Congress & the Presidency, 39:51–73, 2012

ISSN: 0734-3469 print / 1944-1053 online
DOI: 10.1080/07343469.2011.640383

Presidential Vision or Congressional Derision? Explaining Budgeting Outcomes for NASA, 1958–2008

Richard S. Conley

Department of Political Science, University of Florida, Gainesville, Florida

Wendy Whitman Cobb
University of Florida, Gainesville, Florida

This study examines presidential-congressional relations on appropriations for the National Aeronautics and Space Administration (NASA). The objective is to examine differences between presidential requests and congressional appropriations for NASA spanning fiscal years 1959–2009. The analysis accentuates NASA's exceptional situation in the budgeting process as an agency without a core social or geographic constituency, the impact of congressional budget reforms, and presidents' relative inattention to space policy since the agency's inception in 1958. The theoretical basis for the quantitative analysis also draws from perspectives that include domestic economic factors, international contexts, and the congressional electoral cycle. The empirical analysis accentuates the basis for congressional dominance over the agency's funding.

"Lit up with anticipation, we arrive at the launching site
The sky is still dark, nearing dawn, on the Florida coastline
Circling choppers slash the night, with roving searchlight beams
This magic day when super-science mingles with the bright stuff of dreams. . ."
Rush, "Countdown," Signals (1982)

Nearly three decades ago the iconic Canadian rock group *Rush* celebrated the U.S. National Aeronautics and Space Administration's (NASA) space shuttle program. The lyrics of the song have now become an appropriate eulogy for a program that once stirred extraterrestrial reveries and captivated universal human imagination across the globe—at times seemingly more abroad than in America itself. The "bright stuff of dreams" propelled by solid rocket fuel faded into history on July

Address correspondence to Richard S. Conley, Department of Political Science, University of Florida, 234 Anderson Hall, Gainesville, FL 32611. E-mail: rconley@ufl.edu

8, 2011, when the shuttle *Atlantis* made its final voyage to the International Space Station (ISS). *Atlantis*, like its counterparts *Endeavour* and *Discovery*, will now become a museum relic of a bygone era.

With the retirement of the space shuttle fleet and the recent scrapping of the shuttle's replacement program, Constellation, by President Obama and Congress, NASA finds itself in a precarious position. The agency has been plagued by questions of administrative inefficiency, cost overruns, pressures to privatize and commercialize space flight, and high profile shuttle disasters including *Challenger* (1986) and *Columbia* (2003) from which it has arguably never fully recovered. Congressional policymakers' ambivalence towards NASA has been compounded by most presidents' ambiguity in their commitment to human spaceflight since the Apollo era.

NASA's challenges are evident in budgetary politics between the branches and within Congress. Since the creation of NASA under President Eisenhower in 1958 and President Kennedy's urgent challenge before a joint session of Congress in 1961 to put a man on the moon by the end of that decade, NASA's annual budget has hovered around $15.7 billion since 1970.[1] But there is much more to the story. With the exception of just three years since the agency was created—1959, 1961, and 1987—inflation-adjusted congressional appropriations for NASA have fallen *below* presidents' requests by an average of $1.6 billion (s.d. = $1 billion). The divergence between NASA's long-term programmatic commitments and appropriations cuts could not be more evident for the success or failure of the agency's programs. The result has been to jeopardize NASA's ability to engage in strategic, long-term planning for the implementation of human spaceflight and other large-scale programs (DalBello 1989, 80). "All too often," Paxton (2006, 11) asserts, " NASA, in response to external factors (ranging from Congressional earmarks to budget cuts in program elements) is unable to meet its commitments for funding and unable to control costs due to a lack of sufficient programmatic insight and an unwillingness to prevent changes in scope in the mission design."

The following questions naturally arise. Why have presidents not taken a greater interest in NASA's mission since the moon landing? And why has Congress chopped NASA's budget, sometimes by as much as $3–4 billion, from presidents' annual requests in recent decades? One reason is that since the Apollo era space policy has not been a political priority on the national agenda at either end of Pennsylvania Avenue (Johnson-Freese 2004, 80; Logsdon 2003, 80). Another, as many scholars argue, is that presidential leadership on space policy has generally been highly exaggerated, rhetorically symbolic, and lacking in substance (Launius and McCurdy 1997).

This research examines the basis for differences between presidential requests for NASA funding and congressional appropriations for space policy spanning fiscal years 1959–2009. The analysis accentuates NASA's exceptional situation in the budgeting process as an agency without a typical social or geographic constituency, the impact of congressional budget reforms of the 1970s, and presidents' relative

inattention to space policy since the agency's inception. The theoretical basis for the quantitative analysis draws from perspectives that include domestic economic factors, international contexts, and the congressional electoral cycle. The objective is to explain budgetary outcomes for NASA over time and highlight the broader implications for theories of executive and legislative budget politics in "tertiary" policy areas**:** policy areas such as science, immigration, and health research that may be distinguished from "primary" areas such as the economy and international politics (Handberg 1998).

The analysis unfolds in several stages. The next section briefly reviews NASA's precarious position in the congressional budget process as institutional, domestic, and international contexts have changed. The third section details the data and method employed in the empirical analysis of the inflation-adjusted difference between fiscal year presidential budget requests and congressional appropriations from FY 1959–2009 using an autoregressive conditional heteroskedasticity (ARCH) model. The fourth and fifth sections of the analysis, respectively, provide an interpretation of the findings and a recapitulation of the import of this research for an understanding of executive-legislative relations on non-traditional policy areas.

THE POLITICS OF UNEARTHLY BUDGETING: NASA AS AN EXCEPTION TO THE RULE?

Compared to other policy areas, NASA's budget has been vulnerable to dramatic shifts, a frequent lack of (or only feigned) presidential interest, and the focus of incessant congressional cutbacks since the Apollo program. The explanations for this dynamic, discussed below, are multiple and intertwining and provide a critical backdrop to the analysis of budget outcomes that follows.

The Political Environment: From Apollo to "Star Wars"

NASA's success in procuring funding has been largely contingent upon how presidents and Congress have framed its role and usefulness. The agency's programs—whether the space shuttle, the Hubble telescope, or missions to Mars, Jupiter, or the International Space Station—do not fall neatly within any particular policy area. Rather, NASA's programs straddle domestic, defense, and foreign policies.

In the early cold war era, the political environment was highly favorable to space exploration. After the Soviet Union's launch of *Sputnik* in 1957 there was a sense of urgency, both in terms of national security and prestige, to advancing space policy (Kay 1998). *Sputnik* was militarily significant insofar as its launch elucidated that the Soviets had ballistic missile capability, with disturbing implications for the delivery of nuclear warheads. For his part, President Eisenhower supported satellite technology to compete with the Soviets, but was not enthralled with the idea of putting a man on the moon, per se. President Kennedy, on the other hand, used his

support for space policy as a central issue in the 1960 campaign against incumbent Vice President Richard Nixon and to bolster his claims of a "missile gap" between the United States and the Soviets. Indeed, it was under Kennedy's presidency that NASA's budget skyrocketed, only to commence a considerable decline beginning in 1964.

In the post-Apollo era the urgency of space flight waned in light of the protracted conflict in Vietnam, the rising costs of domestic entitlement programs, and exorbitant federal deficits that threatened the discretionary portion of the federal budget significantly by the 1970s and 1980s. These factors contributed to a palpable decline in support of NASA in both the executive and legislative branches (Byrnes 1994, 115–16). President Nixon approved the space shuttle reluctantly, President Ford was preoccupied with "stagflation" (high unemployment and high inflation), and President Carter emphasized space policy only insofar as cost savings were involved. President Reagan utilized lofty rhetoric in terms of space exploration, going so far as to endorse U.S. plans for a space station in 1984. But in reality, Reagan was focused far more on the Strategic Defense Initiative or "Star Wars" than NASA programs (Krug 2004, 67; 92).

Key personalities in Congress seized on domestic concerns during this period in the bid to redirect funding from space exploration to other policy realms. Even before Neil Armstrong set foot on the moon, prominent liberals in Congress resented spending on the Apollo program specifically, and science and technology more generally. In the House, representatives including Ed Koch (D-NY) and James Fulton (R-PA) were particularly skeptical of NASA (*Congressional Quarterly Almanac* 1969, 300-05). Two of NASA's most implacable foes in the Senate through the 1960s and 1970s included Walter Mondale (D-MN), later Vice President to Jimmy Carter (1977–1980), and maverick William Proxmire (D-WI).

Mondale, Proximire, and others were only variably successful in their bid to shift funding from NASA to other programs in an earlier era during which budget politics were less complex in Congress, and the Cold War still loomed large. NASA profited from powerful allies on Capitol Hill to thwart its opponents. James C. Fletcher, the NASA administrator from 1971–1977, noted that "In the Senate especially, but to some degree in the House, there are individuals who seem to sway the rest of the body," (Fletcher 1994, 240). He cited Senators Stennis (D-MS), Goldwater (R-AZ), and Cranston (D-CA) as steadfast supporters of NASA, and attributed these legislators' leadership as a major factor in staving off the efforts of Proxmire and others to de-fund agency priorities such as the development of the space shuttle. Subsequent changes to Congress' internal organization, however, complicated these key figures' ability to influence NASA funding as they were once able in the heyday of the "textbook Congress."

Budget Reform, Constituency "Matters," and the NASA Bureaucracy

Whereas the 1970 Legislative Reorganization Act sought to better coordinate the House Appropriations Committee's review of the president's annual budget (Kravitz

1971, 385–86), the Budget and Impoundment Act of 1974 consolidated NASA's funding with that of Housing and Urban Development (HUD), Veterans Affairs (VA), and more than a dozen independent agencies, including the Environmental Protection Agency (EPA). In assessing annual budgeting for VA-HUD-NASA-Independent Agencies after the 1974 changes, as Johnson-Freese (2004, 82) explains, "it is useful to think in terms of numbers of voters in each category directly benefiting from federal expenditures." NASA's budget became far more susceptible to the whims of Congress compared to traditional policy areas (Handberg 1998; Handberg, Johnson-Freese, and Moore 1995; Murray 1987).

The reason is straightforward: the agency lacks a geographic and core constituency tantamount to that for other policy areas. Although public support for NASA has generally been strong (Launius 2003), the segment of the population "attentive" to space exploration issues is ten percent or less (Miller 1987). Public opinion therefore does not provide a genuine "constituency" of significant influence over members of the powerful authorizing and appropriating committees in Congress. Moreover, NASA's spaceflight programs typically generate *intangible* rather than broad, *direct* benefits that affect specific social or geographic constituencies. As Roberts (1990, 140) contends, NASA's arguments about "spinoff" technological advances have "not persuaded many voters, and the perceived benefits of space are limited to a narrow community which does not garner much public, hence political, support."

The agency's geographic constituency consists largely of nine field centers in eight states which employ the vast number of NASA's employees and contractors: The Ames Research Center, and Dryden Flight Research Center, in California; Glenn Research Center, in Cleveland, Ohio; Goddard Space Flight Center, in Maryland; Johnson Space Center, in Houston, Texas; Kennedy Space Center, at Cape Canaveral, Florida; Langley Research Center, in Hampton, Virginia; Marshall Space Flight Center, in Huntsville, Alabama; and Stennis Space Center, in Mississippi. These states are most affected by the agency's budget (Congressional Budget Office 2009, 25). Together they culled $10.5 billion in NASA funding in FY 2003. All told, the other 42 states received $2 billion total at an average of just $47 million each (NASA Budget by State). Members from constituencies with NASA employees certainly have strong electoral incentives to protect funding for the agency's human spaceflight programs (Broniatowski and Weigel 2008, 150). Yet from l974 until NASA's reorganization to the House Science, Justice, and Commerce Committee in 2004 (discussed below), such members were routinely outnumbered relative to appropriators whose core constituents include veterans, construction firms desiring federal subsidies for public works for housing projects, or environmental lobbying groups.

It is understandable, then, why NASA's long-term programmatic goals were subordinated to more pressing social or economic concerns. Members of authorizing committees, and of the powerful House Appropriations Committee, assessed the relative benefits versus the costs of space exploration compared to their own constituency interests. In the annual appropriations process, members naturally

attempt to "earmark" projects to the states or districts they represent to maximize the benefits to those who elected them. Cuts to NASA's budget, particularly in an era of scarce resources and high federal debt, entailed few constituency ramifications for most members on Capitol Hill. "Civilian space projects," Vedda (2002, 287) accentuates, "have never been significant campaign issues, and there has been little in the way of organized efforts by political parties to take sides in this area."

From 1974–2004 NASA's budget was at a distinct disadvantage when it reached the final stage of the appropriations process, amalgamated as it was with VA, HUD, and other independent agencies. While many members may have found space exploration and human spaceflight appealing, the imperatives of their own reelection incentive (Mayhew 1974) and constituency concerns operated against NASA's long-term programmatic interests:

> . . . supporters of programs in a given subcommittee—who had been allies up to this stage—now compete against each other within that subcommittee. Thus, the 'currency' in which votes trade is far from transparent. A shuttle flight is the equivalent of how many jobs, houses, and veterans' benefits; how much national prestige; how many new recruits into the study of science and engineering . . . (Macauley 1992, 55)

Simply put, compared to other policy areas such as veterans affairs, housing, health, or law enforcement, space policy appears far more "discretionary" for most members of Congress (Lambright 1992, 192).

In 2004 House Speaker Tom DeLay—whose district included the Johnson Space Center—proposed a reshuffling of appropriations subcommittees to end the VA-HUD subcommittee's jurisdiction over NASA. DeLay's particular objective was to realign subcommittees to circumvent NASA's competition with Veterans Affairs, which comprised the lion's share of funds appropriated by the VA-HUD subcommittee. Under DeLay's initial plan, responsibility for the space program would have moved to a revamped Energy and Water subcommittee (Taylor 2005a). Instead NASA was eventually shifted to the House Science, Justice, and Commerce Committee where the agency is theoretically in a better position to vie for funding absent the VA. The results of the reshuffling, however, have been mixed. NASA continues to confront an environment of increased competition (Taylor 2005b), and finds itself in a budgetary struggle with other entities including the National Science Foundation and the National Institutes of Health. Congressional "horse trading" across programmatic areas, often to the agency's detriment in an era of scarce resources (see Telscon 1992), has not vanished.

Large-scale programs like NASA's are always vulnerable to congressional re-evaluations (Ginzberg et al. 1976, 18–19). But as Kay (1998, 63) posits, "most government programs succeed or fail only in a relative sense." This has not been the case for NASA. Cost overruns for long-term programs have not only tarnished NASA's image in Congress since the Apollo era (McCurdy 1994, 281), but the loss of the Mars orbiter and the space shuttles *Challenger* (1986) and *Columbia* (2003)

are dramatic examples of the agency's putative shortcomings that have received much media attention. Such disasters have exacerbated congressional criticism of the space program in recent decades. NASA has become a frequent target of congressional reproof for alleged over-bureaucratization. Whatever the number of successful ventures the agency has undertaken, recriminations of NASA's organizational culture—one purportedly defined by needless administrative complexity and bureaucratic inflexibility—have undermined congressional confidence, adding to NASA's woes in the battle of the budget (Augustine Committee 1990; Lambright 1992; McCurdy 1991; 1992).

Combined with the tendency of elected representatives to consider their ability to justify programs to their constituents on a two-year (House) or six-year (Senate) electoral cycle, highly technical and long-term projects within NASA regularly face unstable budgets (Kay, 1995). NASA's ability to influence congressional commitment to space policy has been hampered by bureaucratic intransigence and a failure to alter its own agenda priorities as political control and priorities of the White House and Capitol Hill have alternated. As Klerkx (2005, 57) contends, "the pace of human spaceflight is whatever pace NASA says it should be," regardless of congressional skepticism. NASA programs have been criticized for their path dependency—programs taking on a life of their own independent of congressional or presidential calls for change (Bruggeman 2002; Roberts 1990, 144).[2] Path dependency inhibits successful liaison with either Congress or the Office of Management and Budget (OMB).

NASA's Performance Assessment and Reporting Tool (PART) evaluations, as well as the frequent disjuncture between the agency's own budget estimates with those of OMB and the Congressional Budget Office (CBO), have not inspired congressional confidence. These dynamics further accentuate the complicated relationship between programmatic planning and congressional funding for the agency. FY 2004 provides several examples. PART was initiated with the FY 2004 budget in an effort to encourage agencies to develop performance measures in order to help inform funding decisions. In its 2004 PART evaluation, NASA claimed that the agency had met 79% of its annual performance goals, and failed at only 2%. Further, NASA contended the agency was on track to meet 83 percent of its goals for multi-year projects (NASA 2004, 19–20).

Yet the agency's own budget estimates came under intense scrutiny by fall 2004, casting doubt on such glowing internal reviews. Not content with agency and OMB estimates of the cost of President George W. Bush's Vision for Space Exploration (VSE, discussed below), the Subcommittee on Science, Technology, and Space of the Senate Commerce, Science, and Transportation Committee requested that the CBO undertake its own assessment and make long-term budgetary projections. CBO assessed historical program cost growth for NASA in addition to similarly bold proposals of the past (such as the Apollo program) to estimate the future costs and potential overruns. The CBO analysis also used out-year projections based on a different measure of inflation than the one employed by OMB. The

mismatch between NASA's budgetary planning assumptions and CBO's conclusions was palpable. The report stated:

> CBO's analysis indicates that NASA's total funding needs through 2020 might be $32 billion greater than NASA's current projection anticipates . . . An increase of $32 billion would represent a rise of about 12 percent relative to NASA's total projected funding of $271 billion through 2020. It would constitute an increase of about 33 percent relative to the $95 billion that NASA has projected for the exploration portion of its program over that same period (CBO 2004, xiii–xvi).

Congress, of course, substantially cut back the funding for Bush's VSE. The example underscores the highly complicated dialogue between NASA and members on Capitol Hill, and between the executive branch and Congress more generally. On the one hand, Congress relies to some degree on agency self-evaluations and OMB cost estimates. On the other hand, the CBO can provide an entirely different perspective. Congressional cuts to NASA's budget often result from plans and estimates—such as the VSE—that are unrealistic and/or do not confront the realities of budget limits in an era of significant constraints. Members of Congress are left to decipher which set of proposals and budget projections appear most feasible and accurate.

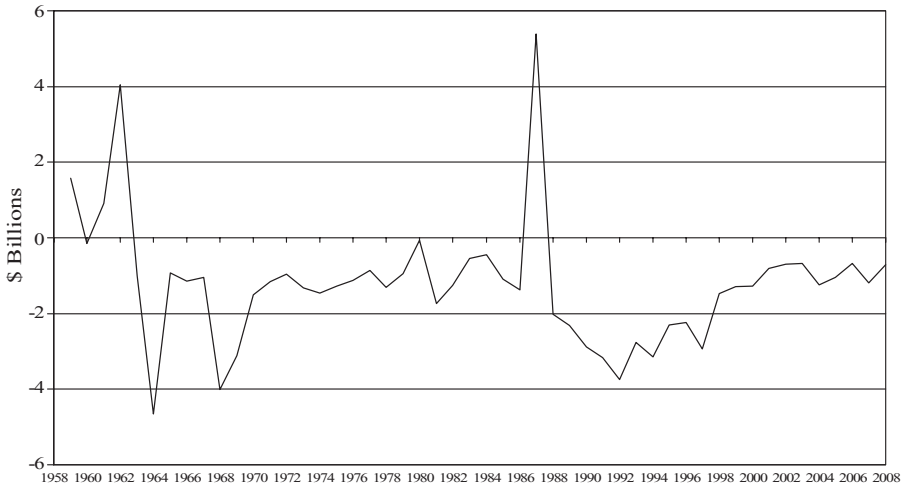
Further, NASA and OMB do not always see eye to eye on programmatic goals. As one example, in September 2008 NASA Administrator Mike Griffin grew angry when OMB censored some of his comments about the imperative of returning to the moon before the Russians or the Chinese in a prepared statement to the House Science and Technology Committee. Griffin accused OMB of launching a "jihad" to retire the space shuttle. One NASA official put the conflict this way: "Whether this is cost-cutting across the board or if some people in OMB just don't like NASA, we don't know. But the result is that our budget always seems to be less than it's supposed to be," (quoted in Space Politics 2008).

Indeed, Congress has had few qualms about cutting NASA's budget. As Figure 1 shows, with rare exception, Congress has almost continuously funded NASA at levels well below presidential requests. In inflation-adjusted dollars, the amounts range from a few million to $4 billion over the agency's lifespan. In recent decades such cuts have been made despite the articulation of clear-cut policies by Presidents George H. W. Bush and George W. Bush. The data confirm, as Vedda (1996, 186) notes, that "presidential enthusiasm is a necessary but not sufficient element in the success of space projects. It doesn't guarantee a high probability of political acceptance."

Presidential Leadership and the Post- Cold War Era

Few presidents have been willing to put their "political capital" on the line for space policy—this complex, "constituentless" policy area (Light 1999)—since the Apollo era. And the international and domestic political context has changed considerably

FIGURE 1. Difference in Presidential Budget Requests and Congressional Appropriations for NASA, 1958–2008 in Billions (Constant $ = 2009).



Source: Compiled by authors from NASA budget data. The unit of analysis is funding for the next fiscal year (e.g., 1958 reflects FY 1959 appropriations).

since NASA's inception. NASA's *raison d'être* has become less clear following the end of the Cold War and with increased multinational cooperation on projects, such as the ISS involving Russia and the European Union (Murray 1991), not to mention China's emerging interest in space exploration.

Still, two presidents—George H. W. Bush in 1989 and George W. Bush in 2004—attempted to articulate long-term visions for NASA. Their relative success was contingent not only on congressional action but also their successors' commitment as party control of the White House changed. George H. W. Bush proposed the Space Exploration Initiative (SEI) in 1989, with the explicit goal of putting mankind on Mars. The large price tag inhibited congressional action in his inaugural year, and the SEI was not taken up by Congress until 1990 for fiscal year (FY) 1991.

In 2004 George W. Bush proposed the VSE, which called for phasing out the space shuttle program and emphasizing programs designed to use the moon as a launching pad for eventual exploration of Mars. Yet President Obama, following his 2008 election victory, signaled that such efforts were a low priority on his overall agenda and attempted to scale back the Constellation project significantly.

"The President," Lambright (1992, 192) contends, "looms as the most important ally NASA must have." Yet presidents have only infrequently taken an active role in the bid to restore the agency's funding to match their requests since the end of the Cold War. Such rare cases include restitution of some $2 billion for the International Space Station proposed by George H. W. Bush in 1991 several years following his announcement of the SEI (*Congressional Quarterly* 1991), veto

threats by Bill Clinton in 1999 as congressional appropriators sought to eliminate Vice President Al Gore's Triana satellite project at an estimated savings of $75 million (McCutcheon 1999), and a veto threat by George W. Bush—against appropriators of his own party—if they did not restore some $1.1 billion to NASA funding he had requested as part of the VSE (Wayne 2004). Are these recent cases anomalies?

Such veto threats directly relating to NASA's budget are, in fact, a recent development. The implications for theories of presidential-congressional relations on budget politics are considerable. As Kiewiet and McCubbins (1988) contend, it is typically when chief executives prefer to spend *less than Congress* that they are likely to employ the veto or veto threats. If Congress consistently prefers to spend less than they request, presidents have little incentive to engage in protracted interinstitutional battles unless the policy area affected is a high political priority—which is traditionally not the case with NASA.

Congress's routine funding of NASA at levels below presidential requests sets the agency's budget politics apart from many other governmental programs, which Congress is often likely to fund *in excess* of presidential recommendations, prompting veto showdowns between the branches. The analysis that follows highlights the uniqueness of NASA budget politics by examining the differences between presidential requests and congressional funding for the agency.

DATA AND METHOD

The dependent variable for analysis is the difference in inflation-adjusted congressional appropriations and presidential budget requests for NASA spanning fiscal years 1959–2009, as depicted in Figure 1. Ordinary least squares (OLS) regression is inappropriate for the analysis on several accounts. First, a Dickey-Fuller test of the dependent variable shows the probability of a unit root (non-stationarity) at $p < .001$. Second, partial autocorrelation analysis shows serial correlation in the dependent variable. As a result, an autoregressive conditional heteroskedasticity (ARCH) model with a lag term (t_{-2}) is employed for the analysis using robust standard errors for the independent variables. ARCH models assume a conditional mean and conditional variance for non-linearly distributed data based on the unit root (see Engle 2004). Such models are frequently employed in financial market forecasts to adjust for seasonality and other forms of non-constant variance (Gouriéroux 1997).

The independent variables in the model comprise contextual and institutional dynamics hypothesized to affect congressional budget decisions. The explanatory variables constitute the following:

Congressional Election Year

A dummy variable for congressional election years is included in the model to test the impact of electoral politics on budgeting decisions. As a "constituentless" policy domain, NASA's budget should be more susceptible to greater cuts as

members of Congress eye reelection and attempt to shift funds to more tangible constituency-based projects.

Ideological Difference between the President and the House Appropriations Committee

Although appropriations are a bicameral process, this analysis privileges the role of the House. First, by precedent, spending bills commence in the House. Second, the House Appropriations Committee traditionally acts as defender of the budget and budget priorities. DW-NOMINATE scores (Poole and Rosenthal 1997), which are scaled from −1 (most liberal) to +1 (most conservative), are utilized to calculate the ideological "distance" between the president and mean score for the majority on the House Appropriations Committee. The expectation is that the farther "left" of center the House Appropriations Committee mean falls from the president, the higher the probability that NASA's budget will be cut below the president's request. As noted earlier, key Democrats in Congress to the left of the ideological spectrum have often championed the channeling of funds away from space to domestic concerns. A similar dynamic is visible in survey data, with Democrats in the electorate far more skeptical of the space agency's funding compared to other domestic priorities (see Kraemer 1993).

The average distance of the majority on the House Appropriations Committee from the president from 1958–2008 is −.33 (s.d. = .63). At the extremes, the Committee was 1.11 points to the left of President George W. Bush from 2007–2008, and .83 points to the right of President Clinton from 1997–1998.

Annual Change in Federal Debt and Change in Inflation

These two variables capture the economic context under which Congress has considered presidential budget requests for NASA. The percent annual change in federal debt as a proportion of national gross domestic product (GDP) and the annual change in the rate of inflation were calculated from Bureau of Labor Statistics data. The expectation is that higher levels of debt and inflation should lead to decreased NASA funding as congressional appropriators and the White House struggle to define national policy priorities. From 1958–2008 the annual average change in inflation was 3.9 percent, with lows of less than 1% for much of the 1960s, and highs ranging from 7% to 8% in the early 1980s. The average annual change in the debt ratio to GDP was 4.9% for the entire period, with the figure averaging a little more than 3% from the 1960s–1990s, and exceeding 6% beginning in 2004.

Human Competition

This variable reflects the number of international states that have the proven capability to independently launch manned spaceflight missions. Until 2003, when China launched its first manned mission, this number stood at two—the United States and the former Soviet Union. Because of the geopolitical environment out of which the U.S. space program evolved, international competition in spaceflight

is theorized to impart a sense of urgency on U.S. space policy and thus increase NASA expenditures.

Launch Competition

International launch competition is measured by the annual number of other countries that have independent launch capabilities (i.e., can send satellites or probes into orbit without the assistance of other countries). These data were compiled from several domestic and international sources (History of Europe in Space; JAXA History; Steinberg n.d.). Increased international competition is expected to lead to greater congressional funding for NASA, both for reasons of national prestige and technological innovation.

Number of Annual NASA Launches

This variable measures the number of manned and unmanned launches undertaken by NASA annually. The data were derived from *Air Force Magazine*'s annual Space Almanac (Mehuron 2009). Two hypotheses are possible in terms of the impact of space exploration activities on congressional budgeting. The first is that Congress may seek to scale back appropriations for NASA for the upcoming fiscal year if the agency undertakes a high number of missions, as further missions may be regarded as redundant. The second is that successful missions in one year may lead to greater appropriations in the following fiscal year.

Percent Annual Change in NASA Civilian Personnel

The percent change in NASA civilian personnel (lagged by one fiscal year) is a control variable in the model designed to capture the amount of bureaucratization within the agency (McCurdy 1993). As with any other federal agency, as civilian personnel increases or decreases, presidential requests for appropriations should follow suit. The mean of the variable is a positive net annual change of just under 1% for the entire period, which reflects the relative stability in NASA personnel beginning in the 1970s. The most dramatic increase was 40% (1960) following the agency's inception. The most significant decrease came in 1995 and 1996, at 6.9% and 7.7%, respectively, when the Republican Congress squared off against Democratic president Bill Clinton over deficit reduction and government spending. The data were compiled from NASA.

Cold War Era

1958–1989. A dummy variable for the Cold War is included in the model to test the hypothesis that, ceteris paribus, inflation-adjusted appropriations were higher during the era of intense military and space competition between the United States and the Soviet Union.

Apollo, Challenger, and Columbia Disasters

Dummy variables for the Apollo launch pad disaster (January 27, 1967), the loss of the space shuttle *Challenger* (January 28, 1986), and the explosion of the space shuttle *Columbia* (February 1, 2003) are included in the model to gauge congressional reaction to NASA's most dramatic failures. Each accident occurred early in the year, before Congress took up appropriations for the following fiscal year. It is unclear whether these tragedies may have contributed to greater or lesser spending on space exploration vis-à-vis congressional requests, the most important of which was the replacement of the space shuttle *Challenger* in President Reagan's FY 1987 budget request.

Presidential Space Policy Announcements

Dummy variables are included for the space policy announcements of Presidents Kennedy (1960), G. H. W. Bush (1989), and G. W. Bush (2004), and are lagged "forward" two years. These presidents' articulation of space policy "vision" should have sent strong signals to Congress about their commitment to the NASA budget and enhanced the probability that appropriations would more closely correspond to their requests. Lagging the dummy variable is a means to assess the relative "staying power" of presidents' vision on agency appropriations.

ANALYSIS

Table 1 presents the results of the ARCH analysis of the difference in presidential budget requests and congressional appropriations for NASA. Several summary statistics accentuate the model's effectiveness and predictive capability. The R^2 and adjusted-R^2 statistics are calculated just as for a standard OLS regression using the sum of squares of the estimate. The simple R^2 of .77 and adjusted-R^2 of .53 underscore the robustness of the model. However, given the non-stationarity of the dependent variable, some scholars posit that R^2 statistics for ARCH models may be overly optimistic (Harvey 1984). Several other goodness-of-fit measures were calculated to substantiate the findings, including the residual mean square (McCleary and Hay 1980, 101). The statistic shows, in effect, that on average the model under- or over-estimates the difference in congressional appropriations by $114 million annually.[3] The model mean explains 75% of the variance, while the autoregressive (AR) term, per se, only explains 3% of the overall variance. The latter statistic emphasizes that the AR term explains far less than the independent variables in the model. Let us now assess the impact of the explanatory variables in the model in greater detail.

The model does confirm a number of hypotheses. Election years have a moderately negative impact, consistent with expectations. The dummy variable for the two-year electoral cycle shows that, on average, agency appropriations fall

Table 1. ARCH Model of the Difference in NASA Presidential Requests and Actual Congressional Appropriations ($ Millions = Constant 2009), Fiscal Years 1959–2009

Variable	Coefficient	Robust S.E.
Congressional Election Year	−245	169*
Ideological Difference between President and House Appropriations Committee Majority (Mean)	650	186****
% GDP Debt	−1,315	310****
% Change Inflation	−621	138****
% Change NASA Personnel	1.06	.420***
Number of NASA Launches (year of appropriation)	−22	33
Human Competition	3,868	671****
Launch Competition (number of countries)	2,901	651****
Cold War Period (1959–1989)	2,908	1,384**
Apollo Disaster (1967)	3,372	625****
Challenger Disaster (1986)	−2,235	1,402*
Columbia Disaster (2003)	−2,435	658****
Kennedy–Space Policy Announcement 1961	2,444	1,210**
Kennedy–Space Policy Announcement 1961 $_{(t-1)}$	4,343	1,387***
Kennedy–Space Policy Announcement 1961 $_{(t-2)}$	2,243	1,161***
George H. W. Bush Space Policy Announcement 1989	2,026	1,169**
George H. W. Bush Space Policy Announcement 1989 $_{(t-1)}$	1,537	864**
George H. W. Bush Space Policy Announcement 1989 $_{(t-2)}$	−1,952	663***
George W. Bush Space Policy Announcement 2004	−2,097	488****
George W. Bush Space Policy Announcement 2004 $_{(t-1)}$	−3,829	984****
George W. Bush Space Policy Announcement 2004 $_{(t-2)}$	−1,153	719*
Constant	−6,148	3,087**
AR (2)	−.794	.112****
Sigma	622136	188958****
Log Pseudolikelihood = −358.30		
Wald $\chi^2 = 1104.17$****		
Residual Mean Square = 113.86		
$R^2 = .77$		
Adjusted $R^2 = .53$		
Autoregressive $R^2 = .69$		
% Variance Explained by Model Mean = .75		
% Variance Explained by AR (2) Term = .03		

****$p < .0001$; ***$p < .01$; **$p < .05$; *$p < .10$ (one-tailed).
N = 48.

$245 million *below* presidential requests, per se. In traditional policy areas, one would expect Congress to appropriate more to select programs with constituency benefits. However, NASA usually does not provide such an opportunity and the Appropriations Committee is inclined to transfer funds otherwise dedicated to space programs to other policy areas. Several examples are pertinent.

One glaring incident occurred during the spring of 1988. NASA's budget was threatened with significant cuts in order to increase funds targeted for housing (Kuntz 1988). NASA's budget had stood at $10.3 billion in the House version of the appropriations bill. However, "One aide warned that even this amount could

be reduced because of pressure within the committee to shift some of the funds to housing programs," (Kuntz 1988, 1468). As another example, in 1990, the NASA appropriations bill was cut yet again in the House in order to increase funds dedicated to housing programs (*CQ Weekly* 1990). The result was $2 and $3 billion less in appropriations to NASA (inflation adjusted) for 1988 and 1990, respectively.

The effect is compounded by the ideological composition of the House Appropriations Committee. For each 0.10 points on the DW-NOMINATE scale that the mean ideological score is to the *left* of the president, agency appropriations fall 65 million below the president's request. The effect is most pronounced in 1980s and 1990s under Reagan/H.W. Bush. For both presidents, Democrats on the House Appropriations Committee averaged nearly a full percentage point to the left of the ideological scale (−.92 to −1.30). The model predicts that this ideological gulf lowered NASA appropriations between $600 and $650 million below presidential requests from 1981–1992. The only saving grace for Reagan was that from 1981–1986 Republicans held the Senate, where appropriators in the upper chamber were variably successful in hammering out somewhat greater funding for military and space programs.

Under President Clinton, the House Appropriations Committee was 0.15 to the *right* from 1993–1994, and about 0.84 points to the right after the mid-term elections gave Republicans control of Congress. It is noteworthy that appropriations increasingly conformed to presidential requests during Clinton's two terms. First, almost immediately upon taking office, Clinton ordered a review of the space station, program to produce three scaled-down options for him to choose from. His eventual choice would call for NASA to spend $2.1 billion a year on the space station, making the program relatively more stable than it had been in years prior (McCutcheon 1998). Second, in the wake of wrangling over the space station, NASA administrator Dan Goldin (appointed by George H. W. Bush), realized that NASA would need to operate in a more austere budgetary environment. To do so, Goldin initiated plans called "Better, Faster, Cheaper," encouraging NASA to do smaller projects on a quicker time scale and with less money. Finally, the Republican Revolution of 1994 brought more Republicans into the Congress. Republicans have tended to be more supportive of NASA and U.S. space policy for largely geopolitical and defense-related reasons.

NASA appropriations are highly sensitive to domestic economic contexts. Both the debt and inflation variables are negatively related to congressional conformity with presidential requests. The debt ratio has the greatest effect. Every 1% increase in the federal deficit to GDP lowers congressional appropriations by approximately $1.3 billion in constant dollars. Further, an increase of 1% in inflation leads to an additional $621 million in cuts to the NASA budget below the president's request. These two variables are responsible for much of the variation in congressional under-funding of NASA. This is particularly true for the Reagan–Bush years from 1981–1992. Inflation rose steadily from 3.2% in

1981 to 6.3% in 1992. Indeed, 1992 was the nadir for congressional underfunding of NASA, as members on Capitol Hill cut nearly $4 billion from George H. W. Bush's request, despite the SEI vision he had articulated in 1989. Ceteris paribus, the model predicts a 6.3% inflation rate to reduce congressional appropriations by $3.9 billion. Similarly, the sharp dip in NASA appropriations in 1980 may be attributed to a 2.7% increase in the debt to GDP ratio—a figure that the model predicts drove down appropriations by $3.5 billion under the president's request.

The annual percentage change in NASA personnel has only a negligible impact on funding, and the number of annual launches is statistically insignificant. Human and launch competition with other countries, however, is positively correlated to funding levels closer to the president's budget requests. As international competition in both manned and unmanned form increases, Congress acts to appropriate more for NASA in line with the president's budget requests. For example, following Chinese manned spaceflights in 2003, congressional appropriations increased (or rather, got closer to the president's request) by $3.8 billion. Similarly, appropriations increase by $2.9 billion annually as new countries develop independent launch capability. These elements of the model underscore not only how contemporary international competition may have a positive effect on the NASA budget, but also the genesis of the space program as a product of the Cold War. Indeed, the dummy variable for the Cold War indicates that holding all other variables constant, NASA funding from FY 1959–1990 was closer to the president's requests by $2.9 billion.

A further question to consider from the model is how the Congress has reacted to presidential pronouncements of space policy. Clearly, the strongest effect follows John F. Kennedy's announcement making a manned landing on the moon a goal by the end of the 1960s. In response to Kennedy's request, the Congress appropriated $4.3 billion more in FY 1962 and $2.2 billion more in FY 1963 than had been requested by the administration. Following the introduction of George H. W. Bush's Space Exploration Initiative in 1989, the Congress did act to increase presidential appropriations by $1.5 billion in FY 1990. As previously noted, however, the economic situation that followed had a damning effect on Bush's plans and essentially canceled out any legislative movement towards his vision.

Quite unlike either of the previous presidential policy announcements, George W. Bush's Vision for Space Exploration (VSE), introduced in 2004, experienced a different reception on Capitol Hill. For fiscal years 2004 through 2006, the Congress appropriated an average of $2.4 billion less than requested. The VSE became official policy, despite failing to gain any budgetary traction in Congress. Lack of congressional interest in funding the project was compounded by Bush's waning commitment in light of the seemingly intractable wars in Iraq and Afghanistan.

The dummy variables for the three major NASA accidents—*Apollo 1*, *Challenger*, and *Columbia*–show varying impacts in Table 1. Following *Apollo 1*, the model predicts an increase in appropriations of $3.3 billion in inflation-adjusted dollars above the president's request, while for both *Challenger* and *Columbia* a lower appropriation (between $2.2 and 2.4 billion, respectively) is predicted. Actual appropriations accord well in only one of these cases—*Columbia*. In the other two,

appropriations in the fiscal year following the disaster were lower in the case of *Apollo 1* and higher in the case of *Challenger*. These results are partially a reflection of the ARCH function and the autoregressive term present in the model that attempts to calculate the overall trends in the data. However, it is important to note that the budgetary dynamics that played out particularly in the case of *Challenger* are not captured well by the model and thus deserve to be examined in further detail.

1987: An Exceptional Budget with Unexceptional Presidential Leadership

On the morning of January 28, 1986, an unfortunate series of events led to the explosion of the space shuttle *Challenger* just moments after lift off. The tragedy ultimately prompted Congress to appropriate $5 billion more than President Reagan originally requested for NASA. But the additional funding was *not* a product of forceful presidential leadership. Reagan's hesitation concerning a replacement shuttle is instructive. Budget issues dominated the debate in the midst of Gramm-Rudman requirements that mandated a balanced budget (Roberts 1986).

NASA did manage to increase its appropriations for FY 1987 by 35% from the previous year ("NASA Chief Is Gloomy on Budget for Shuttle" 1986), but the process occurred by fits and starts at either end of Pennsylvania Avenue. Members of Congress—not the White House—initially pressed the issue of a new shuttle orbiter (Blakeley 1986a, b). Many members had been frustrated by "official silence from the White House about future space funding" due to conflicts between the Defense Department and OMB regarding how much extra to request for NASA (ibid.). In May, the Senate Appropriations Committee approved supplemental funds of $526 million for NASA's recovery but withheld voting on replacing *Challenger* until President Reagan gave his nod to a replacement (Blakeley 1986c).

The Reagan Administration's position prior to *Challenger* had been that a fifth orbiter for the fleet was not needed (Pear 1986). After the incident, it was Reagan's Defense Secretary, Caspar Weinberger, who initially supported a replacement shuttle (Blakely 1986b; *CQ Weekly* 1986). Yet it was not until July 1986, well into the appropriations process for FY 1987, that President Reagan himself began to give serious consideration to a replacement shuttle. A month later the White House finally committed to the proposed replacement (Boyd 1986). Throughout this process, Congress stood poised to pass funding for a replacement shuttle, but had delayed any major action on FY 1987 appropriations for NASA as members waited for a revised budget from the White House (Blakeley 1986d).

The FY 1987 bump in NASA appropriations was ephemeral. NASA's original budget request, which included the replacement shuttle, was cut by the OMB by $540 million dollars (Blakeley 1987). For the following fiscal year (1988), Congress trimmed $2 billion from the president's request. As forecast by the model, economic and electoral factors returned NASA's budget situation to the predominant pattern.

The singular nature of appropriations for FY 1987 is evident when compared to NASA's other two major accidents: The *Apollo 1* fire in 1967 and the loss of the space shuttle *Columbia* in 2003. In the 1967 launchpad disaster, NASA's budget

was already in a steep decline. Yet the imperative to land on the moon by the end of the decade, and the significant progress already made toward that goal, lessened the budgetary impact. The *Columbia* accident, however, is a far more comparable incident to *Challenger.* In the 17 years between the two shuttle disasters, three major circumstances had changed that would highlight just the kind of political environment that existed in 1986. First, in 1986, the shuttle was only years into its expected lifespan. In 2003 the shuttle program was already almost 30 years old. If *Challenger* highlighted the fragility of the shuttle program, *Columbia* accentuated the aging of the shuttle fleet. Bureaucratic dependence on the relatively young shuttle program in the late 1980s required that NASA fight to hold onto the large chunk of its portfolio that the space shuttle program represented. Comparatively, by 2003, NASA had been considering follow-on programs to the shuttle for years, sending a signal that the shuttle program was ripe for change.

Second, by 2003, NASA had been under more intense scrutiny on Capitol Hill. The agency came under intense criticism for the major cost overruns and technical blunders with the *Columbia* Accident Investigation Board noting how little had changed in NASA following *Challenger*. To many in Congress, NASA seemed incapable of "organizational learning." Finally, the role of the president was quite different in each of these cases. Reagan was ambivalent in submitting a revised budget for a replacement orbiter in 1986. He allowed Congress to take the lead in NASA appropriations, and then gave his stamp of approval. By contrast, in 2004 George W. Bush introduced his expansive VSE only a year after one of NASA's most spectacular failures. There was little appetite on Capitol Hill for the costs involved in the program, especially as the Iraq and Afghanistan conflicts drained the federal budget and consumed attention at both ends of Pennsylvania Avenue.

The Anomalous Years

For three years in the time series—1964, 1968, and 1992—congressional cuts to NASA's budget below the president's request were so large that the error terms in the model are worthy of further scrutiny. Two of these years, 1964 and 1968, reflect the rapid growth of NASA in its early years and the desire of Congress to limit not only growth, but redirect the agency's appropriations. President Johnson was committed to Kennedy's vision of putting a man on the moon—but he was more committed to his "Great Society" domestic agenda. Congress swung the axe to the NASA budget in 1963. The Johnson administration followed suit in 1964, trimming $200 million for the prior year's appropriations (Finney 1964). Election year pressures to keep budgets in check played a central role in the reduced appropriations request. Much to NASA's dismay, on top of the president's cut in requested funding, the House of Representatives proceeded to trim the agency's budget by an additional 5% to $5.2 billion (non-adjusted).

Budgetary pressures were also at the forefront of congressional cuts to the NASA budget in 1968 (for FY 1969). Congress cut NASA's budget to $4.7 billion

(non-adjusted). The costs of the war in Vietnam clearly formed a critical backdrop to the budget situation. But trimming the NASA budget was also facilitated by the fact that the agency—now a decade old—had moved well beyond its initial "startup costs," had acquired much of the resources, physical and otherwise that would be required in a functioning space program**,** and did not require the same level of support (Schulman 1975).

Congressional cuts to the NASA budget in 1992 underscore NASA's tenuous situation during the presidency of George H. W. Bush. His SEI proposal gained little support in Congress, which attempted to end the space station program. Further, internal dissension in NASA added to the appearance of an agency in disarray. The forced resignation of NASA Administrator Richard Truly in early 1992 came on the heels of apparent NASA intransigence in the face of administration desires to take NASA in a new direction. Truly's resignation reflected not only disagreements between NASA and the administration over "basic policy issues" but also the White House's ill-fated attempt to centralize space policy under Vice President Dan Quayle's National Space Council (Broad 1992).

The proposed space station project caused great consternation on Capitol Hill. The estimated cost of the space station had ballooned from $8 billion to $40 billion (Pianin 1992; non-adjusted figures). Increasing costs with decreasing capabilities in the proposed space station design led members of the House of Representatives to repeatedly attempt, unsuccessfully, to end the program—but they left their mark. The space station was allocated $2 billion less than had been requested by the White House (Pianin 1992). The restoration of the space station program was achieved largely because the program had job-generating contracts in "37 of 50 states and 151 of 435 congressional districts," (Pianin 1992). But this factor did not preclude Congress from trimming $3.7 billion less from the NASA budget than had been requested by the Bush administration.

CONCLUSIONS

Space exploration is an atypical policy area. The politics surrounding congressional funding of NASA, and presidential-congressional interaction on the agency's appropriations, defy assumptions in the literature that hold true for other "traditional" policy areas. This research highlights a particular institutional lesson with respect to a tertiary policy area.

Congressional dominance of NASA and U.S. space policy is a disincentive for presidential involvement. Presidents, in order to place their own stamp on space policy, must purposefully insert themselves into the policy-making environment, but do so at their own risk and peril. Presidents' commitment is crucial for their chance for success. But such commitment is not a guarantee that either Congress or NASA will follow their lead, and more pressing issues—such as the economy or foreign affairs—often distract presidential attention from space policy. In addition, the opportunity for presidents to succeed in reordering policy is highly contingent

on the given economic context. Because the availability of discretionary funding hinges on the state of the U.S. economy, presidents are generally leery of making major policy changes that require long-term funding and decade-long research and development. Moreover, in hard economic times, Congress finds it appealing to cut areas of the federal budget that seemingly have few immediate, tangible benefits. Presidents have shown little resolve to challenge the legislature. Finally, NASA's traditional "independence" in asserting the agency's own vision of long-term programs is an additional impediment to presidential leadership in space policy.

NASA's lack of an engrained and strong constituency amplifies the impact of these factors. With no major interest group, and only a limited community of scientists, aeronautical engineers, or space clubs who do not form a geographic constituency in most cases, NASA is vulnerable to the whiplash budget decisions of the yearly appropriations process. This analysis highlights that Congress is more likely to shift funds away from NASA to other agencies in election years. The structure of the authorizing and appropriations committees of which NASA formed a component from 1974-2004 was part and parcel of the dilemma. Why was the VA likely to draw funds away from NASA? Governors, mayors, and other local officials are critically important to the reelection efforts of members of Congress in their districts. Programs for veterans offer more immediate benefits than most NASA programs can possibly contemplate. Veterans groups form a powerful interest group that members will not ignore. The swift congressional response to the scandals surrounding veterans' health care at the Walter Reed Hospital and elsewhere in the past several years is a case in point. It is too early to tell whether NASA's reorganization into the House Science, Commerce, and Justice Committee will improve the agency's fortunes in a continuing environment of competition for scarce resources.

Is NASA alone in its budgetary dilemma? The brief answer is no. Future analysis might focus on how the findings of this research correspond to the problems that other independent, "constituentless" agencies face in the yearly budget cycle, and the relative impact of variables brought to bear in the NASA case, including presidential leadership, the economic context, and electoral pressures. For example, other policy areas—particularly those involving research and development such as the National Science Foundation (NSF), the National Institutes of Health (NIH), the Environmental Protection Agency, etc.—may suffer from a similar type of irregular congressional (and presidential) attention that undercuts efforts to develop long-term programs. NASA now competes with NSF and NIH, rendering a future comparative case study further intriguing. The short-term imperatives of congressional and presidential budgeting may rob such agencies of many desirable long-term outcomes, whether in medicine or technological development.

Finally, the findings of this research shed considerable light on the political environment that NASA faces as the Obama administration attempts downplay the importance of space policy. In the spring of 2010, President Obama opposed the fundamental elements of the Constellation program proposed under George W.

Bush's Vision for Space Exploration (VSE). Obama has encouraged private industry to provide human transportation to and from the space station. NASA is to focus its efforts on a larger heavy-lift rocket. This artifact of the executive-legislative relationship surrounding NASA buttresses the notion of the traditionally dominant role that Congress has played in the agency's five-decade long history.

NASA's mission, programs, and budget, as this analysis suggests, have attained a shifting, "conditional" equilibrium. Such equilibrium is one punctuated far more by the uncertainties of economic and international contexts, as well as the tentativeness of internal politics in Congress and between the branches, than by sustained presidential vision and leadership.

ENDNOTES

1. All budget figures referenced in the text are constant, inflation-adjusted 2009 dollars.
2. The concept of path dependency as used here means "social processes that exhibit increasing returns" (Pierson 2000, 252). In other words, as the costs of "exit" from the policy direction increase, the likelihood of changing direction decreases.
3. The residual mean square is calculated as 1/N $\sqrt{SSE}$, where SSE = $\sum (y - \hat{y})^2$.

REFERENCES

Augustine Committee. 1990. (U.S. Advisory Committee on the Future of the U.S. Space Program).

Blakely, Steve. 1986a. "Members Critical of NASA Management: Congress Inclined to Replace Space Shuttle, Chairmen Say." *CQ Weekly*, February 22, 449–50.

———. 1986b. "Space Program Faces Costly, Clouded Future." *CQ Weekly*, April 5, 731–36.

———. 1986c. "Panel Votes $526 Million for NASA." *CQ Weekly*, May 17, 1134.

———. 1986d. "Congress OKs $7.8 Billion NASA Authorization." *CQ Weekly*, October 25, 2682.

———. 1987. "NASA Budget Request Draws Congress' Fire." *CQ Weekly*, February 7, 228.

Boyd, Gerald M. 1986. "Reagan Hints He May Reject Some Space Shuttle Contracts." *New York Times*, August 8, A28.

Broad, William J. 1992. "NASA Chief Quits in Policy Conflict." *New York Times*, February 13, p. A1.

Broniatowski, David A., and Annalisa L. Weigel. 2008. "The Political Sustainability of Space Exploration." *Space Policy* 24: 148–57.

Bruggeman, David. 2002. "NASA: A Path Dependent Organization." *Technology in Society* 24: 415–31.

Byrnes, Mark E. 1994. *Politics and Space: Image Making by NASA*. Westport, CT: Greenview Press.

Congressional Budget Office (CBO). 2009. "The Budgetary Implications of NASA's Current Plans for Space Exploration." Washington, DC: CBO.

Congressional Quarterly Weekly Report. 1986. "NASA Chief Resigns; Budget Hearings Begin." March 1, 529.

———. 1990. "Appropriations: HUD-VA Funding OK'd by Panel." June 16, 1889.

———. 1991. "Key Votes: Economy, Events Overseas Drive '91 Confrontations." December 28, 3763.

DalBello, R. 1989. "Space Transportation and the Future of the U.S. Space Program." In *Space Policy Reconsidered*, ed. R. Byerly. Boulder, CO: Westview Press, 73–82.

Engle, Robert F. 2004. *ARCH: Selected Readings*. New York, NY: Oxford University Press.

Finney, John W. 1964. "Space Program Faces Leveling-Off Under Next NASA Budget." *New York Times*, January 5, 54.

Fletcher, James C. 1994. "Problems and Opportunities at NASA." In *NASA: A History of the U.S. Civil Space Program*, ed. Roger D. Launius. Malabar, FL: Krieger Publishing Company, 236–48.

Ginzberg, Eli, James W. Kuhn, Jerome Schnee, and Boris Yavitz. 1976. *Economic Impact of Large Public Programs: The NASA Experience*. Salt Lake City, UT: Olympus Publishing Company.

Gouriéroux, Christian. 1997. *ARCH Models and Financial Applications*. New York, NY: Springer-Verlag.

Handberg, Roger. 1998. "The Fluidity of Presidential Policy Choice: The Space Station, the Russian Card, and US Foreign Policy." *Technology in Society* 20: 421–39.

Handberg, Roger, Joan Johnson-Freese, and George Moore. 1995. "The Myth of Presidential Attention to Space Policy." *Technology in Society* 17: 337–48.

Harvey, A.C. 1984. "A Unified View of Statistical Forecasting Procedures." *Journal of Forecasting* 3: 245–75.

"History of Europe in Space." ESA-About ESA–History of Europe in Space. (Accessed July 12, 2010.) http://www.esa.int/SPECIALS/About_ESA/SEM7VFEVL2F_0.html

"JAXA History." JAXA: Japan Aerospace Exploration Agency. (Accessed July 12, 2010.) http://www.jaxa.jp/about/history/index_e.html

Johnson-Freese, Joan. 2004. "Congress and Space Policy." In *Space Politics and Policy*, ed. Eligar Sadeh, Volume 2. New York, NY: Kluwer Academic Press, 79–103.

Kay, W. D. 1995. *Can Democracies Fly in Space?: The Challenge of Revitalizing the U.S. Space Program*. Westport, CT: Praeger.

———. 1998. "Mission Control: Politics, Not Size, Is The Real Threat to Megaprojects at NASA." *Forum for Applied Research and Public Policy* 13: 62–66.

Kiewiet, D. Roderick and Matthew McCubbins 1988. "Presidential Influence on Congressional Appropriations Decisions." *American Journal of Political Science* 32: 713–736.

Klerkx, Greg. 2005. *Lost in Space: The Fall of NASA and the Dream of a New Space Age*. New York, NY: Pantheon.

Kloman, Erasmus H. 1988. "Competing for a Future in Space: NASA and the Department of Defense." *Space Policy* 4: 7–11.

Kraemer, Sylvia K. 1993. "Opinion Polls and the U.S. Civil Space Program." NASA Archives, (NASA-TM-109788).

Krug, Linda T. "Presidents and Space Policy." In *Space Politics and Policy*, ed. Eligar Sadeh, Volume 2. New York, NY: Kluwer Academic Press, 61–77.

Kuntz, Phil. 1988. "$60 Billion HUD Bill Approved: Spending Tug of War Intensifies Between NASA, Other Programs." *CQ Weekly*, May 28, 1468–1469.

Lambright, W. Henry. 1992. "The Augustine Report, NASA, and the Leadership Problem." *Public Administration Review* 52: 192–95.

Launius, Roger D. 2003. "Public Opinion Polls and Perceptions of U.S. Human Spaceflight." *Space Policy* 19: 163–75.

Launius, Roger D. and Howard E. McCurdy (eds.). 1997. *Spaceflight and the Myth of Presidential Leadership*. Champaign, IL: University of Illinois Press.

Light, Paul C. 1999. *The President's Agenda: Domestic Policy Choice from Kennedy to Clinton*. Baltimore, MD: Johns Hopkins University Press.

Logsdon, John M. 2003. "Reflections on Space as a Vital National Interest." *Astropolitics* 1: 78–8.

Mayhew, David R. 1974. *Congress: The Electoral Connection*. New Haven, CT: Yale University Press.

Macaulay, Molly K. 1992. "The NASA Budget: For Whom, For What, and How Big?" In *Space Policy Alternatives*, ed. Radford Byerly, San Francisco, CA: Westview Press.

McCleary, Richard, and Richard A. Hay, Jr. 1980. *Applied Time Series Analysis for the Social Sciences*. Beverly Hills, CA: Sage Publications.

McCurdy, Howard E. 1991. "Organizational Decline: NASA and the Life Cycle of Bureaus." *Public Administration Review* 51: 308–15.

———. 1992. "NASA's Organizational Culture." *Public Administration Review* 52: 189–91.
———. 1993. *Inside NASA: High Technology and Organizational Change in the U.S. Space Program*. Baltimore, MD: Johns Hopkins University Press.
———. 1994. "The Cost of Space Flight." *Space Policy* 10: 277–89.
McCutcheon, Chuck. 1998. "Pressure on NASA Intensifies as Space Station Struggles." *Congressional Quarterly Weekly Report*, January 24, 180–81.
———. 1999. "Tough Conference, Possible Veto Await NASA Authorization Bill That Grounds Gore's Satellite Project." *Congressional Quarterly Weekly Report*, May 22, 1211.
Mehuron, Tamar A. 2009. "2009 Space Almanac." *Air Force Magazine*, August, 52–65.
Miller, John D. 1987. "The *Challenger* Accident and Public Opinion: Attitudes Towards the Space Programme in the USA." *Space Policy* 3: 122–40.
Murray, Bruce. 1991. "Can Space Exploration Survive the End of the Cold War?" *Space Policy* 7: 23–34.
NASA. 2004. "Fiscal Year 2004 Performance and Assessment Report." Washington, DC: GPO.
NASA Budget by State. n.d. http://prod.nais.nasa.gov/cgi-bin/npms/map.cgi (Accessed July 9, 2011).
"NASA Chief is Gloomy on Budget for Shuttle." 1986. *New York Times*, December 8, B15.
Paxton, Larry J. 2006. "Managing Innovative Space Missions: Lessons from NASA." *Journal of Knowledge Management* 10: 8–21.
Pear, Robert. 1986. "Changes Expected in NASA's Budget." *New York Times*, January 31, A16.
Pianin, Eric. 1992. "Senate Votes to Proceed with Space Station." *The Washington Post*, September 10, A7.
Pierson, Paul. 2000. "Increasing Returns, Path Dependence, and the Study of Politics." *American Political Science Review* 94: 251–67.
Poole, Keith T., and Howard Rosenthal. 1997. *Congress: A Political-Economic History of Roll Call Voting*. New York, NY: Oxford University Press.
Roberts, Christopher B. 1990. "NASA and the Loss of Space Policy Leadership." *Technology in Society* 12: 139–55.
Roberts, Steven V. 1986. "Congressional Leaders to Hold Extensive Hearings Into Cause." *New York Times*, January 29, A9.
Schulman, Paul R. 1975. "Nonincremental Policy Making: Notes Toward an Alternative Paradigm." *The American Political Science Review* 69: 1354–70.
"Space Plans to Be Reviewed." 1986. *New York Times*, July 13, p. 17.
Space Politics. 2008. "More NASA OMB Tensions." September 14. http://www.spacepolitics.com/2008/09/14/more-nasa-omb-tensions/ (Accessed July 10, 2011.)
Space Studies Board. 2004. *Steps to Facilitate Principal Investigator-led Earth Science Missions*. National Academies Press, Washington, DC.
Steinberg, Gerald M. "Satellite Capabilities of Emerging Space Competant States." (Accessed July 12, 2010.) http://faculty.biu.ac.il/∼steing/military/sat.htm
Taylor, Andrew. 2005a. "Plan for Appropriations Makeover." *Congressional Quarterly Weekly Report*, February 7, 307.
———. 2005b. "Chambers Spar Over Spending Panels." *Congressional Quarterly Weekly Report*, February 7, 306–7.
Telscon, Michael L. 1992. "NASA and the Budget Process." In *Space Policy Alternatives*, ed. Radford Byerly Jr. Boulder, CO: Westview Press, 77–91.
Vedda, James A. 1996. "The Evolution of Executive Branch Space Policy Making." *Space Policy* 12: 177–192.
———. 2002. "The U.S. Congress and the Post-Apollo Civilian Space Program, The First Twenty-Five Years." *Strategies and Organizations in Transition* 3: 287–313.
Wayne, Alex. 2004. "Veto Threat Joins House Skirmish over Level of NASA Funding." *Congressional Quarterly Weekly Report*, July 31, 1866.