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How Do Economic and Political Factors Affect NASA Funding?

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Abstract

The research problem of this study is concerned with the United States' investment in National Aeronautics and Space Administration (NASA). This funding is important for several reasons. Firstly, NASA's accomplishments provide benefits not only to America, but to the rest of the world. All of humanity can be proud of landing a man on the moon. NASA's space expeditions are indeed monumental in their own right, but human pride is not the only benefit of NASA. The technological advancements required to make such explorations possible have impacted our daily lives. NASA's research is directly responsible for the CAT scan, microceramics used to fight cancer, personal water filters, and 1,300 other advances we use every single day. Some of NASA's inventions are now used to save lives; while others are used to make life a little easier. It is important to understand that NASA is a significant technological agency and providing funding for it implies that America is committed to advancing technology. Our country is beginning to lose its once vast lead as the world leader in technology due to other competing nations and the decreased amount of available funds for NASA. Investing in NASA is important if we are going to maintain our status as a world leader. The question, therefore, is how much are we willing to sacrifice as a country in order to pursue advancements in this industry?

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I. INTRODUCTION & THESIS

The research problem of this study is concerned with the United States' investment in National Aeronautics and Space Administration (NASA). This funding is important for several reasons. Firstly, NASA's accomplishments provide benefits not only to America, but to the rest of the world. All of humanity can be proud of landing a man on the moon. NASA's space expeditions are indeed monumental in their own right, but human pride is not the only benefit of NASA. The technological advancements required to make such explorations possible have impacted our daily lives. NASA's research is directly responsible for the CAT scan, microceramics used to fight cancer, personal water filters, and 1,300 other advances we use every single day. Some of NASA's inventions are now used to save lives; while others are used to make life a little easier. It is important to understand that NASA is a significant technological agency and providing funding for it implies that America is committed to advancing technology. Our country is beginning to lose its once vast lead as the world leader in technology due to other competing nations and the decreased amount of available funds for NASA. Investing in NASA is important if we are going to maintain our status as a world leader. The question, therefore, is how much are we willing to sacrifice as a country in order to pursue advancements in this industry?

The funding trends analyzed in this paper aim to answer that question. By analyzing our country's funding of NASA in relation to economic success factors, such as unemployment and debt, and political factors such as party in power and military activity, we can determine the level of support the public maintains for investing in NASA. This analysis will show us how much dedication there is to funding NASA during both prosperous and difficult economic times. This research is also meant to identify any other factors that significantly affect NASA's funding.

The hypothesis for this research project is that difficult economic times, periods of increased military spending, and high levels of debt will negatively affect NASA's funding.

II. LITERATURE REVIEW

One of the most relevant pieces of literature to my project is Lambright's (2010) research on NASA. Lambright sets the stage by supporting the importance of NASA. This paper looks at the history of NASA, its costs, and its contributions to society. Lambright (2010), therefore, deems that NASA is indeed a worthwhile investment. Lambright (2010) goes on to argue how significant it is to continue NASA's funding since the future of NASA is expected to continue to provide significant technological advances. Additionally, Robolledo and Nollet (2011) provide evidence for the use of cooperation in advanced technological sectors. Cooperation saves time and resources while expediting the Research and Development (R & D) process greatly. NASA is a central hub for the space exploration industry. All of the private companies are connected through NASA, which gives out funding and contracts to the private companies that work in the industry. Since they all have a connection, they are better able to utilize each others' knowledge. Since NASA awards contracts and funding on a competitive basis, the companies are still motivated to be as efficient as possible. This study further supports Lambright's conclusion that NASA is a valuable agency that should be maintained in coming years.

Dussauge and Garrette (1993) support the combining of efforts to advance aerospace, defense, and space exploration technology. They cite how many resources are saved, especially when private companies are able to collaborate. Scott (1993) discusses the benefits of the high concentration of aerospace companies in southern California. Scott finds that the close proximity is beneficial to all of the companies

in the industry. Whether this is due to cooperation or not is unclear. Dussage and Garrette (1993) also analyze the factors that cause an industry to change and evolve. They argue that private innovation is the most efficient form of advancement but allow for the need of government funding when circumstances call for it. They discuss NASA's need for billions of dollars which, while impractical for most institutions, is a relatively small investment for a national government such as America's. Dussage and Garrette point out that under such circumstances it is very beneficial for the government to fund NASA. Analyzing the factors that affect NASA's funding will reveal how effectively the US government fulfills this potential benefit.

Schoeni and Dardia (1998) focus on government assistance to the space industry. They found that the government gives assistance to the industry workers so that they may be maintained when project work is down. Their research supports the notion that the unique skills that specialized workers have are valuable enough that the government wants at least some of the workers to stay onboard with NASA and its affiliates even if there is not enough work to warrant keeping them employed. This suggests that the government does indeed value NASA and space exploration workers, especially in the long run.

Bowen (2012) compares and contrasts discretionary spending, like NASA, to entitlements, such as social security. Bowen discusses how beneficial it is for a government to have power of rejection that comes with discretionary spending. However, his research shows that entitlements are usually more consistent in their success for the obvious reason that they can predict their funding consistently. When discretionary funding for technology is looked at, he concludes that it should not be cut lightly. This can be directly applied to NASA as they are entirely focused on technological development.

III. THEORY

Schoeni and Dardia (1998) did find that NASA is important to the government but they do not take the same approach as the analysis in this paper. The focus of this research project will involve the economic principles of discretionary spending and public choice; as opposed to simply analyzing facts like Schoeni and Dardia (1998). The theory behind this research is that discretionary funding will decrease as a result of public choice during difficult economic times. This theory stems from the fact that difficult economic times require governments to

cut spending or raise taxes, and from the fact that the public demands more welfare during recessions, which puts further pressure on decreasing discretionary spending. Bowen (2012) explains that NASA has not received a "guarantee" on their funding since the space race was won in 1969. Ever since then NASA has been discretionarily funded. Although even during the Space Race NASA was never officially guaranteed funding, they could just be extremely confident in their continued funding due to the national security interest in beating the Soviets to the moon.

When looking at government spending it is crucial to differentiate between discretionary spending and entitlements. Entitlements are previously set costs to the government that they cannot back out of. Entitlements include things like Medicare or Social Security. Discretionary spending, like funding for NASA, is usually determined on a yearly basis and depends on the performance of the agency and on the amount of funds available for the government to give out in the first place. As a matter of definitions, discretionary spending will react more to shocks to the country than entitlement spending will. The issue is how much will NASA's funding react to such shocks. This will depend on the type of shock and the dedication our government and the American people have to NASA.

The most important factor for discretionary spending is, theoretically, the health of the economy. This depends on if our Gross Domestic Product (GDP) is high, the United States' unemployment low, the interest rates under control, and basically if the economy is in a recession or not. But this is not the only factor that may affect discretionary funding. The amount of government spending as it compares to the total GDP is an important thing to take into consideration as well. If the economy grows but government expenditure stays the same, then discretionary spending will not increase even though the nation's growth could support more spending. In addition to breaking down government spending as a portion of GDP, it is also important to account for the most influential shock to our economy: war. Several wars like WWI, WWII, Vietnam, Korea, and to a certain extent the Cold War, utterly consumed our government's main attention. War is a serious enterprise and requires vast resources which may have to be taken from other discretionary spending. This suggests that defense spending as it compares to our GDP must be considered when analyzing discretionary spending trends.

Another fiercely contested issue that is important to discretionary spending is the national debt. Today, more so than ever, the national debt has been a crucial issue, as it is in every country. Yes, some debt helps fuel growth. But once the debt reaches the point where people realize that they, and their descendants, are going to be bearing a heavy burden for the governments overspending, they call for decreases in government spending or for an increase in taxes. A decrease in government funding is going to affect discretionary funding first. Of course, not all discretionary funding is viewed as equally important. This research paper aims to find out how NASA's funding is affected, by national debt levels, the health of the economy, political factors, and other crucial indicators.

IV. EMPIRICAL MODEL

The figures for NASA's budget can be obtained from the United States Office of Management and Budget. Unemployment, total government expenditure, military expenditure, and national debt can be found in the World Data Bank dataset for the United States. The values for political parties and the space race time period are commonly available.

The empirical model for this analysis will be as follows:

$$\begin{aligned} \text{NASA Budget (NASA)} = & \alpha + \\ & \beta(\text{Unemployment}) + \beta(\text{Total Government} \\ & \text{Expenditure/GDP}) + \beta(\text{Military Expenditure/GDP}) + \\ & \beta(\text{National Debt/GDP}) + \beta(\text{Political Party}) + \beta(\text{Space} \\ & \text{Race}) + e \end{aligned}$$

The empirical model is designed to test what affects the government's level of funding for NASA, which is measured in constant 2007 US Dollars. Unemployment will represent the health of the economy, and is expected to be negatively correlated with NASA's funding. Unemployment was chosen because it is a dependable indicator of the state of the economy. It is affected by business cycles and it increases during recessions. Most importantly the unemployment measurement will capture the level of discontent within the nation. When people cannot find a job they want the government to step in and assist. This suggests that citizens will want the government to spend wisely so that all available funds can go towards supporting them in their time of need. This will ultimately demonstrate how much people value NASA as an organization. If NASA retains funding even when unemployment is high then that would represent very interesting results.

Total government expenditure as a percentage of GDP is included to control for increased government spending overall. If the government spends more across the board then NASA will obviously benefit as well; this implies that this variable is expected to be positively correlated with NASA funding. Additionally, the percentage of GDP that the government spends on military spending will account for several things. Firstly, it will represent whether or not our nation is at war. The costs of war can be expected to draw funding from nearly every other candidate the government supports. Secondly, this variable will account for the overlap that is present between NASA and the department of defense. Missile defense, satellite systems, and global defense grids all use similar, if not the same, type of technology that NASA is continuously developing. These overlaps indicate that NASA and the department of defense may be substitutes to some degree. If they are substitutes then when military spending increases, NASA's funding will decrease. Whether due to war, or due to substitution, it is expected that the military spending variable will be negatively correlated with NASA funding.

National debt is also an important variable. As national debt increases the public calls for more responsible spending and for cuts in spending. If the government decides to reduce deficits through spending cuts then those cuts are most likely going to come from discretionary spending, such as NASA. The cuts will almost definitely not come from entitlements spending because the government is obligated to pay that already. This means that funding programs like NASA will come into question as our national debt increases. Our country has never shied away from debt in the past, for better or worse, and this makes it seem like NASA's funding is not hugely threatened by increasing national debt. Despite this, it is still expected that this variable will be negatively correlated with NASA funding.

The last two variables are both dummy variables. The first one, political party, is meant to control for the different spending preferences between Democrats and Republicans. The difficulty with this variable is that NASA is not definitively supported or opposed by either party. It can be inferred by political party platforms that Republicans prefer military spending while Democrats prefer social spending. NASA is a little bit of both with many social benefits in addition to providing technological advances for defense. Political Party is not expected to largely impact NASA funding negatively or positively, though one will certainly win

out. The Republican party is the one being tested so the results will apply to them.

The variable for the Space Race is another significant variable. During the Space Race the government was committed to landing a man on the moon as quickly as possible. Cost was almost not a serious issue. Due to this it is necessary to control for this variable or else all of the other results will be skewed.

The data for this analysis will include all of the variables for the years 1958-2010. There are no more data to draw from and the variables included are each important as well. High significance rate for unemployment, government spending, and military spending is expected. Political party is expected to be insignificant but it will be interesting to see if either party is partial to NASA funding.

V. RESULTS

Figure 1 represents the funding levels for NASA from 1960 to 2009. Figure 2 through 5 represent the data for the independent variables. Table 1 displays the regression results and analysis.

Figure 1 shows that funding for NASA clearly spikes soon after the creation of the agency. The decrease after the spike occurs due to the end of the Space Race. The overall trend after that drop is slightly upward although there are clear shocks. Around NASA's thirty-fourth year, the largest shock occurs. This is around the same time the oil crisis in the 1980s occurred. Although gas prices are not tested in the regression, it seems likely that this is not a coincidence.

Figure 2 shows that unemployment, government spending, and military spending have fairly fluctuating values. There is no clear relation between NASA's funding trend and the trends for these three variables. As Figure 6 shows later, these variables definitely impact NASA's funding significantly, it is just not apparent when comparing the raw data.

Figure 3 shows that the national debt does not have any clear relationship to NASA's funding. The debt level fluctuates significantly while the trend for NASA's funding, other than during the Space Race years, is relatively smooth.

Figure 4 shows the years when a Republican was president. Again, there is no clear relationship

between this independent variable and NASA's funding trend in Figure 1.

Figure 5 shows there is a very clear relationship between the space race and the spike in NASA's funding. While these two trends being so similar is not enough in its own right to confirm the relationship, it is a fact that the Space Race fueled NASA's high funding level, which is why it must be accounted for in the regression.

Table 1 represents the regression results. It shows a .497 adjusted R-Square, which indicates that a significant amount of the variation in NASA's funding has been explained by the tested variables. This is a skewed value given that the data sample was small. It means that the regression was still able to find worthwhile results regarding the factors that affect NASA's funding, however the sample size might bias the results. A larger sample size would have demonstrated a more significant variation among the data. Table 1 also shows that the independent variables are generally statistically significant. Unfortunately, the variable for the National Debt as a percentage of GDP was not statistically significant. The poor significance value for the debt variable indicates that the regression analysis was not able to identify a significant relationship between the national debt and NASA's funding.

Unemployment is one of the most essential variables because it represents the health of the economy in this analysis. Table 1 shows that the significance value for this independent variable is 0.001 which means the results are highly significant. The negative impact value for unemployment indicates that as unemployment rises the funding for NASA decreases. This meets the previously established expectations and proves that as people lose their jobs, presumably due to difficult economic times, they, through the government, divert resources away from this important agency to handle matters that are considered more pressing. The nominal value of the negative impact that unemployment has is -1,935.381 (in millions of dollars). This means that as unemployment increases by one percentage point the funding for NASA decreases almost 2 billion dollars. This is a huge decrease given that NASA's funding was only 17.8 billion in 2010. This is not a good sign because it means that the government takes away fairly aggressively from NASA during difficult economic times. This means that the government, and theoretically the people they represent, is not very willing to support the advancement of technology and exploration when money is tight for many individuals across the nation.

Unemployment is not the only variable that impacts the amount of funding NASA receives, though.

The next variable analyzed in Table 1 is total government spending as a percentage of GDP. The significance level of the results for this variable is smaller than .000. This means the correlation results between total government spending and NASA's funding is extremely significant based on this regression. The results show that the impact that a one percent increase in this variable has on NASA's funding is 6,175.06 which comes out to over 6 billion dollars. The positive correlation is expected because if the government is spending more, then all of its agencies and programs are likely to receive at least some extra support. What is interesting is the size of the positive impact that increased government spending has on NASA funding. A one percent increase in government spending leads to a 6 billion dollar increase in funding when the most funding NASA has ever received is 33.5 billion dollars. That is almost a 20 percent increase for NASA funding as a result of a 1 percent increase in government spending. Such a disparity implies that NASA is a very valued agency to the US Government. This contradicts what the results of the unemployment analysis reveal. NASA is either important to the government or it is not. It is possible that the high funding that still occurs after the Space Race throws off the regression results.

The analysis of the military spending variable is also provided in Table 1. The regression shows a significance value of less than .000 which means the results are very accurate just like for government spending. The impact that a one percent increase in this variable would have on NASA funding is - 4,032.593 (millions of dollars). Such a large negative correlation indicates that the military and NASA can't both get what they want. Military spending increases in the United States are usually in response to a threat of attack. So it makes sense that NASA must take budget cuts in order to protect our national interests, especially safety. Even though NASA's technology is the same as much of the military's global defense network it can be seen that they are not both utilized to respond the national threats. It could be that most threats are not advanced enough to require NASA's expert aerospace technology. It is also possible that the military's structure of command allows it to be more efficient or perhaps more trusted than NASA. It is the case that the government turns to the military as a priority over NASA. Whether it is a matter of safety first or simply avoiding funding the same thing twice does not change the results.

The political party variable is the next variable analyzed in Table 1. The regression analysis shows that when a Republican is the president there is a - 4,198.071 (millions of dollars) impact on NASA's yearly funding. The significance level for this factor is .007. Republicans have a reputation of wanting smaller government and cutting taxes. So, in theory, it makes sense that such downsizing would negatively affect NASA. However, the magnitude of the downsizing seems excessive. A 4 billion dollar decrease in NASA funding would be roughly 25 percent of their current budget. While such a cut would not destroy the agency by any means it seems like a drastic cut to me. The explanation may lie in the dates used for the Space Race variable. It is also possible that the increases in military spending that usually accompany Republican presidents is what causes NASA spending to drop during Republican administrations.

Finally, Table 1 also shows the Space Race variable is significant at the .005 level which indicates high significance. The positive magnitude for the impact of this factor on NASA funding is extremely high at 13,963.558 (millions of dollars). Such an accurate and high correlation between the Space Race and NASA is not surprising since the Space Race is what fueled NASA's creation and it was the purpose of NASA to win that race. This variable was originally intended to avoid the extreme bias that would occur if the Space Race was not accounted for. After the Space Race was won, the funding for NASA dropped off significantly. This excessive drop is not accounted for in the model since it occurs after the Space Race officially ended. It cannot be concluded indefinitely, but it would seem that this excessive drop, which occurred during a Republican presidency, negatively influenced the results for the Political Party variable.

VI. CONCLUSION

In conclusion, the hypothesis that NASA follows the trends for discretionary spending is proven true. NASA's funding decreases significantly during economic strife and when defensive spending increases. NASA's funding increases when government spending increases and was much higher during the space race. The one aspect of the hypothesis that was not proved is that the debt level would have a negative impact on the level of funding for NASA. The political party variable did its job of controlling for party influences and indicated that Republican presidents are likely to cut funding to NASA.

This paper does not strongly confirm the results of Schoeni and Dardia but does not disprove them either. Bowen's recommendation that technology be funded intensely is not followed by the American government. The future of our nation is said to rely upon our staying ahead technology wise. NASA's funding has proven to be discretionary funding without a doubt. The trends seen and the correlations found in the data prove that the technological advances that NASA had accomplished have not allowed them to maintain a well funded position, but as seen in Figure 1, the funding levels have not suffered to a severe extent. It is important that the United States maintain interest in this organization and the technology sector in general in order to maintain or success in the future.

Future research may benefit from including additional control variables. Finding a way to account for the government providing funding simply to keep aerospace technicians employed, even if they were not currently needed, so that they would be available in the future, might help account for NASA's funding. Also, controlling for the lagging effects of the Space Race would be a valuable addition to this study. Accounting for lagging high funding will help account for everything that could affect NASA's funding.

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VIII. APPENDIX

Table 1: Regression Results & Analysis	
Independent Variable	Impact on NASA Funding (Millions of Dollars)
Constant	-50,143.823*** (-3.347)
Unemployment	-1,935.381*** (-3.586)
Total Government Spending/ GDP	6,175.060*** (5.595)
Military Expenditure/ GDP	-4,032.593*** (-3.927)
National Debt/ GDP	14.292 (.249)
Political Party	-4,198.071* (-2.818)
Space Race	13,963.558** (2.946)
*** Significant at .001 level ** Significant at .005 level * Significant at .01	
Adjusted R-Square = .497	

Figure 1: NASA Funding History (2007 Dollars)

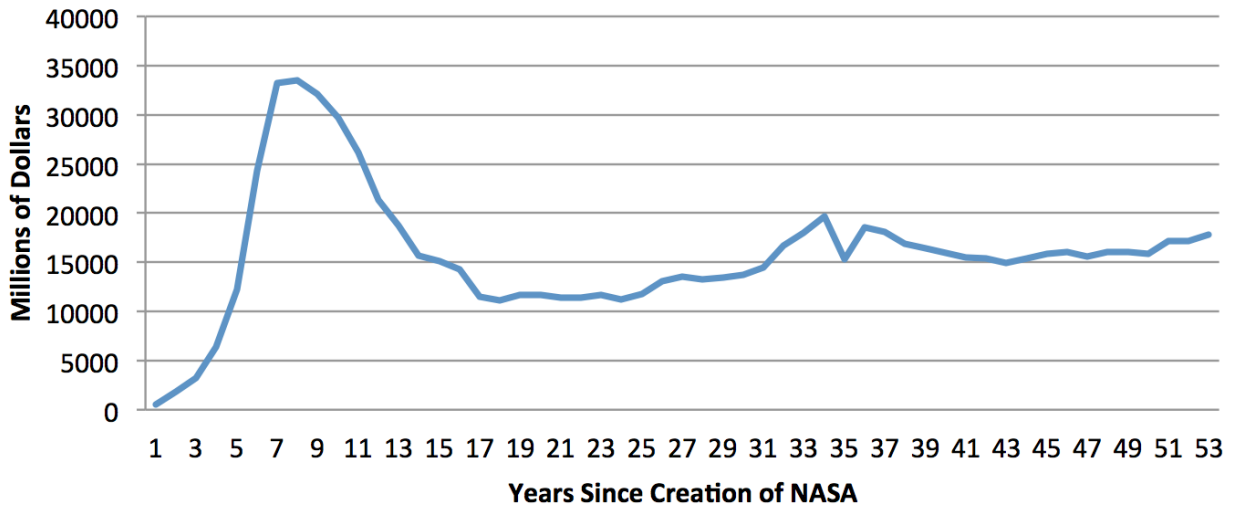


Figure 2: Spending and Unemployment

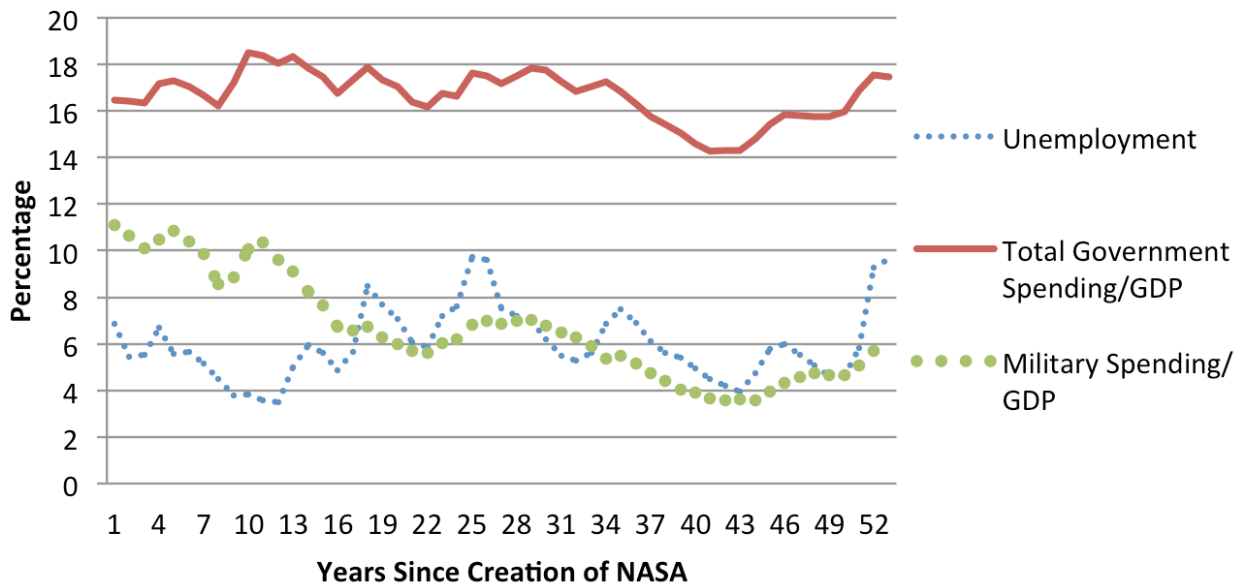


Figure 3: National Debt

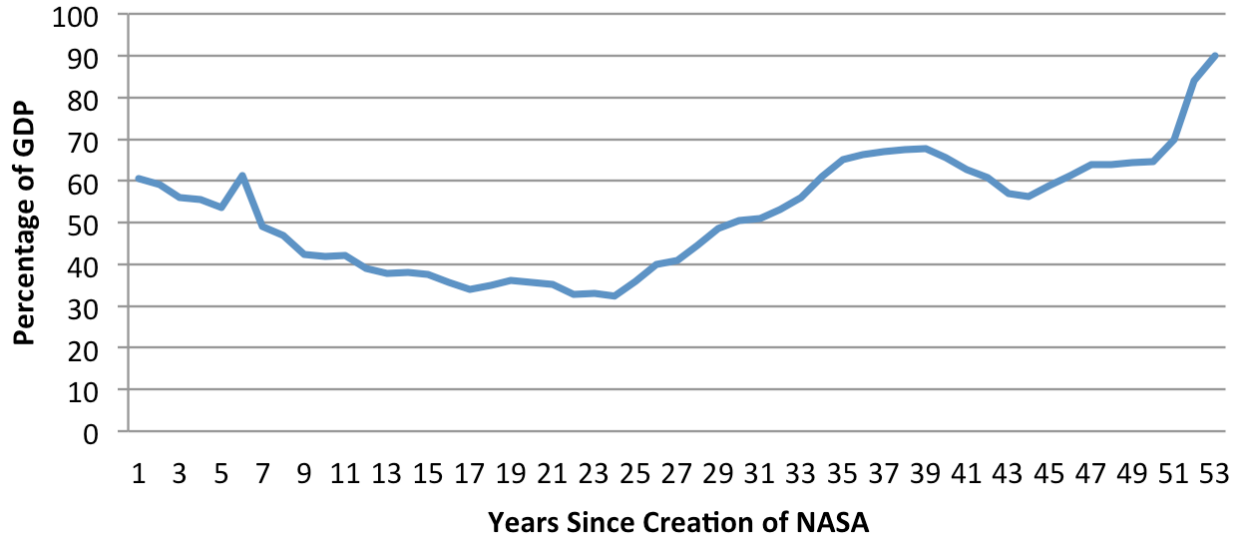


Figure 4: Republican Presidency Years

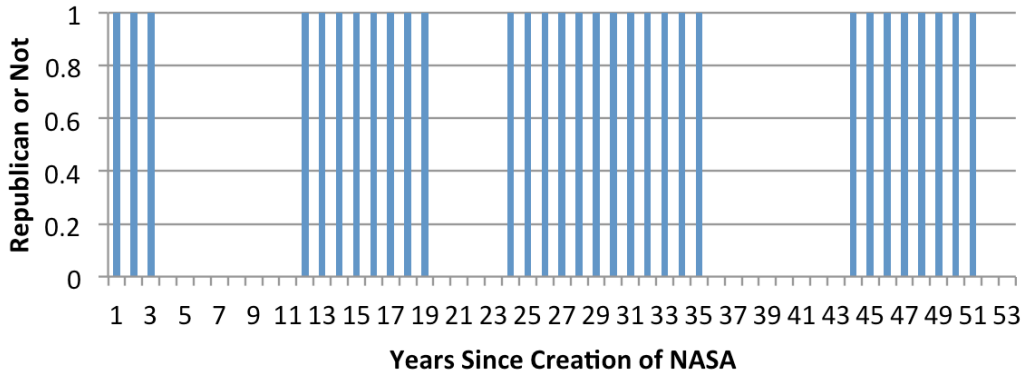


Figure 5: Space Race

