online and by face-to-face interview.

In the last five years, the desire for the U.S. government to play a major role in advancing space exploration has increased. All other categories decreased. However, a deeper analysis of the public's awareness regarding private companies and their thoughts about private involvement is necessary.

The 2019 survey also asked about the role private companies should play in advancing space exploration. While 41% of respondents answered "major role," 43% chose "minor role." The

public demonstrates a desire for private companies to be involved, but not to necessarily be the leaders.

In 2018, a sample population was asked:

How much, if anything, have you heard or read about private companies, such as SpaceX, Blue Origin and Virgin Galactic, developing space exploration capabilities? ... A lot, a little, nothing at all

This question is vital in determining whether or not the public is aware of the recent boom in commercial space activities.

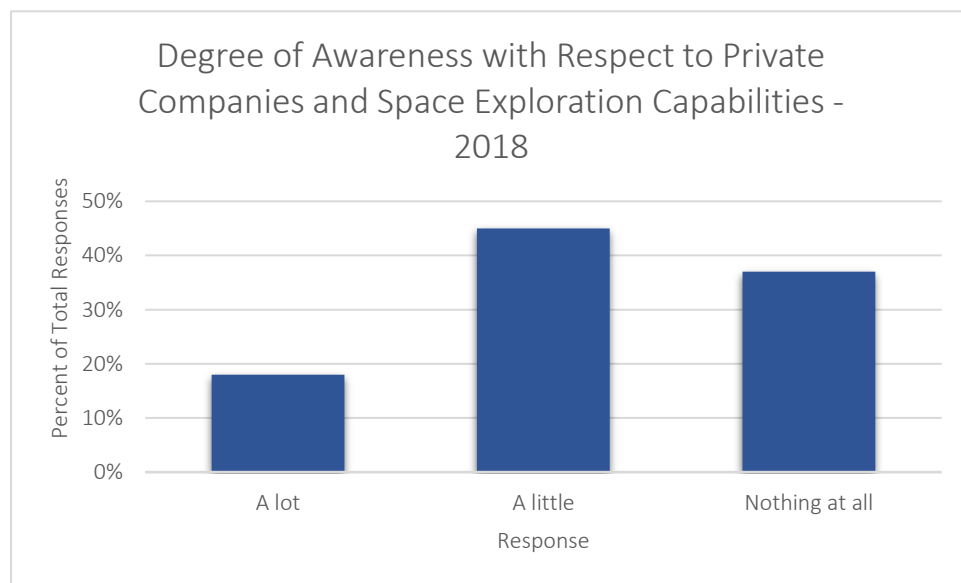


Figure 4

Note: Respondents who did not give an answer are not shown.

Source: Survey conducted by Gfk with 2,541 completed interviews online.

The majority of the public is aware of the emerging private space industry, but the role that the public would like to see for this industry is what is important.

The following two surveys for 2018 and 2019 respectively were phrased as follows:

Which statement comes closer to your views--even if neither is exactly right?... (1) It is essential that NASA (National Aeronautics and Space Administration) continue to be involved in space exploration; <OR> (2) private companies will ensure that enough progress is made in space exploration, even without NASA's involvement

Do you think American space exploration should be carried out and funded by NASA (National Aeronautics and Space Administration) and the federal government, by private companies, a mixture of both, or should America not be involved in space exploration at all?

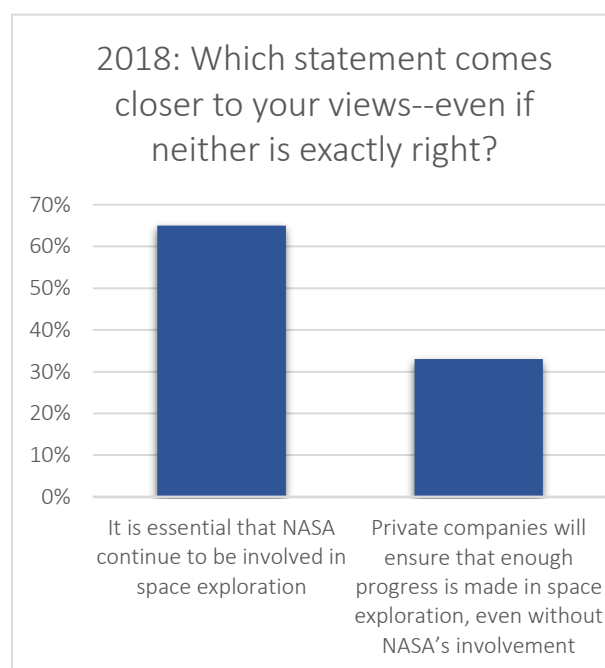


Figure 5

Note: Respondents who did not give an answer are not shown.
Source: Survey conducted by Gfk with 2,541 completed interviews online.

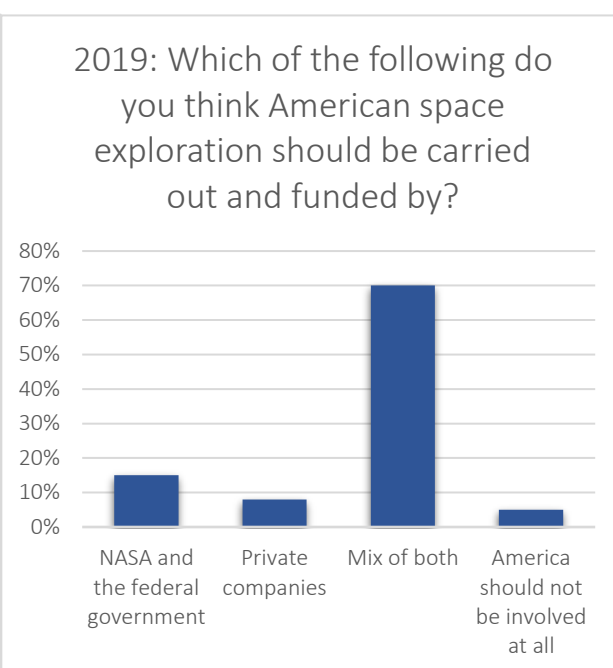


Figure 6

Note: Respondents who did not give an answer are not shown.
Source: Survey conducted by Social Science Research Solutions with 1,201 completed interviews by telephone.

These charts are especially revealing of the public's attitude toward public and private involvement in the space exploration industry. When provided with the choice between two beliefs, that NASA should continue to be involved in space exploration or that private companies

will make enough progress in space exploration on their own, even without NASA's involvement, about two-thirds of responses wanted NASA to remain involved, while about a third of respondents believed that private companies could progress in space exploration on their own. However, when a different survey group was given the option to have a mix of both public and private involvement the overwhelming majority, about 70%, chose this option. Solely government involvement received 15% of responses, solely private received 8% and only 5% of respondents believed America should not be involved in space exploration at all. This reaffirms the earlier conclusion that the majority of Americans would prefer a mix of public and private involvement in the industry, but if forced to choose³, they would rather the government remain in charge.

Finally, we must examine why might the public hold these preferences. The following survey presented a sample population with several questions aimed at understanding American's expected outcome from privatized space exploration:

How much confidence, if any, do you have that private companies developing space exploration capabilities will...

- ...conduct basic scientific research to increase knowledge and understanding of space?
- ...make a profit for their companies?
- ...build rockets and spacecraft that are safe and reliable?
- ...control costs for developing rockets and spacecraft?

³ While prohibiting private involvement is not a viable policy option, this is revealing about the public's desired power dynamic in a public-private partnership.

- ...minimize the debris from rockets, satellites and other human-made objects in the Earth's orbit?

Each was presented the choice of a great deal of confidence, a fair amount of confidence, not too much confidence or no confidence at all.



Figure 7

Notes: Respondents who did not give an answer are not shown.

Source: Survey conducted by GfK with 2,541 completed interviews online.

This survey provides many key takeaways:

- 70% of respondents were confident⁴ that private companies will conduct basic research
- 80% of respondents were confident that private companies will turn a profit

⁴ Where “confident” represents a great deal or fair amount of confidence, and “not confident” represents not too much or no confidence.

- 77% of respondents were confident that private companies will build safe and reliable rockets
- 65% of respondents were confident that private companies will control costs
- 51% of respondents were not confident that private companies will minimize manmade debris in the Earth's orbit, which was the only category to earn a non-confident majority

The first key takeaway listed above, complimented with the second, already presents a complex mix of perspectives. Basic research aims to increase knowledge for knowledge's sake and is not meant to immediately aid in the creation or invention of something, which is why it is not closely associated with making a profit, nor private enterprises. Applied research, on the other hand, seeks to address practical issues and improve current conditions; technological innovation, for example, is well affiliated with private companies. Figure 7 displays a high degree of belief that private companies will conduct basic research. This belief could, in part, be attributed to the financial position of many space exploration companies' founders, many of which are at the height of wealth and therefore are not bound to the typical monetary constraints of a private company. However, there is much debate regarding whether research should be funded by the government or private entities. Daniele Archibugi and Andrea Filippetti, two economists who focus on how research leads to progression in technology, claim that "It does matter *where* knowledge is produced: knowledge produced in the public sector has very different economic characteristics compared to knowledge produced in the business sector" (Archibugi). This excerpt goes on to argue that the privatization of knowledge in advanced countries will impose major consequences on innovation, economic development, and social welfare. This could explain, as demonstrated in Figure 5, why the majority of a sample population chose the belief

that it is essential NASA remains involved in advancing space exploration. Thus, the first possible perspective of the public is that which believes science should be a public good. An example of a public good in the space industry is the Hubble Space Telescope. “Its data have been used in more published research papers than data from any other single scientific instrument, in any discipline” (DeGrasse Tyson)⁵. This exemplifies the importance of knowledge or science remaining a public good.

In consideration with the second key takeaway, private companies will conduct basic research and turn a profit, a new lens is presented where science is not a public good. The book *Sex, Science and Profits: How People Evolved to Make Money* by Terence Kealey aims to dismantle the ideology that science is a public good. According to Kealey, it is more beneficial to have privately funded research, the reasoning for which is multi-fold: science predominantly funded by the government is not only subject to its politicization, but this also crowds out private investment thus creating a monopoly with low competition. Whereas, in the private sector, there is a high degree of competition which in turn increases efficiency and innovation, promoting economic growth (Charlton). Interestingly, the well-known and highly respected astrophysicist, Neil DeGrasse Tyson, agrees with Kealey’s sentiments on the government’s politicization of science. He claims that for twenty years in space policy the topic was nonpartisan, but in the 2000’s it began to fall along party lines (DeGrasse Tyson). Despite the first two takeaways of Figure 7 and the extensive scholarly arguments for the privatization of science, Figure 6 suggests the majority of Americans are not in favor of private companies advancing space exploration alone.

⁵ In 2004, NASA cancelled a mission to service Hubble which sparked an outcry from average Americans until they ultimately reversed the decision (DeGrasse Tyson). The public good ideology reaches beyond research in the scientific society and touches the lives of everyday citizens.

Continuing with the theme of science as a good, the final perspective would be that science is a quasi-public good which can be provided by public or private systems (György). In his paper for the Bucharest Academy of Economic Studies Research Centre for Analysis and Regional Policies, Attila György argues the advantage of this dual public-private dynamic is that the government works to offer goods that the private sector may not prioritize but remains open to their benefits, mentioned prior. This perspective likely aligns best with the findings of Figure 6, where 70% of respondents believed American space exploration should be carried out by both NASA/the federal government and private companies. Todd Harrison, who specializes in national spending on space and defense at the Center for Strategic and International Studies, provides concrete examples of the advantages to this partnership arrangement in his paper *NASA in the Second Space Age: Exploration, Partnering, and Security*. He largely discusses risks associated with space exploration that explain why the government needs to stay involved. For example, the International Space Station is an enormous piece of infrastructure that serves as a public good, but at a cost of over \$100 billion, it would not make sense for a private company to fund (Harrison). As was mentioned in the perspective where science is not a public good, the private industry fosters competition. This remains true even when the federal government is still involved, for example, the way private involvement offers competitive pricing. After NASA implemented the public-private partnerships referred to as Commercial Orbital Transportation Services, the cost of sending a kilogram of cargo to the International Space Station through SpaceX was a third of the price it was estimated to be with the Space Shuttle⁶ (Weinzierl). Furthermore, SpaceX and Blue Origin both seek to develop reusable rockets which substantially reduces costs even more.

⁶ Through Orbital Sciences, the cost was one-half the price it was estimated to be with the Space Shuttle.

NASA Investment

Methodology

This section will first examine how NASA's overall and space exploration specific budget has varied over the past decade. Then it will determine how much NASA spent on public-private partnerships each year. This second set of data does not include general procurement contracts, delivery orders or grants to non-profit entities. Rather, it strictly examines three special award types that are meant to facilitate progress for both NASA and the commercial space industry.

Budget Data

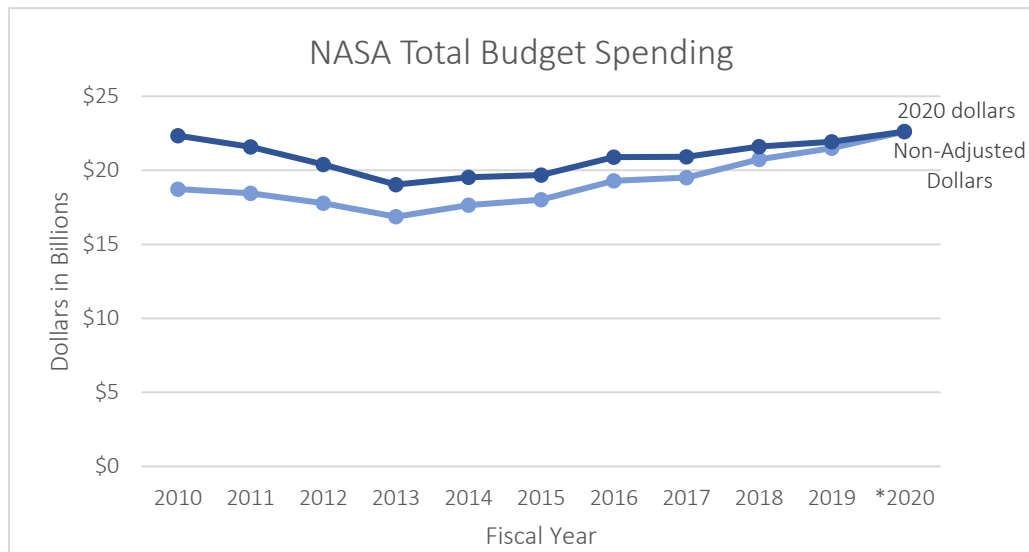


Figure 8

* Fiscal Year 2020 data is based on the enacted budget and not actual dollars spent

While it would seem the NASA budget has had a 21% increase from 2010 to 2020, it truly has only risen 1% in inflation-adjusted dollars during this period⁷.

⁷ The Budget Control Act of 2011 played a significant role in shaping government budgets from 2011 to present.

The following chart represents NASA's expenditures towards space exploration specific programs. The budget breakdown of these categories has slightly varied over time from Exploration, Space Technology, and Space Operations in 2010 to Deep Space Exploration Systems, Exploration Technology, and LEO and Spaceflight Operations in 2020⁸.

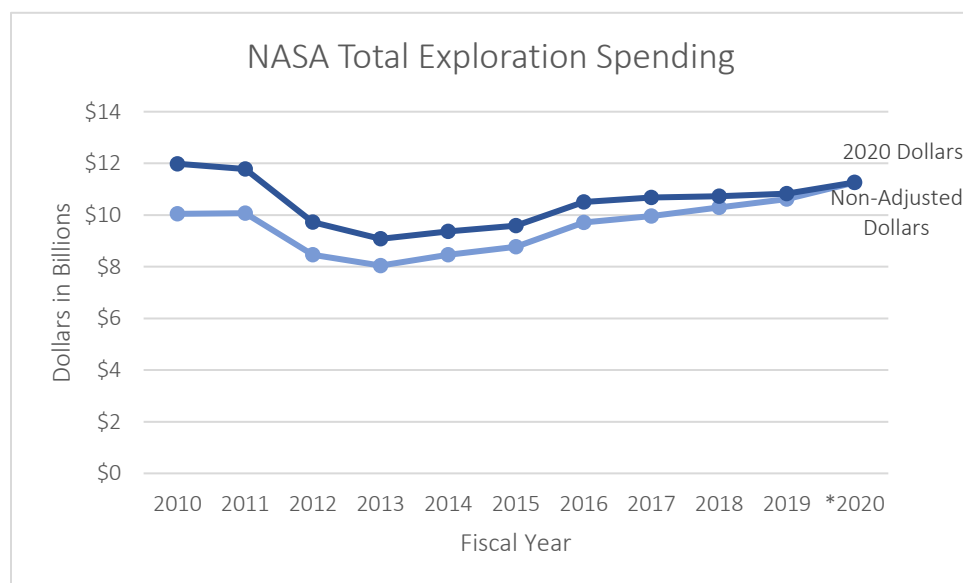


Figure 9

* Fiscal Year 2020 data is based on the enacted budget and not actual dollars spent

NASA's total spending on space exploration closely resembles its overall budget. The decline from 2010 to 2013 is not too surprising as NASA slowly phased out the Space Shuttle Program in this period until it was retired permanently in 2013. It is notable that in 2020 dollars, NASA expenditures on space exploration declined. This could largely be due to the increase in public-private partnerships which tend to be more cost effective for both parties, as explored earlier. However, award contract data is vital in understanding the nature of the relationship between NASA and the private industry.

⁸ For more complete budget information see <https://www.nasa.gov/news/budget/index.html>

Award Types and Value

The awards discussed in this section are typically of a high value that is paid over several transactions throughout the contract length. They are largely performance based and therefore have sporadic payments that may make it difficult to trace a clear trend over time. Nonetheless, they aid in establishing the relationship that NASA is cultivating with the private industry.

Space Act Agreements (SAA's):

Agreements where, typically, NASA provides solely services or facilities to aid an outside party in achieving a mutually desired goal for a current NASA project. SAA's are special transactions that do not constitute a contract, grant or cooperative agreement⁹.

This agreement type was founded at the same time as NASA itself in 1958. They can be reimbursable, non-reimbursable or funded.

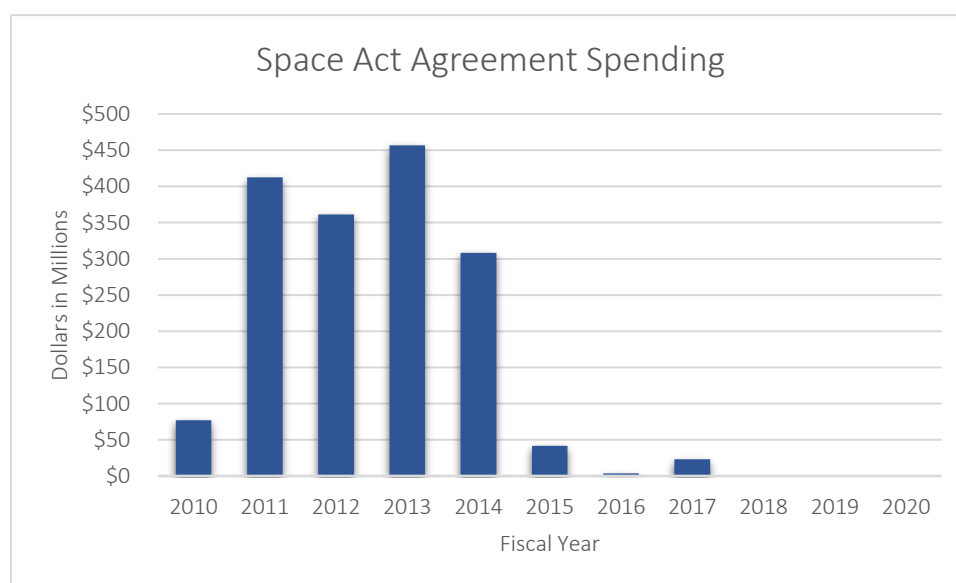


Figure 10

For example, in 2013 Boeing received over 200 million dollars from NASA's Commercial Crew Integrated Capability initiative, which seeks to mature design elements for a Crew

⁹ For more complete information on Space Act Agreements see <https://prod.nais.nasa.gov/cgibin/npdv/adhoc.cgi>

Transportation System to Low Earth Orbit. Although no money was exchanged after 2017, NASA still entered new contracts with a variety of companies whose payment is contingent on reaching specified milestones. The number of SAA's has declined from the first half of the decade to the second¹⁰. In fact, in 2014 a new award type called a "Tipping Point" Selection was introduced by NASA and this could partially explain the sharp decline in SAA's.

Tipping Point Selections:

Tipping Point Selections are public-private partnerships between NASA and space companies that combine NASA resources with a minimum 25% industry contribution towards program costs. A technology is at a tipping point if an investment will significantly mature the technology and consequentially bring the technology to market for both government and commercial use¹¹.

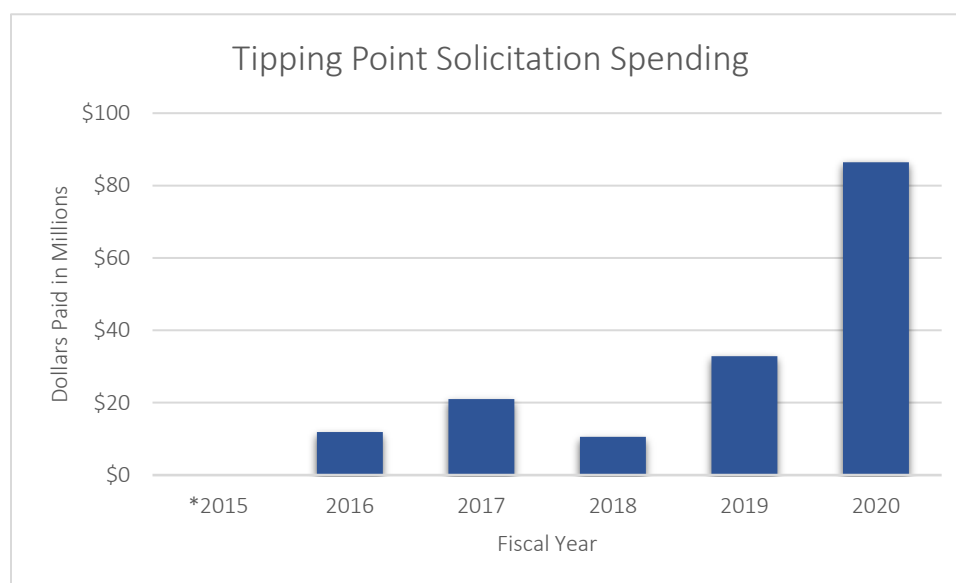


Figure 11

* Fiscal Year 2015, the first year selections were made for Tipping Point partnerships, does not have spending data available

For example, in 2020 Eta Space entered a partnership valued at 27 million dollars for a new system to collect fluid management data on board a satellite. The company is collaborating with

¹⁰ 48 SAA's were signed from 2010-2015 and only 12 were signed from 2016-2020.

¹¹ For more complete information on Tipping Point Selections see https://www.nasa.gov/directorates/spacetech/solicitations/tipping_points

NASA's Marshall Space Flight Center, the Glenn Research Center and the Kennedy Space Center. As the Tipping Point Selections are relatively new, their growth in number and value is to be expected.

Cooperative Agreements:

In Cooperative Agreements both NASA and the awardee contribute funds or effort to, typically, achieve a mutually desired goal for a current NASA project where both parties have completed some amount of preliminary work in order to avoid the unnecessary duplication of costs. Cooperative Agreements require a high degree of NASA involvement¹².

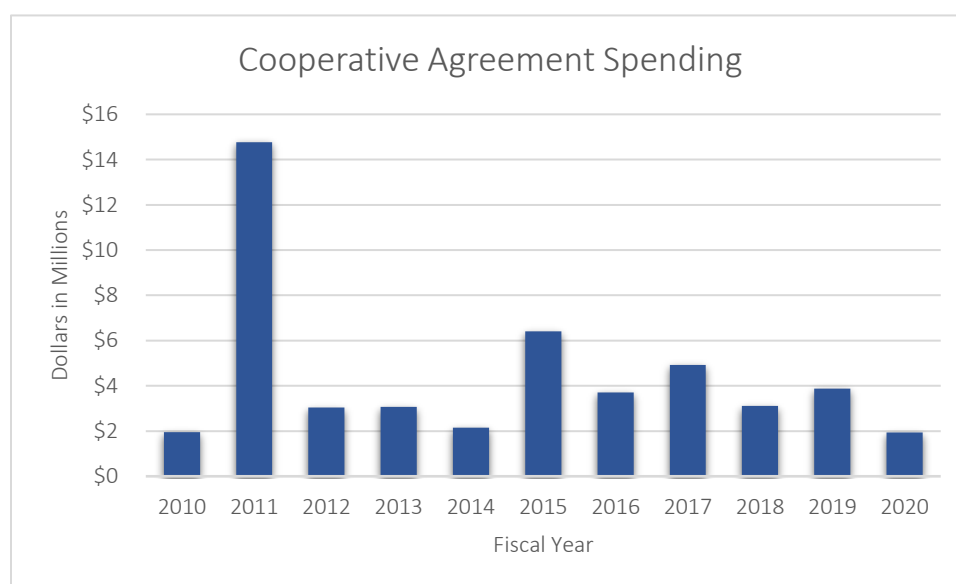


Figure 12

For example, Dynaflow received \$80,000 in 2020 for their partnership with NASA's Glenn Research Center to create a system that will separate gases from liquids in space in order to recycle and reuse both. The value of these awards is relatively stable over the past decade, with one large increase in spending in 2011.

¹² For more complete information on Cooperative Agreements see <https://prod.nais.nasa.gov/cgibin/npdv/adhoc.cgi>

Conclusion

The space exploration industry is in a new era, and the public seems to know what they want from it. Overall, the public is largely content with NASA's level of spending, with about equal percentages wanting to see an increase or decrease. The public also values public-private partnerships more than the federal government or private enterprises working alone, although there is reason to believe that this desired relationship places NASA in the driver's seat. There is substantial academic reasoning for the differing stances on public and/or private involvement, with real examples or input from those directly related to the industry, that support one dynamic or another. Much of the scholarly debate focuses on the root issue of whether or not knowledge is a public good. The belief that it should be a public good surfaces in resources available to all like the Hubble Space Telescope and relates to the opinion that the government, or NASA, should continue leading the way in space. There is another little-supported belief that solely private companies should be involved in space exploration. The reasoning includes an increase in competition which facilitates innovation, as well as avoiding the politicization of science that occurs under the government, which Neil DeGrasse Tyson himself agreed is a real issue. However, the poll numbers did not provide support for either of these beliefs or possible perspectives. The overwhelming take away was that the public would like a mix of government and private involvement in space exploration. This allows competition in the commercial sector to push progress, while NASA maintains important programs that may not directly be profitable. NASA awards are largely performance based and project times vary, therefore, it is difficult to establish or identify a trend of NASA investment into private companies. Although, the mere fact that NASA is creating entirely new award types in order to foster partnerships with the

commercial sector is extremely revealing. NASA and private space exploration companies have a close, collaborative, and mutually beneficial relationship, which seems to be what the public desires. This does not demonstrate, however, that the public's wishes are determining the investment patterns of NASA. Nonetheless, understanding what the public expects from public-private partnerships, regardless of whether they play a role in the design of government spending, is essential in the way that both industries market themselves. Currently, the presentation of these partnerships largely focuses on collaboration between NASA and private businesses and emphasizes that all developments pertain to a specific NASA project.

Much like the industry itself, public polling on the commercial space exploration sector is beginning to grow. As the quantity and quality of these data increase, the role of public opinion on investment into the industry should be reexamined, as well as their possible motivations. It also could be insightful to explore investment by the military into these same companies, and if the public holds different sentiments with respect to the armed forces, rather than a largely research-oriented entity like NASA. It would also be interesting to examine the role of media coverage, which has certainly gained SpaceX popularity among the public in recent years.

References

Archibugi, Daniele, and Andrea Filippetti. “The Retreat of Public Research and Its Adverse Consequences on Innovation.” *Technological Forecasting and Social Change*, vol. 127, Feb. 2018, pp. 97–111. ScienceDirect, doi: 10.1016/j.techfore.2017.05.022.

Daniele Archibugi and Andrea Filippetti, two economists who specialize with technology, investigate the decline in public Research & Development (R & D) in Organisation for Economic Co-operation and Development (OECD) countries through the lens/public opinion that research is a public good. They argue that the source of knowledge (public or private) greatly changes the applied and economic implications of that knowledge and that ultimately, the shift from public research to private research will have negative effects long-term. These two authors treat scientific research investment like a business investment and want to see the research produce results that lead to technological progression. They believe that when privatized, public access to knowledge is no longer available and this thus halts progression. They do, however, acknowledge that there are many who praise the increase in business investment that shun public institution involvement in scientific research and even cite a couple articles for reference to those arguments.

Charlton, Bruce G. “Invisible colleges, private patronage and commercial profits versus public goods, government funding and ‘crowding-out’: Terence Kealey on the motivations and incentives driving science” *Medical Hypotheses*, vol. 72, no. 2, Feb. 2009. ScienceDirect.

This editorial describes the arguments included in a book written by Terence Kealey, a professor at the University of Cambridge, who thinks there is a large financial drive behind science.

Kealey aims to dismantle the science as a public good ideology and illustrate that it would be more beneficial to have privately funded research. He argues that the motivations behind science are largely misunderstood. Scientists seek status within their own field (so much so as to fund their own work) while government contributions are solely political maneuvers. Kealey believes the public fears no government funding equates to no funding at all, while he claims this is not the case. This contrasts well with the other sources listed which stand in favor of a mix of funding or solely government funding. The author, Bruce Charlton, ultimately lists five reasons why it doesn't matter if Kealey is correct or not, simply claiming his analysis will be ignored.

DeGrasse Tyson, Neil. "The Case for Space: Why We Should Keep Reaching for the Stars."

Foreign Affairs, vol. 91, no. 2, 2012, pp. 22–33. JSTOR, www.jstor.org/stable/23217218.

Neil DeGrasse Tyson is a renowned astrophysicist and science communicator. His article, published by the Council on Foreign Relations, argues the importance of continuing space exploration in the United States and how certain goals are made achievable. He emphasizes the benefits, such as technological innovation, that stem from the cross-pollination of disciplines, which is exactly what space exploration provides. There is also a large critique of the role of the government in the politicization of science.

György, Attila. "Knowledge from Research as a Quasi-Public Good." *Annals - Economy Series*, vol. 2, 2011, pp. 56-62. Research Gate.

Atilla György is a writer and journalist with numerous publications regarding economics. His paper on knowledge as a quasi-public good highlights the importance of both public and private involvement in the development of knowledge as both sectors have unique advantages. Private

enterprises may have a disinterest for certain, important, research and therefore public entities are essential to address these gaps in knowledge.

Harrison, Todd, and Nahmyo Thomas. "NASA in the Second Space Age: Exploration, Partnering, and Security." *Strategic Studies Quarterly*, vol. 10, no. 4, 2016, pp. 2–13. JSTOR, www.jstor.org/stable/26271527.

Todd Harrison is Director of Defense Budget Analysis and Director of the Aerospace Security Project at the Center for Strategic and International Studies (CSIS). Nahmyo Thomas is Director of Executive Education at CSIS. Their paper addressing the new space age argues that the private sector is ready to venture into Low Earth Orbit but NASA must remain involved because they are in a position to assume the large risks associated with space. These include both risks to human life as well as risks of large capital public good projects, such as the International Space Station.

Muscio, Alessandro, et al. "Does Government Funding Complement or Substitute Private Research Funding to Universities?" *Research Policy*, vol. 42, no. 1, Feb. 2013, pp. 63–75. ScienceDirect, doi: 10.1016/j.respol.2012.04.010.

The authors of this paper hold PHD's in Economics and use a financial approach to analyze the impact of government funding in Italian university research on external funding within the same university. They argue that the public opinion driving the need for a financial relationship between industry and university research is due to the desire for research to result in new technologies. Adding that the effort to increase constraints on public spending stems from a political lens or bias. The study concluded that government and private funding are complimentary and suggests that government funding is a necessary first step in beginning a

relationship with industry. They also stated that the complimentary relationship between public and private funding is underestimated in its data due to the fact that not all statistics regarding consulting activity is reported to university administrators.

Weinzierl, Matthew. "Space, the Final Economic Frontier." *The Journal of Economic Perspectives*, vol. 32, no. 2, 2018, pp. 173–192. JSTOR, www.jstor.org/stable/26409430.

Matthew Weinzierl is a professor at the Business, Government, and the International Economy Unit at Harvard Business School and a research associate at the National Bureau of Economic Research. His article on space exploration details the economic advantages of private businesses involving themselves in space. He provides many examples of the way companies have been able to cut costs to make space more accessible for all.