# Projections for Future Funding of NASA And NASA Science Activities: Reassessing the Obama FY 2010 Budget Request

C. N. Hartman

*Space Policy Institute, Elliott School of International Affairs*
*George Washington University*
*1957 E Street, NW*
*Washington, DC 200052*
*202-994-6451;* cnhart@gwu.edu

**Abstract.** This paper develops a novel approach for predicting future funding for the total NASA budget and for science activities within that budget. Although the budget process is inherently political, it is adequately characterized by analyzing the last thirty-two years of NASA budgets, organized by the party of the President. Over the last thirty-two years, Republicans have increased the buying power of the NASA budget while Democrats have decreased it, with significant differences in the rates. The President's budget projections for NASA, available since 1990, are used to produce a model that may be applied to future budget projections. Before final conclusions are drawn from these results, the most significant NASA budgetary event of this decade is examined: the one billion dollar share of the American Recovery and Reinvestment Act of 2009. The hypothesis is that an unanticipated, significant, one-year increase to the NASA budget can affect NASA's funding profile for more than one year. This is tested with the only other similar event in NASA history, the unanticipated budget increase following the loss of Space Shuttle Challenger in 1986. An event study of the changes in NASA's total budget before and after the loss of Challenger indicates that the one-year spike in funding increased subsequent NASA growth rates for four years. These results are combined to predict future NASA top-level and science budgets for FY 2011 and FY 2012.

**Keywords:** Space Science, NASA, Government Funding, Stimulus Package
**PACS:** 01.78.+p, 01.75.+m

## INTRODUCTION

This paper develops a novel approach to predicting future National Aeronautics and Space Administration (NASA) budgets, including the budget for science activities at NASA. Predicting future NASA budgets is important because the federal budget process is a year-by-year process. Each year, funding is approved for only the upcoming year. All future funding is merely a projection and the government is under no obligation to continue funding NASA beyond the upcoming year. Yet many NASA activities are inherently multi-year efforts. Designing, constructing and launching a spacecraft takes years. Once on-orbit, spacecraft can collect terabytes of data, which take many more years for scientists to analyze (Conway, 2006; Dozier *et al.*, 2003). Thus, there is an inherent mismatch in time horizons between NASA mission multi-year efforts and the yearly federal budget process.

This inherent mismatch between multi-year mission plans and the federal budget process may be exacerbated by politics. Since the federal budget process is inherently a political activity, politics sometimes disrupts the process. The budget for federal agencies expires at the end of the fiscal year, so the regular appropriations bill for the subsequent fiscal year must be enacted by a deadline of 1 October. However, since 1978, that deadline for appropriations bills to keep the government running was met only three times: FY 1989, FY 1995, and FY 1997. When government agencies do not have an appropriation by 1 October, they must operate on a temporary spending bill called a Continuing Resolution that provides a spending rate generally based on their previous year's budget (Bamboa, 2006; Fenno, 1966) until the regular bills become law. Besides a straight-forward disagreement on funding level, other considerations may delay Congressional action. Political maneuvers contributing to missing the deadline include refusing to approve an Agency budget in order to force action on an unrelated political goal or adding earmarks, sometimes with an eye toward reelection campaigns. (Lazarus, 2009; Levitt and Snyder, 1995).

CP1208, *Space, Propulsion & Energy Sciences International Forum–SPESIF-2010,* edited by G. A. Robertson
2010 American Institute of Physics 978-0-7354-0749-7/10/$30.00

The mismatch in time horizons is especially acute for science activities at NASA. NASA science activities are diverse, but fall broadly into four disciplines that are currently budgeted within the Science Mission Directorate at NASA Headquarters: heliophysics, planetary sciences, astrophysics, and Earth sciences. Multi-year plans are created in each of these science disciplines in order to allocate scare resources to the most pressing space and Earth science questions. The multi-year plans include funding allocations to individual scientists and to aerospace firms. Many university space and Earth scientists rely predominantly on NASA for resources since there are not many other sources of funding for space-based research. Aerospace firms build most of the NASA spacecraft for science investigations and at least some of the science instruments they carry. In order to have these spacecraft built, NASA officials must sign multi-year contract agreements with aerospace firms even though the Agency itself has no guarantee that funding will be available one year hence. In addition, NASA spacecraft for science investigations are one-of-a kind research and development endeavors. Careful funding plans can easily be derailed because of unanticipated hardware or software problems, causing a ripple effect throughout NASA science programs as managers attempt to rebalance the budget. Given this complicated balancing act, it is clear that accurately projecting future NASA science budgets is a key component to successfully managing science activities at NASA.

Despite the importance of accurate budget projections for both NASA and its partners, academic and industry analysts often use the President's budget projections for their analysis (*e.g*. Iannotta, 2009; Kintisch, 2009; Koizumi *et al.*, 2009). Although this analysis is useful because it focuses on the funding proposals published by the White House, it does not attempt to predict the future NASA budget and thus may miss large upcoming fluctuations in funding. This paper will develop new tools for adjusting NASA budget projections to quantifiably predict the outcome of this complicated budgetary process.

## BACKGROUND

The primary source of data for budget projections is the President's budget request. Each year, federal agencies develop their own budget requests that are then reviewed by the Office of Management and Budget (OMB), modified appropriately, and approved by the President. The consolidated President's budget request is then submitted to Congress each year in February and published on the OMB website. The request is the President's proposal to Congress; Congress is not bound by the President's request and they may modify the President's budget or opt to develop their own budget with their own priorities.

Prior to 1990, the President's request for NASA provided no projections beyond the upcoming budget year (year-one). In 1988, Congress passed Public Law 100-685 which required NASA to provide at least an additional two years of budget projections (year-two and year-three) starting in 1990. In 1996, NASA began providing five-year budget projections. The President's request also contains last year's 'actuals.' Actuals are the amount of budget authority provided to a government agency by Congress in the yearly appropriations bill. Budget authority allows a federal agency to expend federal funds.

Past budgets reveal how well the President's budget projections performed when compared to the actuals. The year-one budget is a very good predictor of actuals. A simple regression of the last thirty-two years of budget requests shows that the year-one request accurately predicted the actuals about 94% of the time. But there is a mere eight months between the submission of the President's budget request and the start of the year-one fiscal year, so they do not provide much of a projection. The year-two and year-three projections will be evaluated to determine how accurately they predict future budgets.

Figure 1 shows past forecast accuracy. Figure 1(a) shows the top-level NASA budget and Figure 1(b) shows a subset of the top-level allocated to NASA science, with all numbers lagged and normalized to the actuals. Fiscal year 1996 will be used as an example to help explain the graph. In the President's 1995 budget request, the projected amount for 1996 (year-two) was 104% more than the actual budget passed by Congress for 1996. In the President's 1994 request, the projected amount for 1996 (year-three) was 116% greater than the actual. Since data is necessary for the previous two years (lagged year-two and year-three), fiscal year 1992 is the first year for which these projections were available.

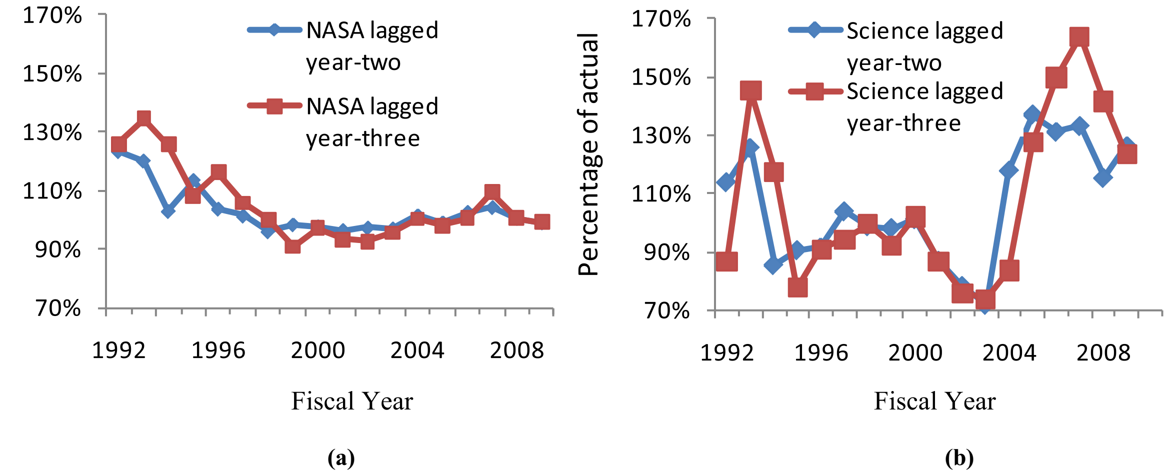



**Figure 1. a)** NASA top-level budget projections as a percentage of actuals and **b)** NASA science budget projections as a percentage of actual by fiscal year.

The general accuracy of out-year projections for both NASA and for science activities at NASA is easy to see from Figure 1. The NASA top-line budget prediction for year-two lagged data varied between 96% and 123% of the actual and for year-three lagged data, it varied between 91% and 135% of the actual. The NASA science budget projection for the year-two lagged data varied between 72% and 137% of the actual and for year-three lagged data it varied between 74% and 164% of the actual. The science projections are a poorer predictor of actuals than the NASA top-level projections. These figures make clear that when analysts use the President's budget projections without further analysis, they are using predictions that have historically been rather inaccurate.

Relying on the predictions from the President's budget request is clearly inadequate. Other factors need to be considered in order to improve the fidelity of the predictions. These factors can be divided into three categories: budget corrections with special emphasis on science activities, political considerations, and confounding events.

Budgets must be corrected to allow for accounting changes that do not impact program funding. By deconstructing the budget and determining the core activities for NASA and for science, this paper will attempt to reconstruct a more accurate historical budget picture. For instance, the Deep Space Network is a multi-million dollar yearly effort that has been transferred multiple times between the science directorate and the space operations directorate. This transfer would cause large fluctuations in the science budget if the activity were not appropriately accounted for, even though it is merely an accounting change. A list of the science activities that were modified to obtain a consistent baseline may be found in Appendix A.

An important component to this analysis is the collection of the budget in all areas pertaining to NASA science. The science activities at NASA must be carefully culled in order to include all appropriate funding over the thirty-two year span under investigation. NASA science activities have changed dramatically over the years and Congressional budget line items for science activities have come and gone under a variety of names. A broad definition of NASA science activities is used here. For instance, in the early 1980's NASA science included "Space Science" and "Space and Terrestrial Applications." In 1984, these activities were called "Space Science and Applications." In 1994, "Mission to Planet Earth" was created and in 1995, "Life and Microgravity Sciences and Applications" was created. In 2004, Earth science and space science were combined into the Science Mission Directorate. The funding for all of these areas of NASA science activities are included in this analysis and called science.

Political considerations play a role in both the President's request and in the final Congressional appropriations. The President's veto power, for instance, has been shown to influence Congressional appropriations decisions (Kiewiet and McCubbins, 1988). A more subtle Presidential influence may be found in the staffing of the executive branch. Presidents often reach back to senior members of the last President of their party to help them govern. For instance, President George W. Bush selected many senior advisors from both his father's presidency and even that of Ronald Reagan (*e.g.* Vice President Dick Cheney, Secretary of Defense Donald Rumsfeld, and Deputy Secretary of State

Richard Armitage). President Obama has also selected senior members of the Clinton Administration to help him govern (e.g. Ambassador to the United Nations Susan Rice, Deputy Secretary of Defense William J. Lynn III, and Secretary of State Hillary Rodham Clinton). The same people often return to government with the same policies and opinions about governing that were evident during their first terms of service. Although most NASA Administrators were not from previous administrations (James Fletcher and Dan Goldin are the exceptions), government policy-making at the White House is often defined by returning senior officials. NASA budgets might be more accurately projected if political trends were included in the analysis. Of course, politics cannot easily be quantified, so one must find a proxy for it. How such a proxy might work is describe in the Methodology section.

Budget corrections and political considerations may improve a budget projection in a normal year. But 2009 has not been a normal year. The most confounding event for the NASA budget in over a decade is the American Recovery and Reinvestment Act (ARRA) of 2009. In addition to its normal 2009 appropriations, NASA received one billion dollars from the ARRA. Out of this, science activities received $400 million ($325 million for Earth science activities and $75 million for astrophysics.) Most of the remaining $600 million was allocated to aeronautics and exploration activities. The effect of such an unexpected budget increase may last for more than one year, if for no other reason that that NASA may not be able to spend one billion dollars in a single year. In addition, advocates for programs that received an increase may lobby Congress more vigorously and more successfully in coming years to keep an increased funding base. Not accounting for such a significant budgetary event might significantly skew budget projections for 2010 and beyond. The unanticipated budget increase following the loss of Space Shuttle Challenger in 1986 will be used to predict a multi-year effect from the ARRA.

## Limitations of the Dataset

The dataset is limited in several ways. Since NASA only began providing multi-year budget projections to Congress in 1990, the dataset of projected budgets consists of twenty years, a relatively limited set. Also, the science data required in-depth review so that accounting adjustments did not affect the analysis of trends. One particularly vexing problem is that full cost accounting was implemented at NASA in 2002, causing the institutional charge for each science activity to increase by a varying manpower estimate. It took several years before full cost accounting techniques were applied consistently. The analysis of unanticipated budget increases is also limited because NASA has had only one similar event in its history, the 1987 funding for the replacement of the Space Shuttle Challenger. In addition, the 1987 Challenger budget is four times greater than the AARA in constant year dollars. It is assumed that there is no secondary effect due to the size of an unexpected significant change in the budget and that results from the Challenger event may be scaled.

## METHODOLOGY

Since politics does matter, there is a logical rationale for including some proxy for the fact that the budget process is a political process. This process is complicated and does not have an easily quantifiable observable. However, the political party of the President may be used as a proxy for politics. Figure 2 shows the NASA top-level budget and the requests for each year from 1978 to the end of the Obama budget projections in 2014. By separating the data by Presidential term, it is easy to see that the NASA budget might be usefully analyzed by eras based on the Presidential term. Presidents are identified at the top of the chart and colors are selected based on the party of the President: reds for Republicans, blues for Democrats. Of course, the outcome of the political process may be highly dependent upon which party controls Congress along with various other factors, such as the state of the economy, public perception of the National debt, and the unemployment rate. But here the simple proxy of the President's political party proves to be a significant predictor.

Figure 2 shows an unusual budgetary event labeled "Challenger effect" showing the increase in NASA funds to replace the Space Shuttle Challenger after the accident in 1986. This large, unanticipated funding increase is off-nominal, so the 1987 and 1988 budget data must be excluded from the general trend analysis. However, the "Challenger effect" will prove critically important to analyzing the effect of the 2009 AARA. The data will be analyzed in the following three distinct ways.

First, the data will be analyzed to determine basic statistics for each Presidential era. The years 1987 and 1988 and the ARRA funds in FY 2009 are excluded in order to consistently compare Presidential eras without a significant, off-nominal budgetary event. Using constant FY 10 dollars, the mean of each of the Presidential eras will be found.

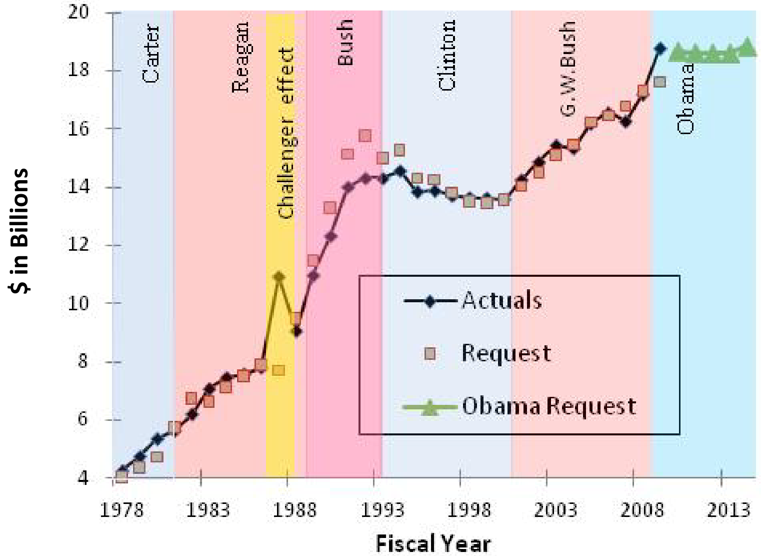



**Figure 2.** NASA top-level requests and actuals, delineated by Presidential term and Challenger effect.

A simple t-test is performed to determine if the means of Presidential eras are significantly different. This is done for both the top-line NASA budget and the science budget, with modifications to the science budget given in Appendix A. Then using nominal dollars, a regression is performed on each Presidential era to determine the rate of increase of the budget, or slope. This too is performed on the top-line NASA budget and the corrected budget for science. The results of the means and of the regression line slopes are compared to confirm general trends.

Second, the data from FY 1990 – 2009 will be used to determine the accuracy of past budget projections. This analysis will not include the 2009 ARRA funding. The data is divided into Presidential eras as well, providing a proxy to predict the accuracy of Presidential projections by party affiliation.

Third, the confounding effect of the AARA will be analyzed. A one billion dollar increase to the NASA budget is a highly unusual event that may undermine any statistical analysis for projecting future budgets. The effect of such a significant, unexpected budget increase may last several years, disrupting the normal budgetary process for some time. However, there is a way to model this event with a hypothesis test. The hypothesis is that an unanticipated, significant, one-year increase to the NASA budget can affect NASA's funding profile for more than one year. This is tested with the only other similar event in NASA history, the unanticipated budget increase following the loss of Space Shuttle Challenger. After the January 28, 1986 Space Shuttle Challenger accident, Congress appropriated the largest unanticipated increase to the NASA budget in the last two decades. Relative to the pre-accident baseline, an additional $2.4 billion was appropriated in 1987 to replace Challenger. An event study of the changes in the top-level and science budget before and after the loss of Challenger is used to determine a multi-year, post accident budget "excess." This budget excess is then scaled to the AARA event and used to modify the Obama budget forecasts.

One additional modification to the data must be made in order to perform the event analysis accurately. Significant new initiatives at the time of the Shuttle accident would produce changes in the budget that might inappropriately be attributed to an effect of the sudden Shuttle replacement funds, biasing the model. Yet in actuality the increased budget would have no relationship to changes due to Shuttle replacement funds. There is one major new initiative during this timeframe: the Space Station. The Space Station was first publicized in 1984 by President Reagan. Significant funds began to be appropriated in 1986 and continued growing after the Shuttle accident. Before further analysis is performed, the Space Station funds are removed from both the request and actual for the entire time-span of 1984 through the Obama budget projections in order to obtain an unbiased model.

# RESULTS AND DISCUSSION

The results are divided into three sections: basic statistics on the Presidential eras, an analysis of past budget projects, and an event analysis of the Challenger accident. In each section, the results of the analysis will be applied to the Obama budget projections to provide new predictions. Since each of the three sections also may be applied as a consolidated whole, the last section on the Challenger event analysis will provide integrated budget predictions.

## Basic Statistics on Presidential Eras

Table 1 provides the slope of the best fit regression line and the mean for the top-level NASA data actuals, segmented by Presidential era and excluding Space Station funds and the FY 1987 and FY 1988 to avoid the impact to the budget from the Challenger accident. The mean is calculated using constant FY 10 dollars. A simple independent t-test indicated that the means differed significantly. The regression is performed with nominal dollars and the slope is a measurement of the rate of change of the NASA budget.

**Table 1**. Simple regression slope and mean results for the NASA top-level budget, dollars in thousands.

| President (years of term) | Slope (Nominal $) | Mean (FY 10 $) |
|---|---|---|
| Ford (1974 – 1976) | Not significant | 16,409 ± 683 |
| Carter (1977 – 1980) | 492 ± 38 | 18,178 ± 617 |
| Reagan (1981-1986) | 397 ± 77 | 18,317 ± 1,612 |
| Bush (1989 – 1992) | 828 ± 175 | 20,269 ± 1,200 |
| Clinton (1993 - 2000) | -177 ± 35 | 16,919 ± 2,052 |
| W. Bush (2001-2009) | 482 ± 42 | 16,986 ± 1,064 |

The dispersion of the mean was relatively small until Reagan's presidency when it more than doubled; it has remained large ever since. This indicates that the NASA top-line budget since 1981 varies with a larger frequency than it did between 1974 and 1981. This might indicate that the political aspects have been playing a more active role in the budget process than they did before Reagan's presidency. This notion again raises the importance of a proxy for politics. By breaking the eras down by presidency, a trend due to politics appears. Since the beginning of Reagan's first term, Republican Presidents have increased NASA's budget while Democrats have not. This observation gives some credence to the notion that because Presidents recall senior advisors from their party's past presidential teams, Republican administrations will change the NASA budget in ways similar to past Republican administrations, even though the baseline may have changed. The same might be said of Democrats. When analyzing the Obama budget, then, the Clinton trends are more important than those of past Republican administrations. Clinton decreased the buying power of NASA. There may be many political reasons for this fact, including an attempt to balance the budget and those reasons may resonate in today's political environment. However, the reasons do not have to be ascertained. The Clinton regression results may simply be applied to the Obama projections. Since Obama's 2010 budget has not been approved, the 2009 actuals, including the AARA funds, will be the starting point for applying the Clinton regression. This analysis yields $18.5 ± 0.04 billion for NASA in 2011, $100 million less than the Obama budget projection for that year and $18.3 ± .07 billion in 2012, $300 million less than the Obama budget projection for that year.

**Table 2.** Simple regression slope and mean results for the NASA science budget, dollars in thousands.

| President (years of term) | Slope (Nominal $) | Mean(FY 10 $) |
|---|---|---|
| Carter (1977 – 1980) | 107 ± 11 | 2,147 ± 193 |
| Reagan (1981-1988) | 138 ± 11 | 2,965 ± 152 |
| Bush (1989 –1992) | 310 ± 34 | 4, 022 ± 569 |
| Clinton (1993 –2000) | 71 ± 40 | 5,013 ± 366 |
| G. W. Bush (2001–2009) | 44 ± 32 | 5,267 ± 272 |

Table 2 provides the mean and the slope of the best fit regression line for NASA science budgets, after the data is corrected as described in Appendix A. There are no detailed science data for 1974 – 1976 available at this time, so the presidential eras start with Carter. President Reagan maintained the buying power at NASA both at the top-level and at the science level. The top-level increase in the rate of change in the G. Bush years did reach science, whose rate of change more than doubled from Reagan's tenure. Clinton reversed the growth rate for NASA, yet the rate of change for science did better under Clinton than under G. W. Bush, even though G. W. Bush more than doubled the rate of change of NASA's top-line budget.

Applying the Clinton era regression results for science yields a prediction of \$5.1 ± 0.1 billion in 2011, \$700 million more than the Obama budget projection for 2011, and \$5.1 ± 0.1 billion in 2012, \$200 million more than the Obama budget projection for 2012.

## Analysis of Past Budget Projections

Since predictive data for year-two and for year-three are available starting in 1990, there are only three Presidential eras to consider: G. Bush (1991–1992), Clinton (1993–2000) and G. W. Bush (2001–2009). For G. Bush, the regression did not produce statistically significant results. Table 3 presents the statistically significant regression results. For science, none of the projections produce regressions yielding statistically significant results.

**Table 3.** Regression results for the top-level NASA budget predictions, dollars in thousands.

| **Prediction Year** | **Clinton (1993-2000)** | **G. W. Bush (2001-2009)** |
|---|---|---|
| Year-2 regression | y = (0.18 ±0.07*x) + 11,253 | y= (0.79±0.09*x ) + 3,320 |
| Year-3 regression | y = (0.14 ±0.02*x) + 11,823 | y= (0.69 ±0.09 *x) + 5,089 |

There is a problem applying the Clinton era regression results to the Obama budget. If the regression for the Clinton years is applied to the Obama projections, the NASA budget would sustain billions of dollars of reduction in both 2011 and 2012. But a straight-forward application of the regression results in this case may be misleading. In 1995, the politics of the budget process came to a head and the President and Congress not only failed to agree on a budget, but also failed to agree on a continuing resolution to keep the government operating, causing the government to shut down. Even though the shut-down itself lasted only a few days, the delay in obtaining an appropriation for the year caused the NASA budget in 1995 to be anomalously low, resulting in a significant outlier in the regression analysis. President Clinton also appears to have exploited this opportunity to keep the NASA budget below the buying power of the previous President for the rest of his term.

## Event Analysis of the Challenger Accident

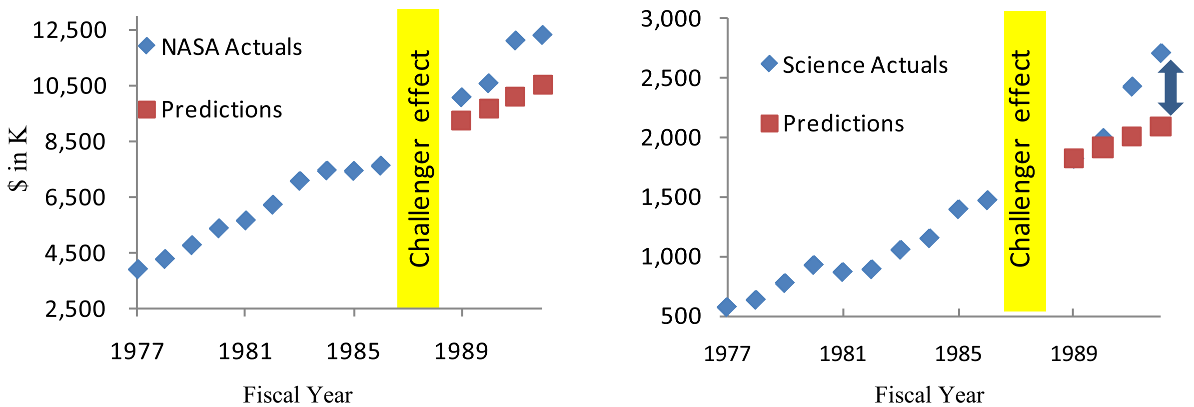
Table 4 shows the simple regression results and means for pre- and post-accident timeframes. As previously noted, Space Station funds are excluded from this analysis and the slope is given in nominal dollars while the mean is given in FY 10 dollars.

**Table 4.** Results of a simple regression and calculation of the mean for the NASA top-level and science budget, dollars in thousands.

| **Funding Category** | **Pre-accident** (1974 – 1986) | **Post-accident** (1989 – 1992) |
|---|---|---|
| **NASA Top-level** | | |
| Slope (Nominal \$) | 430 ± 18 | 828 ± 175 |
| Mean (FY 10 \$) | 17,834 ± 1,385 | 20,269 ± 1,300 |
| **NASA Science** | | |
| Slope (Nominal \$) | 89 ± 8 | 310 ± 34 |
| Mean (FY 10 \$) | 2,926 ± 178 | 4,022 ± 285 |

The regression results are consistent with the means of each of the timeframes. Post-accident, the rate of growth of funding nearly doubled at the NASA top-level. For science, the post-accident rate of growth is nearly 3.5 times greater than before the accident.

By projecting the pre-accident rate of growth to the years 1989 thru 1992 and comparing it to the post-accident actual, it is found that at the top-level there is 14% more growth over those four years than might have been expected. These results are shown in Figure 3(a). The hypothesis that a large, unanticipated increase in funding will affect the budget for several years is confirmed. For science at NASA, the post-Challenger budget also grew by 14% over what might have been expected. These results are shown in Figure 3(b).




**(a)** **(b)**

**Figure 3. a)** NASA top-level and **b)** NASA science predictions and actuals. All dollars in thousands.

NASA folklore often states that a large increase to one area of NASA activities will, sooner or later, cause a decrease to the budget for ongoing NASA activities. But at least in this one case, both the budget for the Shuttle and the budget for science increased equally.

An application of these results is now used to predict future NASA top-level and science budgets. The actuals for 2009, including the one billion dollar ARRA funds for NASA, is the starting point. The Clinton era median is used because the proxy results suggest the party of the President follows the trends of the previous Presidency of the same party. The Challenger event study is scaled to the size of the AARA. The 2011 budget for NASA is predicted to be $19.0 ± 0.1 billion, $400 million dollars more than the Obama request. The 2012 budget for NASA is predicted to be $19.4 ± 0.1billion, $800 million more than the Obama request. For science, the 2011 budget is predicted to be $5.2± 0.1 billion, $500 million more than the Obama projection and the 2012 predicted science budget is $5.5 ± .01 billion, $600 million more than the Obama projection. For the top-level NASA budget in 2011, this analysis predicts a 5% increase over the Obama projection. For science activities within that budget, this analysis predicts a 10% increase over the Obama budget projection.

## SUMMARY

A novel approach was used to predict the 2011 and 2012 NASA top-level budget and science budget contained within those totals. An analysis of the last thirty-two years of data indicates that the party of the President does have an effect on NASA's budget. The predictive power of the past twenty years of budget projections is analyzed and the limitations of these results are explained. An event study of the increase in NASA's budget after the Challenger accident indicates that the effect from the ARRA funds may increase the NASA budget over the next four years. This analysis gives credence to the prediction that the top-level NASA budget and the science budget may grow beyond the Obama projections in 2011 and 2012.

## ACKNOWLEDGMENT

The author wishes to thank Mr. Craig Tupper and Mr. Roy Maizel from the Science Mission Directorate at NASA Headquarters for their keen insights into the history of the NASA science budget.

# APPENDIX A

## Data Sources

This paper uses the actuals and projections from the President's budget requests and the OMB top-level actuals to construct a dataset from FY 1978 to FY 2014 for NASA and for NASA's science activities. Past President's budget requests for NASA at the Agency level were found at http://www.gpoaccess.gov/usbudget/browse.html and detailed NASA budget estimates for each year were found at http://www.nasa.gov/news/budget/index.html. Comparisons were made with other published final appropriations estimates, such as those reported in the Annual Senate document *Appropriations, Budget Estimates, Etc.* which is prepared under the direction of the Committee on Appropriations of the Senate and House of Representatives as required by law in U.S. Code, Title 2, Section 105. NASA appropriations found in this document within the section entitled "Recapitulation Tables, Appropriations for budget fiscal year by agency" were found to differ at less than 0.2 percent from those found at the websites listed above. Dollars, where necessary, are converted to constant FY 2010 dollars using the Consumer Price Index inflation factors found at http://www.bls.gov/cpi/. All data are in terms of budget authority. All years are fiscal years.

## Adjustments to the NASA Science Budget

Several significant budgetary changes must be taken into account before the last three decades of NASA science budgets may be compared to each other. Major areas of adjustment are listed below in Table 5. A total of $4.4 B in adjustments was required over eleven years.

The largest adjustment was made in Institutional Changes, which includes the change to full cost accounting. Prior to 2002, all NASA appropriations for the salaries of civil service personnel and for essential travel, facilities services, and management and operations of all NASA installations were in the "Research and Program Management (R&PM)" appropriation. All other activities for NASA, except for construction of facilities, were in the "Research and Development" appropriation. Since 2002, the R&PM appropriation was terminated and these funds were added to the Research and Development appropriation. The result was an artificial increase to the science budget due to the inclusion of funds previously budgeted elsewhere. In order to compare the science budget over the last three decades, full cost accounting figures were removed from the years 2002 – 2009.

**Table 5.** Major areas of adjustment to the NASA science budget.

| Activity | Years Adjusted |
|---|---|
| Institutional Changes | 2002-2009 |
| Nuclear Propulsion | 2003-2004 |
| Lunar Exploration Program | 2004-2005 |
| Cross Enterprise Technology | 1997-2000 |
| Jupiter Icy Moons Orbiter (JIMO | 2003-2005 |
| Ground Network | 1996-2002 |
| Deep Space Network | 1996-2002 |

Although costs for Expendable Launch Vehicles (ELVs) were not budgeted within either the Earth or Space Science Enterprises prior to 1996, the adjustment to the budget would be a guess and a constant. As such, it does not change this analysis and no adjustment was made.

Note that all science actuals from 1996 through 2006 were modified by the author for the years given in this table in order to make valid cross-year comparisons with earlier years. Any mistakes belong to the author.

# REFERENCES


Bamboa, Anthony H., *Principles of Federal Appropriations Law*, Third Edition, Vol. II, U.S. Government Accountability Office, GAO-06-382SP, Washington D.C., (2006), pp. 4-146.

Conway, Erik M., “Drowning in data: Satellite oceanography and information overload in the Earth sciences,” *Historical Studies in the Physical and Biological Sciences*, **37**(1), (2006), pp. 127-151.

Dozier, J., Acharya, A., Buja, L., Mark, L., Overpeck, J., Wheeler, M. and Yengst, T., *Government Data Centers: Meeting Increasing Demands*, Committee on Coping with Increasing Demands on Government Data Centers, Committee on Geophysical and Environmental Data, Board on Earth Sciences and Resources, Division on Earth and Life Sciences, National Research Council, National Academy of Sciences, The National Academies Press, Washington, D.C., (2003).

Fenno, Richard F., *The Power of the Purse: Appropriations Politics in Congress*, Little Brown and Company, Boston, (1966).

Iannotta, Becky, “Obama Budget Plan Offers Near-term Boost for NASA,” *Space News International*, **20**(9), (2009).

Kiewiet, D. Roderick and McCubbins, Mathew E., “Presidential Influence on Congressional Appropriations Decisions,” *American Journal of Political Science*, **32**(3), (1988), pp. 713-724.

Kintisch, Eli, “U.S. Budget 2009: Earth Gets a Closer Look,” *Science*, **319**(5864), (2009), p. 717.

Koizumi, K., Muchnick, M., Huerta, M., Marvel, K., Bierly, E. and Eden, H. F., “*Report XXXIII, Research and Development FY 200*9,” American Association for the Advancement of Science, Intersociety Working Group, No. 08-1A, (2009).

Lazarus, J., “Party, Electoral Vulnerability, and Earmarks in the U.S. House of Representatives,” *J. of Politics*, **71**(3), (2009), pp. 1050-1061.

Levitt, S. D. and Snyder, J., “Political Parties and the Distribution of Federal Outlays,” *American J. of Political Science*, **39**(4), (1995), p 958-980.