Literature review and sources have been removed for space purposes

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An Analysis of the Feasibility and Sustainability of the Space Economy.

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The space economy and its subsequent subsidiary industries have seen immense growth over the past 20 years, not just within the United States but abroad as well. While there has been significant progress in the Space Industry due in large part to countries abroad, for the purposes of this paper I have chosen to use a more US-centric approach to center and narrow down my discussion. This is not to say that advancements in space technology abroad will not be mentioned, more so instead they will be looked at from the US perspective and how they help develop the specific US space economy whether that be governmental or private enterprises. On that note, I will also be focusing my discussion more on private enterprises as I believe the entrance of the private sector is a more recent portion of the space economy, whereas governmental enterprises have been dominating this industry since the days of the moon landing. The entrance of the private sector within the space industry signals that enterprises see the potential for profit within the industry ensuring that interesting, relevant, and timely arguments can be made. The share of the budget that NASA gets decreased from about 0.7% of GDP in the mid-1960s to now where it is about 0.1% and, hence, it has allowed many private entrants to come and prosper in this 300 Billion dollar industry (Weinzierl 173), this includes larger innovative space companies like SpaceX and Orbital ATK who have valuations of $21 billion and $7 Billion respectively (Weinzierl 173). Furthermore, small start-ups have also received funding upwards of $2.8 Billion (Weinzierl 173), and, hence, this shows a kind of optimism within the market, where people are willing to invest and hope to see returns.

Before we go further into this discussion the scope or definition of what is included within the space economy according to this paper must be laid out. In my definition, the space economy includes any and all activities that end up with a product in space or use the sub-orbital atmosphere to their advantage. This means that launching and using satellites in space would

come under the definition, however, the profits broadcast companies gain from using these satellites for different types of broadcasts would not be included.

The overall aim of this paper is to truly take a deep dive into the state of the Space Economy at its current moment and evaluate whether there is commercial feasibility for the Space Economy in the future. To do this I will take a historical look back at previous iterations of NASA as well as private enterprises that may have started and not necessarily worked. I will then take an introspective look at the Space economy, looking at the major players to see what has been invested in and what the revenue and profit model for most of these companies looks like. I will then include a discussion on the future of the Space economy, specifically looking at areas that could be developed further or even introducing new areas that companies could potentially look into to create new streams of revenue and profit. This discussion will also include the feasibility of the Space economy not just through a profit-centric approach but also by looking at other externalities like the lasting environmental or societal damage that advancements or increase in research in this specific industry could cause. Lastly, I will conclude with an overall retrospective look into the Space economy as a whole; looking into its flaws and weaknesses and highlighting guidelines that could ensure that the Space economy isn't just a trend but more of a longer-term sustainable industry.

Original Thoughts and Contributions

A newer portion of the Space economy that has recently just gone through more growth and viability is the concept of asteroid mining. This is exactly what it sounds like; in terms of sending missions to specific asteroids pre-picked with large amounts of resources and minerals to

bring these resources for profits back to Earth. Companies are already at the testing stage of this new technology with the start-up AstroForge raising over 13 million dollars after coming out of stealth mode in May 2022 (Wall). While the idea of being able to obtain extra resources might seem like a solution to the problem of rapidly decreasing materials it may lead to some unintended consequences that may not make it a completely sustainable or feasible investment. Assuming that the technological prowess for technologies is viable and becomes standard some other major economic ramifications are present if this plan does come to fruition and becomes standard. The price of precious materials, many of which would be mined on asteroids, is dependent on the demand and supply of such resources. While it is pretty standard for demand for these materials to be ever-changing, due to new technology and use cases being developed daily, there has always been a fixed supply since it was previously impossible to obtain more than the finite resource available on Earth. With asteroid mining this is not the case anymore and, hence, means that there is technically an infinite supply of a particular resource. This does change the dynamics of the economy itself and does mean the price of these mined resources is likely to be very variable; for companies that may use these resources in their products and manufacturing it is likely to lead to a lower price for inputs due to larger supply but will also be harder to plan out costs and increase costs their. However, the major effect is likely to be on companies that already provide these resources, if the supply of a restricted resource suddenly increases this can decrease the profit margins of these companies substantially and will lead to these companies having to drastically alter their supply chain and general business plan. If asteroid mining does become a viable option these companies will likely need to integrate the asteroid mining supply chain within their manufacturing process to truly capitalize on the decrease in costs, this will also likely affect future trading for these materials as well in case

large asteroid shipments are predicted to come in as there is likely to be significant time lags between the launch of these missions and the missions coming back with the resources.

The largest assumption I have made in the above comments is that asteroid mining will actually become significant and possible. However, one of the worst things that could occur is that an industry like asteroid mining is an eventual fad where after significant investment, people realize that this industry is not indeed viable and, hence, stop investment and the specific sector crashes. This will lead to a significant loss in capital and will also likely lead to other companies and investors in the Space Economy reconsidering their investments and probably becoming more cautious. The worst-case scenario for the Space economy, in this case, would be something like what happened in the dot com bubble which could be one of the worst things for the innate sustainability and feasibility of the economy. The Space economy has seen consistent growth in investment specifically in the private sector for the last few years, however, this has not led to large profits and, hence, many companies based in this economy have garnered interest and investment but to no avail for the specific investors who have not made their investment or a portion of their money back. While most investors do realize this industry is truly in its infancy and don't expect to reap profits for a longer term it only takes one or two rash investors to pull money from these projects to create a culture of panic, whereby, more and more investors will move capital away from these projects leading to the collapse of specific industries and maybe the whole economy as a whole. That is why it is of utmost importance to the sustainability of the Space economy that investors truly raise capital for companies they believe can succeed and do not get caught up in the hype, if this happens too often more and more bad investments will occur and these can destabilize and cause a kind of domino effect collapsing the whole industry.

While the previous focus of this paper has largely been on newer companies that focus on the Space economy solely, it is also important to acknowledge that the increase in interest will mean that other established companies may try to enter the industry. This is in the case of Boeing which has a large and established Space division already and would benefit from large economies of scale as they undergo research and development. I believe the majority of larger manufacturing companies will start a space division soon as the need arises for different supplies and different things.

Before this paper finishes I do want to bring it back to the original question at the start of the paper; the feasibility and sustainability of the Space economy in the long term. As of now, the Space economy is prospering and growing with the value of the total Space economy being worth $ 447 Billion in 2020, a trend of five-year uninterrupted growth (Space Foundation). What this is to say is that historical data would suggest that the Space economy is already feasible with consistent returns and growth, especially as investment figures stood at about $177.1 Billion in the last decade preceding 2021 with 1343 unique companies invested in throughout this time (D'Souza). Space has traditionally been a kind of exploratory ground for humans to test the limits of innovation and what the human mind can achieve; stuff like the Space landing and the Mars Rover. Humans will always have an innate curiosity about what is beyond Earth and that is how the Space economy started; large-scale government research-funded projects. At this point, the Space economy wasn't an economy per se, more so passion projects funded by specific branches of government and, hence, you could say this was unfeasible. What could be seen as the real driver for feasibility and sustainability has been the entrance of the private sector with a large profit motive and also the large positive externalities that could be associated with the economy for the general public and consumers. Over the past few years, the number of companies

involved in the Space economy has grown tremendously and this indicates that companies do envision and see profit within this economy because they are entering it. As long as companies can see the profit potential the Space economy will stay feasible as new investment keeps on occurring and growing as well. At this point, much of the technology developed is in a kind of proprietary stage and, hence, there is no guarantee that profit will be made from this. While there is definite potential for profit what is likely to happen is that there will be a consolidation in the types of companies present in this space as companies figure out what works and what doesn't. All of these firms are likely to be specialized due to high start-up costs and what may end up happening is that different parts of the same system may be manufactured by highly specialized companies creating a kind of natural monopoly for every specific part.

This addresses most of the concerns about the feasibility but the sustainability of this economy needs to be addressed through the lens of the environment and also the externalities to the general public. Large rockets and general satellite launches are very polluting and with environmental concerns on the rise strict adherence and new environmental standards need to be created. The notion of this is very important as Space technology has excelled communication and many other areas that have created a large positive externality for the general consumer. Strict regulations and research must be in place, however, to ensure that the positive externalities from the development of these areas do not outweigh the negative externalities that can occur due to environmental damage.

In conclusion, the development of Space technology and the increase in private sector entrants means that the Space economy is likely to be feasible and sustainable in the long term. However, it is important to realize that the use of environmental regulations and comparison of general positive externalities is going to be important to ensure the economy stays feasible.