# Breaking Science Stereotypes: Examining the Effects of Party Politics on Federal R&D Funding

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**Executive Summary:** U.S. citizens often perceive the Democratic Party as highly supportive of scientific research, in contrast to Republican oppositions. This article tests the validity of such public perceptions of the parties through the examination of federal research and development (R&D) funding patterns over time. Utilizing multivariate regression models, the study analyzes the effects of presidential and congressional party changes on R&D funding – including overall R&D amounts as well as monetary allocations across federal agencies and research subjects. Although the final results show significant predictive relationships between measures of R&D funding and party politics, these relationships often contradict popular views of the parties. Moreover, the study reveals the strong influence of the presidential administration, the moderate influence of the House of Representatives, and the minimal influence of the Senate on R&D funding. Thus, while elected federal officials play a strong role in science policy, their influence is not as dichotomous as is commonly assumed.

## I. Introduction

In the United States, the public consensus remains strong that changing presidential administrations and congressional dynamics, from Republican- to Democrat-led, impact allocations of federal Science and Technology (S&T) funding (Funk and Rainie 2015). Popular culture perceives a Democrat-led administration as more generous and supportive of S&T funding, while a Republican-dominated government appears in opposition to scientific progress, and consequently, to S&T funding (see Glossary for definitions) (Mooney 2005; Kolbert 2015). But does such a perceived dichotomy find support in federal funding patterns over the past decades or is the party effect a mere myth, overshadowed by growing bureaucracy and path-dependent science policy?

This study utilizes federal research and development (R&D) funding data from 1976 to 2013 to analyze the effects of both presidential administration and congressional changes (Democrat or Republican-dominated) on S&T funding allocations.[1] It also considers the effects of these political changes on individual federal agencies, research functions, and other aspects of the R&D process. More specifically, the article examines the effects of Presidential Administration Affiliation and Senate and House of Representative Party Majorities on several dependent variables that reflect diverse aspects of R&D funding patterns. These dependent variables include: overall R&D funding amounts; R&D as a percentage of gross domestic product (GDP); defense R&D; nondefense R&D; R&D funding by agency; and funding based on research function. Using multivariate multiple regression models that control for economic conditions, the article tests the null hypothesis that a change in executive administrative affiliation and congressional party dominance does not prompt a significant change in federal R&D funding amounts and/or funding allocations within and across agencies. The study's alternative hypothesis, however, is that a Democrat-led government is associated with

[1] The R&D data is adjusted for inflation in constant Fiscal Year (FY) 2012 dollars.

increased federal R&D funding in all agencies and functions, while a Republican-led government may only induce increases in defense R&D funding. Such a finding would provide evidence for the direct relevance of the executive and legislative branches to S&T funding policies. Furthermore, it would signify the importance of party politics and ideological stances to federal science policy, confirming that the field of science is another partisan battlefield. Lastly, the finding would affirm popular stereotypes of political parties.

If, on the other hand, a connection to party politics does not exist, then science policy may be understood to stand as relatively immune to partisan dynamics. Political party stereotypes as related to science would then only lead to erroneous claims and results. Therefore, future generations of voters concerned about the condition of federal R&D funding would find it useful to redirect their political efforts from party affiliations and presidential campaigns to agency rulemaking meetings, civil society, and other forms of nonpartisan lobbying. It is important that citizens are aware of the range of effects (or lack of effects) that their political actions have on certain federal policies. Popular myths, no matter their nature, should not be perpetuated indefinitely.

The article proceeds in four sections. The first section considers the scarce academic literature on the relationship between political parties and federal R&D funding as well as societal perceptions of each party's ideologies and practices. The second section reviews the data and methodological approach of the study. The third section constructs several multivariate multiple regression models to examine the connections between party affiliations in different branches of the federal government and the allocation of R&D funding. Finally, in light of the statistical results, the last section discusses applied conclusions and offers implications regarding the influence and role of ideological politics on S&T policymaking in the U.S.

The final results of this study confirm the alternative hypothesis to a limited extent. The results show that significant predictive relationships exist between measures of federal R&D funding as related to party politics, yet these relationships do not indicate consistent party patterns and may even contradict popular perceptions of the parties. For instance, a Democrat-led administration may induce decreased R&D spending overall, while at the same time generating increased spending among some agencies and research functions. Additionally, while a Republican government appears more supportive of defense spending than their Democrat counterparts (which matches current expectations), this same Republican government also encourages increased R&D spending within some nondefense agencies and research functions. Outside of such patterns, the other main trend that this study reveals is the strong influence of the presidential administration, the moderate influence of the House of Representatives, and the very minimal influence of the Senate on R&D funding. In sum, while elected party officials continue to play a strong role in science policy through R&D funding, their influence is not as black and white as some commentators would like to believe, and party patterns rarely fit into their perpetuated stereotypes.

## II. Background: ideological perceptions of science

Academic research into the links between party politics and S&T funding in the U.S. remains surprisingly scarce and incomplete (Gibbons 1995; Gauchat 2012). Very few scholars have delved deeply into this connection, and even fewer have applied quantitative techniques to discovering relevant R&D funding trends (Guston 2000; Hegde and Mowery 2008; Baccini and Urpelainen 2012). While the topic of party affiliation and science policy is relatively subdued in academic research, it consistently resurfaces in popular media, election and party platform analysis, and citizens' debates regarding the intentions of elected officials (Funk and Rainie 2015; Kolbert 2015; Goad 2014; Fisher 2013). For instance, in the first months of his presidency, Barack Obama gave a speech to the National Academy of Sciences and promised a renewed commitment to fund scientific research and increase R&D efforts. In this speech, he warned, "We have watched as scientific integrity has been undermined and scientific research politicized in an effort to advance predetermined ideological agendas" (Gauchat 2012). [2] President Obama, although concerned about the condition of science in the country, was catering to widely-held public perceptions regarding science – especially as related to the past presidential administration's perceived hostility toward the scientific community (Duncan 2007). As a consequence of the Bush legacy, many

[2] The full, original speech can be accessed at White House, 2010 "The Necessity of Science," *Office of Social Innovation and Civic Participation* <http://www.whitehouse.gov/blog/09/04/27/The-Necessity-of-Science> accessed 15 March 2013.

scientific organizations and advocacy groups continue to worry that political and ideological interests are menacing science and that science will ultimately fall prey to the subjective political whims of society (Gauchat 2012).

On the one hand, Science, Technology, and Society research (STS) has established that science and politics are inseparable, regardless of eras, elites, and changing parties (Jasanoff 2004; Gauchat 2012; Frickel and Moore 2005). In other words, scientific knowledge has always reflected the interests of many social actors and institutions, including scientists, universities, funding agencies, regulatory agencies, and legislators. Yet the prospects of a fully politicized science policy frighten many constituents. As Parsons (1962) argues, scientific knowledge, especially its empirical and objective applications, is crucial to secular lawmaking and institutions. On a similar note, Barber (1990) discusses a "special congruence" of science with rational-legal authority and modern policymaking. Therefore, a highly polarized, ideologically-laden science policy may spell disaster for public trust in science and for science's societal and governmental benefits.

But according to some individuals, such as Kostantin Kakaes, a fellow at the public policy think tank New America and an *Economist* reporter, science and technology are not necessarily partisan. He notes that a politician's campaign rhetoric will rarely match the legislative reality, especially in terms of S&T policies (as cited in Houston 2012). Kakaes points to the demise of the Superconducting Super Collider two decades ago, fallen to Senate versus House bickering, not partisan disputes. As he concludes, "It's a matter of being a politician rather than being a politician of one ideological stripe or another" (Houston 2012). Stacy Cline, Counsel for Ranking Member Mike Enzi (R-Wyo.), Senate Health, Education, Labor, and Pensions Committee, adds that, over broad periods of time, it's most likely true that political party is an insignificant predictor of investment in science and technology legislation in the U.S. Both Democrat and Republican parties have supported science, and at times ignored its societal role (Fisher 2013). Plus, the differences between individual members of the two parties pertaining to science are not always consistent or significant. As Houston (2012) notes, in one instance, the Chairman of the House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies (CJS) Frank Wolf outperformed his Democrat Senate counterpart with respect to National Science Foundation (NSF) funding. For Fiscal Year 2011, the proposed funding for NSF in the House bill was $200 million greater than the Senate bill, primarily due to a difference of priorities among the Chairs of the House and Senate CJS appropriations subcommittee.

Baccini and Urpelainen's (2012) quantitative study, which focuses solely on patterns of public energy R&D, supports the above nonpartisan claim. It finds that, among Organization for Economic Co-operation and Development (OECD) countries, the United States has the lowest level of volatility as related to legislative fractionalization caused by political differences and bickering within legislative chambers. The study concludes that even though the country has reduced public energy R&D spending over time, it has done so in a relatively consistent fashion (Baccini and Urpelainen 2012). But this nonpartisan trend may not hold for all R&D projects as certain areas of scientific research appear more publicly contested than others.

Although many scientists and citizens may not want to admit to S&T's politicized qualities, they cannot ignore extreme ideological calls against more contested scientific claims and proposals. Rejections of climate science, environmental protection, and evolution from the Republican Party have left scientists and regular citizens alike feeling that there is a definite partisan divide brewing. For instance, not long ago, the Republican-held House attempted to close the Environmental Protection Agency (EPA) by passing bills to curb EPA's abilities to regulate greenhouse gas and enforce provisions of the Clean Water Act and Clean Air Act. In general, many House Interior and Environment appropriations bills, which fund the majority of federal environmental projects, include riders to restrict funding for environmental regulations (Wilkey 2014; Goad 2014; Houston 2012).

In addition, the House has adopted amendments by Rep. Jeff Flake (R-AZ) that would reduce R&D funding for NSF's political science division and other social science research (Jan 2014). In 2012, the amendment passed with a handful of votes, 218-208. Five out of 186 Democrats supported the amendment, in contrast to 213 out of 240 Republicans, including CJS Appropriations Subcommittee Chairman Frank Wolf (R-VA) and House Science, Space and Technology Committee Chairman Ralph Hall (R-TX). The leading Democrats on both of these committees, however, opposed the

amendment. In a separate instance, the House rejected another Flake amendment that would have reduced funding for NSF by $1.2 billion by a vote of 121-191, with all 179 Democrats opposing the measure and House Republicans almost evenly split with a slight majority supporting the amendment (Houston 2012). Hence, while House Democrats appear united in support of NSF funding, Republicans are generally more divided on the issue and continue to call for the slashing of social science funding.

This pattern appears to hold true for past administrations, when examined superficially. For example, in 1995, House Republicans proposed to trim S&T programs by one-third over seven years, as part of sweeping cuts in federal spending. Later that year, a dispute between the White House and Congress caused a three-week shutdown of whole agencies, including NASA, the National Institutes of Health (NIH), and NSF (Lawler 1996). Although the federal government managed to resolve the impeding funding catastrophe, the image of Republicans as enemies of science lingered. In the following presidential election, Republican candidate Bob Dole attempted to soften this image by stating that he would favor basic research even as he reduced overall civilian spending for science (Durso 1996). Dole intended to encourage industry to invest in R&D through tax breaks and regulatory reform, rather than through direct government funding, holding true to mainstream Republican philosophy (Lawler 1996).

In response to the same science policy questions before the 1998 election, Bill Clinton pledged to continue funding his administration's S&T priorities "to the highest levels possible." He promised that the Democrats would push for government-industry partnerships, and he criticized attempts to destroy such programs as "dangerous and reckless" (Lawler 1996). Although both candidates in 1996, Dole and Clinton, listed the same priorities at the time – protecting basic research through R&D and improving science education – their proposed methods of achieving those goals differed significantly. The above example showcases one observed pattern between Republicans and Democrats in terms of S&T policy and R&D funding preferences.

Current Democratic president, Barack Obama, continues to embody party stereotypes, with a $66.8 billion request for federal science spending beginning with the 2012 budget proposal. This total represents a six percent increase over past R&D funding. In a climate of fiscal restraint, Obama's proposed budgets "contains more for science than many would have thought possible," said John Holdren, Obama's science adviser (Semeniuk et al. 2011). Continuing down this path, Obama has requested a further six percent increase in R&D funding for the 2016 budget – with NSF and EPA receiving more than five percent increases in agency funds (Trager 2015). Obama's budget proposals, however, portray an alternative universe in contrast to that of Congress Republicans, who are calling for huge cuts to all non-mandated government spending. While both parties claim to support basic research, the opinions diverge on the role of government in fostering innovation – with Republicans eager to sacrifice science to fiscal austerity (Semeniuk et al. 2011).

Based on these historical and recent societal trends, Republicans are portrayed as stingy with their R&D funding and as dogmatic enemies of public science, especially in controversial realms of biomedical research, climate change, and the environment. The Republican Party stands as the beacon of small government coupled with traditional values, in support of free market principles and allocations (GOP 2012). The Democratic Party, in contrast, stands as the expander of government services and as a progressive patron of the sciences (Democratic National Committee 2012). It is reasonable to assume that these divisive public platforms and ideological foundations do not serve as mere rhetorical tools, but may create equally divisive government actions on S&T funding. In other words, both the U.S. President and Congress have specific pathways in which to influence science policy and funding toward ideological ideals and party goals. These pathways and tools of influence are especially important to recall when questioning the effect of party politics on federal science initiatives.

In his arsenal of influence, the President retains removal powers, is in charge of the appointment process of agency officials, and can initiate executive orders to further regulate agency agendas. U.S. presidents have issued more than 13,500 executive orders since the start of the Republic, which have sometimes dramatically changed the administrative agency atmosphere (Kerwin and Furlong 2011). Such presidential powers guarantee channels of

governmental influence on scientific advancement and funding. Aside from executive checks, Congress also holds very strong tools of control against agency discretion through its congressional spending authority, the reorganization of agencies, investigative powers that may prompt hearings, and the enabling statutes of agency missions. Additionally, Congress may reward or punish federal agencies and their R&D missions through budget control (Kerwin and Furlong 2011). In the creation of the federal yearly budget, which includes allocations for R&D spending, the executive administration and Congress vie for political influence: the President first submits his budget proposal to Congress; in time, the House and Senate then create their own versions of this budget and debate the details of the final document. The final budget, however, still requires presidential approval (Saturno 2004). Throughout this long and often hostile process, the dominant political party, whether in the Oval Office or Congress, has ample opportunities to fight for their own ideological interests, and these interests may easily delve into aspects of science policy.

Suspicions over politicized divergence on science policy also exist outside of purely governmental dynamics. Even public trust in science appears to deviate along ideological lines. In a democratic society, this could very well induce specific patterns in party platforms as candidates and legislators attempt to cater to constituent preferences. For example, Mooney (2005) claims that ideological conservatives in the U.S. have become highly disenchanted with the scientific establishment since the 1970s. Mooney (2005) states that in the first two decades after World War II, political parties and ideologies remained neutral and even deferential toward the scientific community. Yet this neutrality began to unravel in the 1970s with the emergence of the NEW Right (NR)—a group aligned with the religious right and skeptical of the intellectual establishment. The NR gained immense political power with the election of President Reagan in 1980. The NR continued to alter public views of science with the election of President George W. Bush in 2000, and according to Mooney (2005), the 2000 election marked the beginning of the conservative "war on science."

Gauchat (2012) has quantitatively tested Mooney's hypothesis and found that conservatives' trust in science clearly declined over the 1974-2010 period. Relative to their liberal and moderate counterparts, conservatives began the period with the highest levels of trust and ended with the lowest. The liberals, on the other hand, began with only marginally lower levels of trust than the conservatives yet ended with the highest levels of trust among ideological groups. According to Gauchat's (2012) study, a large gap opened up between the conservatives and liberals after the 1980s regarding trust in the scientific establishment. But the relationship between public trust in science and political party affiliation are less straightforward. The results of the same study suggest that Democrats and Republicans do not differ in their trust in science even though liberals and conservatives do (Gauchat 2012). One must remember, however, that the main target audience for the Democratic Party is the liberal citizen base, while the target audience for the Republican Party is the more conservative base. Ultimately, in addition to structural mechanisms and elite preferences, the growing conservative distrust of science can threaten science funding through changing constituent demands on elected officials.

Hitherto, academic research has not systemically analyzed such potential patterns as related to party affiliations and direct R&D funding. So far, trends have only been inferred through individual administrations, separate congressional legislations and proposals, and public perceptions of ideological groups and political platforms. But at a time when federal research investments are shrinking as a share of the U.S. economy while other nations are increasing their investments (Clemins 2012), issues of R&D funding between administrations and congressional dynamics become paramount to understanding and propelling not only U.S. scientific activity, but also national economic and technological prosperity. A quantitative analysis of longtime R&D trends as compared to administration and congressional party affiliations would begin to fill in the missing pieces of this complicated puzzle.

## III. Methodological approach

In an attempt to fill the gap in the research, this study tests the alternative hypothesis that party affiliation in the executive and legislative branches influences the amount and allocation of R&D funding – thereby shaping science policy. The study uses time-series data reflecting U.S. federal R&D funding within the 1976-2013 timeframe for several logistical

reasons: it provides the most up-to-date, consistent data sources; it allows for a relatively large sample size; and it can account for exogenous political turning points, such as the end of the Cold War and the post-9/11 political climate, which inevitably changed federal funding priorities. The time-series data helps to account for such extreme political changes as it consistently tests the response of several different administrations and Congressional turnovers during the same eras and political conditions.

| **General Federal R&D** (billions of 2012 dollars) |
|---|
| Total R&D as % of GDP |
| Total R&D |
| **R&D by Function** (billions of 2012 dollars) |
| Health |
| Space |
| General Science |
| Energy |
| Natural Resources/Environment |
| Nondefense |
| Defense |
| **R&D by Agency** (millions of 2012 dollars) |
| Department of Defense (DOD) |
| National Aeronautics & Space Administration (NASA) |
| Department of Energy (DOE) |
| Department of Health & Human Services (HHS) |
| National Institute of Health (NIH) |
| National Science Foundation (NSF) |
| Department of Agriculture (USDA) |
| Department of Interior (DOI) |
| Department of Transportation (DOT) |
| Environmental Protection Agency (EPA) |
| Department of Commerce (DOC) |
| Department of Homeland Security (DHS) |
| Department of Veteran Affairs (VA) |
| Other Agencies |

**Table 1: List of Dependent Variables**

The federal R&D and agency funding dataset, which serves as the study's range of dependent variables, originates from *the American Association for the Advancement of Science (AAAS)* (2013). The dependent variables in the model include different measures of federal R&D funding and allocations, ranging from R&D as a percentage of GDP to R&D funding by function and federal agencies (see Table 1 for details). The congressional composition and presidential data, which serve as the model's independent variables, originate from *the History, Art, and Archives: United States House of Representatives* and the *U.S. Senate archives.* Additionally, the control variable data (GDP and Deficit Spending) is from the *U.S. Department of Commerce: Bureau of Economic Analysis* (2013) and the *U.S. Government Printing Office* (2012). These control variables also account for inflationary effects through constant 2005 dollar adjustments already incorporated within the original data source.

In this statistical model, the predictor variables are in dummy form, with a value of 1 denoting a Democrat majority in the Senate, a Democrat majority in the House of Representatives, or a Democrat president. A value of 0 indicates a lack of the above characteristics, meaning that the party majority and administration affiliation is instead Republican for those years. The study also attempts to account for economic conditions, which may limit the level of available R&D funding for all parties involved, through the control variables of Gross Domestic Product (GDP) and Surplus or Deficit fiscal conditions (see Table 2 for details on all independent and control variables). In a strong economic cycle, funding for all aspects of government may be higher, while in a fiscal cycle of extreme increased deficits, political pressures may lead to decreased R&D funding, regardless of party affiliation and other factors. This study, however, does not account for all possible sources of R&D variability in the federal government due to data and model limitations, a condition that will constrain the final data analysis and interpretations.

Noting the above datasets, variables, and assumptions, the study employs a multivariate multiple regression model to assess the effects of party affiliation in U.S. federal government structures on the patterns of R&D funding. The multivariate multiple regression model not only tests each dependent variable by separately regressing it with all independent and control variables, it also tests the overall significance and fit of the model, accounting for the combined effects of all independent variables on each dependent variable. Since this study includes five independent and control variables and 23 dependent variables, the multivariate multiple regression model stands as the most appropriate statistical method of analysis.

| Variable | Unit of Measurement | Other Information |
|---|---|---|
| **Senate Majority Democrat** | Dummies | 1 Democrat majority; 0 no Democrat majority |
| **House Majority Democrat** | Dummies | 1 Democrat majority; 0 no Democrat majority |
| **Presidential Administration** | Dummies | 1 Democrat executive ; 0 no Democrat executive |
| **Gross Domestic Product (GDP)** | Billions of 2005 dollars | Control variable: Measurement of general health and growth of US economy |
| **Federal Deficit Spending** | Billions of 2005 dollars | Control variable: Measurement of yearly fiscal conditions in federal government |

**Table 2: List of Independent Variables**

## IV. Analysis

*Multivariate multiple regression model - Combined Effects*

The multivariate multiple regression model intends to forecast federal R&D funding and allocations from 1976-2013 based on House of Representative Party Majority, Senate Party Majority, and Presidential Administration Affiliation, while controlling for some economic factors, such as GDP and Deficit Spending. The five combined independent variables within the models significantly predict funding levels for most dependent variables (with default significance level at $p<0.05$; although many relationships are also significant at the $p<0.01$ level). The only exception to this trend occurs with Department of Transportation (DOT) R&D funding, which does not appear affected by party affiliation. Furthermore, the R-Squared values of the model are very high, with the dependent variable Total R&D as a Percentage of GDP showing an R-Squared of 87% and the Total R&D variable showing an R-Squared of 97%. These values and the corresponding R-Squared values for individual agencies and research functions suggest that the model holds strong explanatory power in accounting for funding variations across the years (see Table 3 for details). Such introductory findings point to a significant influence of party politics in the allocation of R&D funding in the federal government. Therefore, the study must now delve into the individual, separate effects of party affiliation within Congress and the presidency to specify the direction and nature of the R&D funding discrepancies.

| D.V. Equation* | RMSE | R-Sq | P-Value |
|---|---|---|---|
| **Total R&D of GDP** | 0.0053 | 0.87 | 0.000 |
| **Total R&D** | 4.929 | 0.97 | 0.000 |
| **Health** | 1.869 | 0.97 | 0.000 |
| **Space** | 1.891 | 0.34 | 0.0188 |
| **General Science** | 0.5841 | 0.93 | 0.000 |
| **Energy** | 1.085 | 0.80 | 0.0131 |
| **Natural Resources** | 0.2338 | 0.36 | 0.000 |
| **Non-defense** | 3.906 | 0.89 | 0.000 |
| **Defense** | 5.959 | 0.89 | 0.000 |
| **DOD** | 5410.192 | 0.91 | 0.000 |
| **NASA** | 1763.378 | 0.51 | 0.0004 |
| **DOE** | 1288.435 | 0.42 | 0.0035 |
| **HHS** | 2319.540 | 0.95 | 0.000 |
| **NIH** | 2073.366 | 0.96 | 0.000 |
| **NSF** | 185.460 | 0.98 | 0.000 |
| **USDA** | 167.578 | 0.81 | 0.000 |
| **Interior** | 85.305 | 0.59 | 0.000 |
| **DOT** | 139.256 | 0.27 | 0.0723 |
| **EPA** | 101.367 | 0.55 | 0.0001 |
| **DOC** | 137.794 | 0.84 | 0.000 |
| **DHS** | 284.206 | 0.72 | 0.000 |
| **VA** | 119.518 | 0.87 | 0.000 |
| **Other** | 257.335 | 0.26 | 0.0878 |

**Table 3: Overall Significance and Fit of Regression Models**
*37 observations for each dependent variable

*Predicting overall R&D funding*

In the first multiple regression model predicting R&D as a percentage of GDP (Table 4), the only significant predictor variable is Presidential Administration, while controlling for all other variables. Contrary to popular belief in the media and among the citizens, since Presidential Administration holds a negative correlation to R&D funding in this case, it signifies that a new Democrat president in office is more likely to prompt decreased funding for R&D rather than increased funding. While this correlation appears weak, the trend holds when predicting total R&D in real terms: a transition to a Democratic president prompts a $6 billion decrease in total R&D funding in the federal government (at $p<0.01$ significance). When holding all other variables constant, total R&D amounts are also significantly related to House Party Majority, but in the opposite direction: a transition into a Democrat-dominated House prompts an almost $6 billion dollar increase in total R&D. Senate Party Majority continues to hold no significant predictive relationship to total R&D funding. Thus, the above numbers signify that, in general terms, a Democratic president is associated with a decrease in total R&D while a Democrat-led House of Representatives is associated with an almost equal increase in R&D funding. In other words, the popular consensus that depicts Republicans as enemies of public science and R&D funding may be wrong in terms of U.S. government influence, as it might just be the Republican president who will serve as the catalyst for greater overall R&D funding (precisely $6 billion higher), not the Democrat. Yet science funding is not as singular and comprehensive as depicted by the Total R&D measures; it is divided among different agencies, with varying scientific missions, research functions, and potential degrees of politicization. Thus, it is imperative to examine the relationship between party politics and R&D allocations to individual federal agencies and scientific research functions.

*Predicting R&D funding across research functions*

Federal R&D funding spans a wide range of objectives, including defense, health, space, energy, natural resources/environment, general science, and other smaller categories, such as education, transportation, agriculture, and international affairs (see glossary for definitions of main S&T functions used in this study). To assist the President and Congress in planning and setting the federal budget and its components, the Office of Management and Budget classifies agency budget requests into these specific categories called *budget functions* (National Science Board 2012). The next regression model attempts to discover predictive relationships across main S&T budget functions and party affiliations (Table 5).

| | **Total R&D of GDP** | **Total R&D** |
|---|---|---|
| **Senate Majority** | 0.0004 | 2.831 |
| | (1.45) | (1.22) |
| **House Majority** | 0.0006 | 5.949 |
| | (1.93) | (2.18)* |
| **Presidential Admin.** | -0.0096 | -6.423 |
| | (-4.71)** | (-3.37)** |
| **GDP** | -3.13e-07 | 0.0882 |
| | (-6.28)** | (18.86)** |
| **Deficit Spending** | -19.163e-07 | -0.0156 |
| | (-2.61)** | (-4.74)** |
| **_cons** | 0.0134 | 14.260 |
| | (23.78) | (2.70) |
| **$R^2$** | 0.87 | 0.97 |
| **N** | 37 | 37 |

**Table 4: Predicting Total R&D Funding**
Note: * $p<0.05$; ** $p<0.01$
The numbers within the gray rows represent regression coefficients.
The numbers in parentheses represent t-values.

To begin, the model shows no significant relationships between R&D funding for health and general science functions and party affiliation, when holding all control variables constant. In the case of space- and energy-related research functions, the Presidential Administration affiliation is the only variable to show a predictive relationship to R&D funding, with a Democrat president prompting a $2 billion increase in space research and almost $1 billion in energy research (which means that a Republican administration would prompt a parallel decrease). R&D funding for natural resources and environmental functions reflects a similar, albeit smaller, effect. Another interesting finding related to R&D funding allocated by function is that while non-defense spending does not relate to party affiliation variables, defense R&D funding does. A Democratic presidential administration is related to decreases in R&D funding for defense purposes, by around $8.5 billion in 2012 inflation-adjusted constant dollars (at $p<0.01$ level). This pattern may help explain why a Democrat-led administration causes decreases in overall R&D

funding, while simultaneously triggering spending increases in other R&D nondefense functions. After all, defense functions often dominate R&D funding at the federal level and heavily affect the overall level of R&D investments.

The overall trend of these findings suggests that Presidential Administration affiliation is the most important predictor of R&D funding by research function, out of the party affiliation variables. While R&D funding by research function does not always relate to party affiliation, when it does, the Democratic presidents seem to stimulate greater funding, while the Republican presidents stimulate decreased funding, with the exception of defense spending. In the case of defense R&D functions, however, Republican presidents prompt much greater funding than Democratic presidents. These trends fit well with popular culture and widespread political assumptions, as Democrats are expected to support "big" government, more government spending, and strong social programs. Republicans, on the other hand, are expected to support "small" government, a laissez-faire economic philosophy, limited government spending on social and scientific programs, but bolstered military spending.

| | **Health** | **Space** | **General Science** | **Energy** | **Natural Resource** | **Non-defense** | **Defense** |
|---|---|---|---|---|---|---|---|
| **Senate Majority** | 0.2508 | 0.8147 | 0.2968 | -0.7864 | 0.1596 | 0.7680 | 2.063 |
| | (0.29) | (0.92) | (1.08) | (-1.55) | (1.46) | (0.42) | (0.74) |
| **House Majority** | -0.1925 | 0.4841 | -0.5849 | -0.1307 | -0.0916 | -0.5208 | 6.470 |
| | (-0.19) | (0.46) | (-1.81) | (-0.22) | (-0.71) | (-0.24) | (1.96) |
| **Presidential Admin** | -1.297 | 2.138 | -0.2769 | 0.9803 | 0.1902 | 2.089 | -8.512 |
| | (-1.79) | (2.92)** | (-1.22) | (2.33)* | (2.10)* | (1.38) | (-3.69)** |
| **GDP** | 0.0032 | 0.0002 | 0.0006 | -0.0008 | 0.0000 | 0.0033 | 0.0055 |
| | (17.92)** | (1.31) | (10.88)** | (-8.14)** | (0.99) | (8.97)** | (9.72)** |
| **Deficit Spending** | -0.0051 | 0.0023 | -0.0015 | -0.0024 | 0.0004 | -0.0061 | -0.0095 |
| | (-4.08)** | (1.86) | (-3.79)** | (-3.27)** | (2.27)* | (-2.35)* | (-2.38)* |
| **_cons** | -12.166 | 5.530 | -0.7593 | 11.030 | 1.854 | 9.604 | 4.656 |
| | (-6.08) | (2.73) | (1.21) | (9.49) | (7.40) | (2.30) | (0.73) |
| **$R^2$** | 0.97 | 0.34 | 0.93 | 0.80 | 0.36 | 0.89 | 0.89 |
| **N** | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

**Table 5: Predicting Federal R&D Funding by Research Function**
Note: * $p<0.05$; ** $p<0.01$
The numbers within the gray rows represent regression coefficients.
The numbers in parentheses represent t-values.

*Predicting R&D allocations across federal agencies*

The last regression model within the study aim to find significant relationships between R&D funding across federal agencies and party politics (refer to Table 6). Within the Department of Defense (DOD), the relationship between party affiliation and funding is positive when considering the House of Representatives composition, negative for Presidential Administration, and insignificant for Senate Majority. This means that a Democrat-dominated House of Representatives induces an almost $9 billion funding increase for the DOD, while a Democratic president induces an almost $10 billion funding decrease. As discovered for overall levels of R&D funding, the presidential and congressional effects may effectively cancel out each other. For NASA and the Department of the Interior (DOI), a Democrat-dominated Senate prompts a significant increase of $1.8 billion and $125 million in R&D funding, respectively, while all other party variables show no significant predictive powers. As for the Department of Health and Human Services (HHS) and NIH, only the Presidential Administration is a significant predictor of funding, with a Democratic president prompting a decrease of about $2 billion. A similar, but weaker, trend funding occurs with allocations for the Department of Agriculture (USDA). For the DOT, EPA, and Department of Commerce (DOC), the presidential trend is reversed, with a Democrat-led administration spending significantly more than a Republican administration. In terms of EPA, this predicted increased spending also holds for a Democrat-controlled Senate. For NSF funding, only the

House Party Majority is a significant predictor – with a Democrat-controlled House surprisingly spending less than a Republican one. The remaining federal agencies, the Departments of Homeland Security (DHS), Veteran Affairs (VA), and Energy (DOE), show no significant connections to any of the party affiliation variables, perhaps because they serve vital bipartisan functions. Such mixed results allude to the strong influence of party politics on R&D funding across federal agencies, but they do not signal a strong, consistent pattern between Democratic and Republican parties across time.

| | **DOD** | **NASA** | **DOE** | **HHS** | **NIH** | **NSF** | **USDA** |
|---|---|---|---|---|---|---|---|
| **Senate Majority** | -319.802 | 1831.784 | 512.653 | 821.929 | 639.791 | 138.421 | 75.868 |
| | (-0.13) | (2.22)* | (0.85) | (0.76) | (0.66) | (1.59) | (0.97) |
| **House Majority** | 8774.535 | -618.405 | 689.985 | -1137.298 | -939.374 | -214.254 | -39.318 |
| | (2.93)** | (-0.63) | (0.97) | (-0.89) | (-0.82) | (-2.09) | (-0.42) |
| **Presidential Admin** | -9784.137 | 803.388 | 288.768 | -2003.427 | -2062.973 | -89.387 | -148.837 |
| | (-4.67)** | (1.18) | (0.58) | (-2.23)* | (-2.57)* | (-1.25) | (-2.29)* |
| **GDP** | 5.441 | 0.4462 | -0.2186 | 3.217 | 3.145 | 0.3516 | 0.1194 |
| | (10.60)** | (2.67)** | (-1.79) | (14.62)** | (15.99)** | (19.99) | (7.51)** |
| **Deficit Spending** | -10.896 | 5.088 | -0.8376 | -1.470 | -1.603 | -0.6344 | 0.1370 |
| | (-3.01)** | (4.32)** | (-0.97) | (-0.95) | (-1.16) | (-5.12) | (1.22) |
| **_cons** | 4430.263 | 7789.62 | 11714.75 | -9849.518 | -10270.06 | 119.361 | 1163.271 |
| | (0.76) | (4.12) | (8.49) | (-3.96) | (-4.62) | (0.60) | (6.48) |
| **$R^2$** | 0.91 | 0.51 | 0.42 | 0.95 | 0.96 | 0.98 | 0.81 |
| **N** | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

| | **Interior** | **DOT** | **EPA** | **DOC** | **DHS** | **VA** | **Other** |
|---|---|---|---|---|---|---|---|
| **Senate Majority** | 124.999 | -63.001 | 126.044 | -71.758 | -109.594 | -17.108 | 152.248 |
| | (3.12)** | (-0.96) | (2.65)** | (-1.11) | (-0.82) | (-0.31) | (1.26) |
| **House Majority** | -21.487 | 27.297 | -69.499 | -89.348 | 145.778 | -103.760 | 27.340 |
| | (-0.45) | (0.35) | (-1.24) | (-1.17) | (0.93) | (-1.57) | (0.19) |
| **Presidential Admin** | 51.670 | 149.702 | 84.781 | 263.926 | -181.817 | 9.480 | 42.844 |
| | (1.57) | (2.78)** | (2.16)* | (4.95)** | (-1.65) | (0.20) | (0.43) |
| **GDP** | -0.0188 | 0.0011 | -0.0070 | 0.0787 | 0.1342 | 0.0835 | -0.0281 |
| | (-2.33)* | (0.08) | (-0.73) | (6.02)** | (4.98)** | (7.37)** | (-1.15) |
| **Deficit Spending** | 0.0656 | -0.1153 | 0.2439 | 0.1621 | -0.3700 | -0.1224 | 0.1188 |
| | (1.15) | (-1.24) | (3.60)** | (1.76) | (-1.95) | (-1.53) | (0.69) |
| **_cons** | 959.385 | 752.450 | 810.507 | 382.513 | -1025.573 | -132.836 | 1558.386 |
| | (10.50) | (5.04) | (7.46) | (2.59) | (-3.37) | (-1.04) | (5.65) |
| **$R^2$** | 0.59 | 0.27 | 0.55 | 0.84 | 0.72 | 0.87 | 0.26 |
| **N** | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

**Table 6: Predicting Federal R&D Funding by Agency Allocation**

Note: * $p<0.05$; ** $p<0.01$
The numbers within the gray rows represent regression coefficients.
The numbers in parentheses represent t-values.

*Accounting for control variables*

Finally, the control variables of GDP and Deficit Spending show consistent and significant trends throughout most of the regression models, with higher GDP prompting higher R&D spending and lower federal yearly deficits prompting higher R&D spending. Greater economic prosperity, as measured via GDP, is expected to create a political environment more conducive to higher discretionary federal spending, while economic recessions are expected to decrease both the federal government's financial ability and political willingness to invest in scientist research and other public programs. While the relationship between deficit spending and R&D funding appears confusing, it may be due to the fact that an increase in R&D funding often requires greater federal deficit-spending activities to begin with. This reverse variable effect, or inherent endogeneity within the variables, may alter or misrepresent the trends for this control variable. Alternatively, it may also be the case that federal R&D spending thrives when national worries over the federal debt or a growing deficit are at a minimum. More research must be undertaken to further refine this relationship. Yet overall, these two economic control variables explain much of the R&D funding variability across the decades, but they do not explain it all. Party politics appears to explain the majority of the funding variability that economic conditions do not account for across time.

## V. Conclusions and policy implications

While one can argue about the level of science investment needed to advance innovation and economic parity in the United States, it is shortsighted to dismiss the policy differences between the Democrats and the Republicans, not just with respect to rhetoric, but how the parties would like to implement science policy. Such differing views may lead to different funding realities and preferences throughout the years between Democrats and Republicans in the House, Senate, and Oval Office. This study's multivariate multiple regression models reveal significant relationships between party affiliation and R&D funding allocations. Yet the results do not necessarily portray a straightforward, constant pattern between Democrats and Republicans that corroborates already existing ideological notions about the party platforms. For example, Democratic control of the government prompts increased spending for some agencies, such as NASA, EPA, DOC, and DOT, while prompting decreased spending in other agencies, such as NSF, USDA, and NIH. In fact, in terms of overall R&D funding, Republican presidents appear more eager to spend than their Democratic counterparts. But this result could be due to Republicans' consistently spending more on defense functions, while their Democrat counterparts consistently spend more on smaller budgetary functions, such as Space, Energy, Natural Resources, and the Environment. Furthermore, Senate Party Majority stands as the weakest player in terms of party politics influence on R&D funding; it only holds predictive relationships to a few agency budget allocations (NASA and DOI). Future research should delve further into the causes of the Senate's weakened role, perhaps linked to weakened public and constituent ties. Additionally, the study shows that some agencies and functions, such as DHS, DOT, and DOE, possess no connection to party politics. This may be due to their strong role in national security matters, essential infrastructure projects, or economic stability. These agencies' fundamentally necessary R&D projects may make them relatively immune to politicization, as tentatively exhibited in Baccini and Urpelainen's (2012) study on energy R&D policy.

It is this author's assertion that the fiscal crisis will make it unlikely for this generation of citizens to witness substantial proposals from either the Republicans or Democrats to drastically increase science funding – regardless of future congressional or presidential electoral outcomes. However, the party controlling the White House and Congress may have an impact on the extent to which investment in science becomes the sacrificial lamb in efforts to reduce the national debt (Houston 2012). Most importantly, as this study implicates, party politics does indeed influence science policy through R&D funding; science is partisan – but not as consistently as some party platforms and ideological divides may suggest. The study also indicates that federal agency bureaucracies do not remove all influence from democratically-elected party officials in the U.S. government. In an indirect way, such a conclusion affirms the continuation of the democratic process in

the science policy realm. In other words, regular citizens throughout the country may signify their personal preferences for national science policy to their federal representatives and expect to gradually alter public policy in their favor via constituent demands and the electoral process. Hence, the majority view of the population or the views of the most dedicated and ardently interested citizens are expected to reign in the creation of science policy. But while citizens should rightly expect their vote to matter in rerouting or changing science policy in some way, they should not rely on the general party stereotypes to cast the votes, as these stereotypes do not often stand through data analysis.

The scope of this article does not extend to explaining the seemingly inconsistent relationships found within the statistical analysis, including the inverse trends on deficit spending and Republican trends of higher overall R&D funding, and Democratic patterns of decreased NSF funding. Such explanations have to account for international security dynamics, bureaucratic cultures, detailed budgetary structures, and more. Instead, this study serves as a cursory introduction to potential, significant relationships between politics, public stereotypes, and R&D trends. Thus, the study opens the door to further research on the more specific effects of party politics on governmental S&T funding. Future research may aim to isolate and explain specific patterns found within this report, strengthen the control variables within the models, or test other relevant forces acting upon federal R&D funding and party politics, such as public perceptions of science. In addition, future studies may wish to analyze why certain governmental branches and actors possess more influence on R&D allocations than others. The main question becomes: if science policy is partisan, what can citizens and governmental actors do to predict, influence, and take advantage of such patterns? Whether one holds to Republican, Democratic, or alternate doctrines on science and government spending, the predominant reliance on party stereotypes will not offer an effective pathway toward the representation of interests in the realm of science policy.

## VI. Glossary of important definitions

**Research and Development (R&D):**

Also called research and experimental development, R&D comprises creative work undertaken on a systematic basis to increase the stock of knowledge—including knowledge of man, culture, and society—and its use to devise new applications (National Science Board, 2012). It is a widely used variable for measuring funding in scientific research, both basic and applied.

**S&T Budgetary Functions Definitions:**[3]

**Energy Function:**

This function contains civilian energy and environmental programs in the Department of Energy (DOE). It also includes the Rural Utilities Service of the Department of Agriculture, the Tennessee Valley Authority, the Federal Energy Regulatory Commission, and the Nuclear Regulatory Commission. This function does not include DOE's national security activities, which are part of National Defense, or its basic research and science activities, which are in General Science, Space and Technology.

**Health Function:**

This includes most direct health care services programs. Other programs in this category fund anti-bioterrorism activities, national biomedical research, protection of the health of the general population and employees, the provision of health services for under-served populations, and the training of the healthcare workforce. Some of the agencies funded include the National Institutes of Health (NIH), Centers for Disease Control and Prevention, Health Resources and Services Administration, and the Food and Drug Administration.

**General Science, Space and Technology Function:**

This function includes the National Science Foundation (NSF), programs at the National Aeronautics and Space Administration except for aviation programs, and general science programs at the Department of Energy (DOE).

**National Defense Function:**

[3] For complete definitions and categorization, see House of Representatives Committee on the Budget (n.d.), *Budget Functions.* <http://budget.house.gov/budgetprocess/budgetfunctions.htm>

The National Defense function includes the military activities of the Department of Defense (DOD), the nuclear-weapons related research of the Department of Energy (DOE) and the National Nuclear Security Administration, the national security activities of several other agencies such as the Selective Service Agency, and some activities of the Coast Guard and the Federal Bureau of Investigation.

**Natural Resources and Environment Function:**

This function includes programs concerned with environmental protection and enhancement, recreation and wildlife areas, and the management of the nation's land, water, and mineral resources. It includes programs within the following federal departments and agencies: Agriculture, Commerce, Interior, Transportation, the Army Corps of Engineers, and the Environmental Protection Agency (EPA).

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