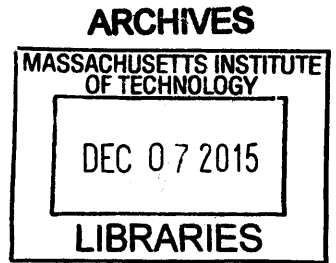


Coordinating Science:  
White House Office of Science and Technology Policy (OSTP) Influence in Federal R&D  
Budgets

by

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**ABSTRACT**

This thesis examines the role of the White House OSTP in the nation's budgeting for science and technology activities. Interviews conducted by the researcher with members of the White House staff as well as federal agency officials are the primary empirical support, with analysis of annual priority memoranda and presidential budget requests reinforcing the findings. The original contribution of this research is to highlight limitations of responsive competence despite presidential attempts to coordinate the R&D bureaucracy. In science policy, presidents obtain responsive competence by hiring entrepreneurial OSTP staff members in the areas that most align with their priorities. The centralized R&D coordination that OSTP does actually perform in budgets is highly constrained by legal authority, bureaucratic resistance, and the epistemic norms of the science policy community itself. The relationship of the President's Science Advisor with the Administration is an important confounder across presidencies.

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## INTRODUCTION

Governments seek to ensure adequate investment in science and technology as it is considered essential for productivity growth, long-term economic development (Porter 2011, 546), national security, and defense (Krepinevich 1994). But allocations towards research and development (R&D) – especially in basic research – tend to be underprovided without public support (Eisenberg 1996, 1667; Salter and Martin 2001; Cockburn, Henderson, and Stern 1999; Rosenberg 1990; Hall 2002; Bernstein and Nadiri 1988). Developed countries, following the example of the United States, have made these investments the norm.

In the United States, most fundamental scientific progress occurs in the vibrant system of public and private universities, with substantial funding from more than thirteen federal agencies (Bush 1945; Atkinson and Blanpied 2008, 30–31; Lane 2008, 248–249). This decentralized model of funding innovation won out in the post-World War II political battle against the alternative, a single, centralized research agency that would direct research towards targeted government missions (Kevles 1977, 12–17). Accordingly, the current science and technology apparatus in the United States did not grow out of a unified strategy.

The White House Office of Science and Technology Policy (OSTP) represents an attempt within the Executive Office of the President (EOP) to coordinate federal (R&D) activities on behalf of presidents. The OSTP differs from other institutions within the EOP because it requires a union between scientific expertise and political activity. It provides science advice to presidential decision-making, while simultaneously it oversees an R&D system that occurs at virtually all the federal agencies. Yet for most of these agencies, R&D is not central to their parochially defined mission. If the OSTP impacts federal R&D activities, it benefits the

Presidents that it serves. As the President is the only politician that serves a truly, national electorate, then the OSTP may even contribute to a public good of national character.

Despite how important the impact of the OSTP may be for the nation's technological progress, OSTP has a difficult task to perform. It has no statutory power in R&D budgeting. Another EOP institution, the Office of Management and Budget (OMB), jealously guards oversight of budgeting. As a result, it is unclear what impacts it actually has on the actions of the agencies.

This thesis seeks to understand what role the OSTP actually plays in federal science and technology policy and why. Based on interviews with policymakers, primarily OSTP staff members and leaders, as well as analyzing R&D budget priorities and outcomes during the modern OSTP's existence, I argue that the OSTP seeks to fulfill the demands of responsive competence (Moe 1985). Unfortunately, the OSTP runs into three strong barriers to fulfilling the true expectations of responsive competence: legal authority, bureaucratic resistance, and the professional training of its own staff.

The first barrier to OSTP impact in R&D budgeting is its lack of statutory authority; OSTP only has as much influence as it can obtain through inclusion by the OMB. OSTP provides technical advice to the OMB through formal and informal mechanisms throughout all phases of the budgeting process, but the OMB ultimately holds the decision-making power, unless the OSTP staff is willing to escalate conflicts up the political ladder. Other institutional barriers to impact include access to agency and OMB data and the size of the OSTP staff relative to other budgeting actors. The OSTP has taken efforts to institutionalize its input across Administrations through yearly activities like the state of the union, R&D budget priority memo, and involvement in OMB review periods.

Like other EOP entities, the OSTP also faces potential opposition from agencies. Its primary behavior in budgeting constitutes attempts to add programs to agency budgets; most importantly, programs situated in crosscutting technology areas that pertain to the missions of multiple agencies. The OSTP links scientific opportunities in the national and international science and technology communities together with the interests of presidents in order to generate these programs. Yet the national interest and the agency interest often differ, and such attempts may not work if each agency does not see its own interests sufficiently at stake in funding the programs.

Surprisingly, the OSTP also faces a unique challenge from its own staff. Those who choose to work on science and technology policy constitute an epistemic community (Adler and Haas 1992) that strongly favors government funding for research. The extensive training required to obtain the necessary scientific expertise, as well as the highly constrained number of paths into science policy positions in the federal government, combine to generate common norms and causal beliefs about R&D budgeting. Presidents may not be able to get fully responsive political operatives in S&T policy simply because shared norms unconsciously constrain the policy analyses of the OSTP staff. Their background shapes the way in which the OSTP staff interprets “policy entrepreneurship” (Kingdon 1984). Although the OSTP staff frequently view themselves as “policy entrepreneurs,” they confine entrepreneurship to advocacy for additional funding for programs that align with presidential priorities. For the most part, the OSTP does not seek out opportunities to streamline programs or cut wasteful, ineffective, or misguided programs from agency R&D budgets. A true ‘coordinator’ would exercise both constructive and destructive power in budgeting. The essence of this argument is that an economist would not perform the same R&D coordination as a scientist.

Chapter I contextualizes the research question within the broader literature on presidents and the bureaucracy. The OSTP formulates and translates presidential priorities within the federal R&D budgeting process. In doing so, the OSTP has a number of possible actions available to it, which I term adding, deleting, modifying, and packaging. Each of these potential activities reflects arguments made about the presidency. The theoretical framework was designed especially to test whether presidents can truly obtain expert policy advice while simultaneously enforcing their political will in the bureaucracy. The interests of the agencies as well as the backgrounds of the OSTP staff members serve as natural limits to behaviors essential to the performance of the OSTP as a central coordinator in R&D budgeting.

Chapter II presents the development of the OSTP as an institution in the political context of the nation's federal R&D system. During the successive presidencies engaged in the Cold War struggle characterized by massive defense investment, OSTP's role and position solidified within the White House. Yet, just like the emergence of the national scientific enterprise, its evolution was haphazard. The office grew out of the original President's Science Advisory Council (PSAC) into the Office of Science and Technology (OST) before becoming the OSTP in 1976 by statute. President Richard Nixon's attempt to kill the OST created an impetus for a statute that would make the office a permanent fixture in the White House complex, yet this statute also solidified the OSTP's role in budgeting in relation to the OMB. In its present form, the OSTP is the EOP entity that acts on behalf of presidents, while external advice comes from the President's Council of Advisors on Science and Technology (PCAST), and the National Science and Technology Council (NSTC) executes system-wide collaborations internal to the Executive Branch. The legacy of its institutional development continues to affect the behavior of the OSTP staff today (Zegart 2000).

Chapter III presents analyses about the effect of presidential agendas in R&D budgets. I show that presidents have meaningful, individual impact on R&D budgeting, particularly in the trade-off between defense and non-defense accounts. Although other factors (e.g., strategic threat context) may also affect this decision, it is clear that changes in presidential priorities – as memorialized in the joint OMB-OSTP budget priority memo -- do indeed affect spending. The President's Science Advisor wields a unique, priority-setting power that is dependent on his or her relationship with the President. This power is exercised partially through this instrument.

Chapter IV turns to my empirical strategy for assessing the impact of the OSTP on science and technology. Among many possible measures of bureaucratic "impact," I focus on budgeting. This metric makes particular sense in the context of OSTP, because the president's budget request represents a definitive reflection of the Administration's decision-making during its internal negotiations between the OSTP, OMB, and federal agencies.

Quantitative measurements of OSTP's impact do not exist, and even qualitative measurements are hard to come by. To identify the effect OSTP has on budgeting, I rely on interviews with twenty-two current and former officials in S&T policy, particularly those associated directly with the OSTP. Chapter V reports the findings from these interviews. The central findings are that OSTP does not engage in much "deletion" or "modification." At the same time, both single-agency and multi-agency additions occur but are highly limited to the union of presidential and agency interests. Packaging – pulling together and relabeling pots of existing funding into apparent initiatives, and creating talking points for the president – may occur, but it is limited to early attempts at generating multi-agency initiatives or failed attempts at addition. OSTP staff members try to act in the mold of 'policy entrepreneurs' but are only successful in certain instances. In other words, "responsive competence" runs into strong limits



that may be unavoidable given the current institutional structure of OSTP interactions in R&D budgeting (Moe 1985).

Chapter VI discusses what these results imply for the president's relationship with the nation's scientific bureaucracy. Presidents obtain a highly qualified version of responsive competence from the OSTP in R&D budgeting, yet they may be able to still obtain it through the OMB more directly. This fact is normatively concerning for the input of technical expertise into budgeting. It may also render OSTP influence in R&D budgeting unduly dependent on the personal relationship between the President's Science Advisor and the President himself.

Ultimately, two potential OSTP organizations exist at any one time: (1) the OSTP that seeks to create political responsiveness in the federal R&D bureaucracy on behalf of the President, and (2) the OSTP that must enhance the quality of scientific knowledge available from within the policymaking process. When designing and operating this institution, selecting the appropriate balance between each option depends upon a normative preference between the quality of science advice and the quality of responsiveness. Both cannot thrive simultaneously because the necessary actions for the success of each are mutually exclusive. High quality science advice is obtained by tapping into an epistemic community that holds fixed causal beliefs that may be at odds with a given political action. On the other hand, high quality political responsiveness is obtained by selecting those who may hold the Administration's agenda dear to their own heart, but may not tap into the most cutting-edge scientific understanding in their policy actions. The modern OSTP operates somewhere in the middle of these two extremes, though empirically it seems to cling to the quality of science advice as its primary endeavor. Future S&T policymakers may wish to tilt the balance towards one or the other, and they may do so by altering the size and composition of the OSTP staff, as well as its powers in budgeting.

## CHAPTER I

### TRANSLATING PRIORITIES TO POLICY WITHIN THE EXECUTIVE BRANCH

In the modern American presidency, various entities within the White House complex, including the components of the Executive Office of the President, serve as the president's agents on a variety of policy issue areas. Successive Presidential Administrations over the past half century have both institutionalized these agents and expanded their roles in order to exercise centralized control over the federal bureaucracy (Moe and Wilson 1994; Lewis 2004; Lewis 2008; Edwards and Wayne 1985, 180–189). At the heart of this quest has been the limited ability of presidents to exert their priorities solely through their political appointees in the federal bureaucracy itself. Presidents have tended to expand these staffs in part due to pursuing the dual need for responsive competence: technical competence in policy areas wedded with individual flexibility to align with presidential priorities (Moe 1989; Rourke 1992; Wolf 1999).

Presidents must restrict their own personal efforts to only the highest levels of policy decision-making. As a consequence, the mission of an EOP staff member is to facilitate the translation of presidential priorities into the policies implemented by federal agencies. Presidents have created a number of entities in the EOP to perform this role. In matters requiring not only political expertise but also expertise in S&T, the White House Office of Science and Technology Policy (OSTP) fills this niche.

Priorities are informed by many sources, but of these, all presidents are primarily concerned with the legacy they leave behind. No other elected actor in the American political system possesses so large an incentive to pay attention to interests of a uniquely national character. Presidents know that their achievements will be judged by history over the long-term and are fully aware that these achievements will cost them significantly in the short-term.

Besides the all-important legacy consideration, powerful secondary motivations generate political priorities as well. These include political ideology and partisanship, campaign incentives and promises, public opinion, media attention, and personal preferences.

The White House staff takes these priorities and then works with federal agencies to execute them. The White House can flex its executive discretion in policy formulation and implementation through rule making and budgeting. It can appoint and remove those filling positions at the top levels of the federal bureaucracy to realign the priorities of agency management to its own. It can convene all the relevant political actors for any given policy area to force compromise and the creation of solutions to urgent national problems. And importantly, the White House can command significant agenda-setting influence, through the proposing of initiatives, presidential persuasion, and legislative bargaining. As a result, EOP staff can conceivably exert a powerful influence over the bureaucracy.

Although technical expertise is essential, the most important arguments in S&T policy focus on achieving the proper allocation of resources into the available buckets. Scientists and engineers largely decide the most vexing questions of S&T policy through scholarly debate, and for the most part this debate does not happen in the federal government but at university campuses and in corporate boardrooms. Policymakers spend much of their time instead thinking and arguing about how to provide public resources to the most promising endeavors while still promoting the integrity of the system as a whole (Averch 1985, 216:xii). The goal is to fuel what the S&T community sees as the only viable engine for long-term social and economic progress. Accordingly, seemingly every scholarly work having to do with S&T policy inevitably starts out with characterizing the size of the research and development (R&D) system in present dollar terms and as a portion of the federal budget. The S&T policy community focuses on relatively

small trade-offs between R&D accounts in comparison to the much larger budget battles in Washington.

Naturally, the factors that determine presidential priorities and presidents' success in forcing them through the bureaucracy may be particular to S&T. These are in desperate need of updating in the literature, as the field of presidential politics and its implications for other literatures like distributive politics has advanced rapidly in recent years (Edwards and Howell 2009; Moe 2009; Berry, Burden, and Howell 2010) but its science policy ramifications have not. Attention to how policymakers go about funding this system is even more lacking. Though the most crucial works that examine presidents and science policy together are of timeless quality, some are dated (Katz 1978; Averch 1985; Golden 1993; Hart 1998). These works combine analyses of Presidential Administrations with an understanding of S&T policy to present decision-making and influence during past eras. Yet, because this literature has emerged from the personal writings of former presidential science advisors, it tends to focus narrowly on presidential personalities rather than institutions, and controversies rather than processes. No one has yet applied the lenses of "new institutionalism" described by Zegart (2000, 6–9) and elaborated by Moe (1982; 1985; 1993; 2009) or the bureaucratic politics of Wilson (2000) to S&T presidential policymaking. The most detailed scholarship with a similar focus on the OSTP and the bureaucracy (Katz 1978) is based solely on personal and persuasion notions of power.

#### Applicable Theories for the EOP

Research on the Executive Office of the President (EOP) is limited (Moe and Wilson 1994; Burke 2000; Zegart 2000; Lewis 2005; Cooper 2014), as a result, there are relatively few well-supported hypotheses about how agencies within the EOP should operate. For OSTP, this dearth of hypotheses is even more lacking, as typically scholars place less attention on S&T

policy than others.

Applying the new institutionalism literature to the American presidency can offer basic insights into the role the OSTP as an EOP agency might have. The EOP staff members may have value as both tools of persuasion and also as collectors of influence due to their access to the president on behalf of others (Neustadt 1991). Impact within the Executive Branch, according to Neustadt, could be more difficult than other endeavors because significant delegation of responsibility to the agency heads is necessary to govern effectively. Certainly, the OSTP staff is designed to in part help the President accomplish management of this delegated responsibility.

Though conflicting with Neustadt's dependence on a personal concept of the presidency, Wilson's (2000, 36) view of bureaucracy generates similar implications for what the EOP is expected to do based on different logic. Bureaucracies adhere closely to their organizational missions and standard operating procedures, which were usually established early in the organization's life. Government agencies also face unique incentives that lead them to focus on organizational processes rather than outcomes. A central prediction is that bureaucracies will remain on autopilot and will be highly resistant to change from the top (including the EOP). For both Neustadt and Wilson, the agency officials will continue to act based upon their own motives regardless of EOP efforts. Agency officials will resist OSTP actions that make adhering to existing agency processes more difficult or that do not serve their own interests.

Allison (1971) further emphasizes the notion of organizational 'repertoires of action' and 'standard operating procedures.' Due to constraints on time and resources policymakers within bureaucracies are essentially limited to pre-existing behavior. Again, the prediction is that organizational priorities and practices will endure even in the face of significant outside pressure.

In sharp contrast with the focus on routines of bureaucracy, Kingdon (1984) points out

that individual agents have a significant impact on policy at propitious moments. His model of policymaking rests on three simultaneous 'streams:' perceived national problems, political circumstances, and solutions. Instrumental to the 'coupling' of policy solutions together with problems given opportune political circumstances are "policy entrepreneurs". These actors are most important to policy when windows of opportunity open due to unexpected shocks in the political or problem streams. Such policy windows quickly attract the attention of entrepreneurs, who work for their 'pet' solution to be the chosen solution.

The concept of policy entrepreneurship would imply that the OSTP staff should act quickly to push 'pet policies' when urgent national problems and political issues make it possible. As uniquely positioned bureaucrats, the OSTP can influence presidential agenda setting in the political stream in order to create windows of opportunity. The 'pet policies' should be related to the OSTP staff member's expertise and reflect active engagement with a subset of the S&T community.

Moe (1985; 1989; 1993) portrays the president as motivated by the desire to be considered successful by history in achieving policy initiatives. In order to achieve this goal that stands in opposition to many of the incentives faced by bureaucrats, presidents seek 'responsive competence,' a union of both technical competence and political responsiveness to the priorities of the president (Rourke 1992, 540). The president faces a principal-agent problem in pursuing responsive competence due to information asymmetries him and the agency officials. The presidential solution is to invest power within the Executive Branch, and this has led the EOP agencies to grow over time. For the OSTP, responsive competence suggests that it should seek to centrally coordinate S&T policy to align with presidential priorities: not just "packaging" but deleting, adding, and modifying budgets to suit the president's priorities.

Zegart (2000) finds that presidents have much less power over regulatory agencies in the domestic policy sphere, as opposed to national security agencies, due to structural interests. Though the primary emphasis is on national security agencies, Zegart expects a domestic agency to be one that engages in regulatory activity that faces a strong interest group presence. Certainly interest groups of both the industrial and higher education varieties care about S&T policy. In Zegart's typology, therefore, interest groups would play a crucial role in obstructing the OSTP's efforts to act as a coordinator.

Clearly, a range of theories in this political science literature may apply. It is unclear given the topical focus of the OSTP as well as its relatively non-politicized subject matter, what kind of role scholars should expect it to perform. To some extent, the OSTP is an ambitious attempt at centralized management because it manages one of the most decentralized policy areas. In the special instance of coordinating the R&D system, does the OSTP act in the mold of policy entrepreneurship? Or do agency interests and operating procedures dominate the outcomes of attempts at this White House management? Another possibility would be that interest groups influence or capture the White House agenda as S&T policy has some of the features of domestic policy – some skeptics even consider components of S&T policy instead a 'glorified industrial policy'.

The management that OSTP performs is a complex one, and perhaps does not vary in form between presidencies as much as might be thought (Bressman 2006). Examining how OSTP acts as a coordinator has the ability to provide insights into how the institution itself might be better designed in line with recent theory (Lewis 2004). The work that follows in Chapters 2-6 set out to do just this by answering a seemingly simple question that remains difficult to answer because the OSTP is a special case within a more well-developed literature: What role is the

White House OSTP, as an institution within the President's Administration, performing within the federal bureaucracy engaged in S&T?

As with any government entity, there are many potential ways to access effectiveness and influence: impressionistic assessments of others, satisfaction of presidents, and extent to which outsiders attempt to lobby OSTP, to name a few. Here I focus on the impact of OSTP on the R&D budgeting process within the executive branch.

Public policymaking decides what programs will be enacted, who will benefit from them, and at what monetary levels they will be supported. Holding rhetoric aside, the budget request represents a comprehensive and accurate snapshot of an Administration's priorities at regularly spaced time intervals. Public policymaking is epitomized through the budget... for when push comes to shove, programs will not be carried out as intended (or at all) unless commitment is memorialized by money. (Wildavsky 1986, 2)

The budget process is the only political setting in which OSTP is set up to interact directly with all of the federal agencies engaged in science and technology. Since the influence of the presidency on the budget process in general takes the empirical form of the annual budget request, the influence of OSTP in this research is defined at its contribution to that request.

**Table 1**

<b>R&amp;D Budget Activity</b>	<b>Add</b>	<b>Delete</b>	<b>Modify</b>	<b>Package</b>
	Multi-Agency	Defund ineffective science	Modify existing programs based on expertise or presidential priorities	Generate talking points by aligning existing programs to fit presidential priorities
	Single-Agency	Eliminate Redundancies		



<b>Suggested Organizational Role</b>	Constructive Central Coordination	Knowledge Assessment	Knowledge Pipeline or Responsive Competence	Negligible Role
	Agency Mole	Destructive Central Coordination		

There are many ways in which the OSTP could influence the budget request. Table 1 sets out a theoretical framework for evaluating the role the OSTP performs -- specifically, adding, deleting, modifying, or packaging in the budget process. Adding could constitute advocating for multi-agency programs designed to serve presidential priorities; such activities would indicate that OSTP is performing constructive central coordination and would support the notion that presidents can obtain responsive competence (Moe 1989). Addition as an activity could also come in a second form, if OSTP staffers advocate for smaller programs within just one agency's budget; this activity would indicate that agency staffers function as internal lobbyists or moles for their own S&T community or agency. Such actions would support the idea that agencies successfully serve their own missions and resist outside influence (Wilson 2000), even in the face of presidential control. Finally, individual staff members may find a way to advocate for the addition of new programs they believe are valuable -- that is, to be political entrepreneurs (Kingdon 1984).

Interference or cuts also has two forms in this context. First, the OSTP staff might attempt to delete a specific program because it judges the program to be a bad idea based upon its expertise. Spending time on this kind of deletion would indicate that the OSTP is actually assessing the quality of science funded. A second type of deletion would be the elimination of redundancies in order to spend R&D funds on non-duplicative efforts aligned to the presidential agenda. Deletion of this type implies that the OSTP acts as a destructive central coordinator.

Deletion, just as addition, could provide an opportunity for staffers to exercise policy entrepreneurship (Kingdon 1984).

If the OSTP asks for minor substantive changes to existing programs in the budget process this would represent modification, and would show either responsive competence or the translation of technological expertise depending on the type of change pursued.

The last category – packaging – implies that OSTP staff spends time bundling pre-existing agency programs into “initiatives” to comply with the presidential agenda. In this case, OSTP would be performing behavior akin to a sophisticated public relations function for the S&T policy domain rather than coordinating R&D funding. Packaging is essentially a null finding of budgeting impact.

One possibility is that OSTP’s actions may be different in different spheres of S&T policy. For instance, OSTP may affect the prioritization of defense versus non-defense spending, with R&D budgets displaying significant shifts in the ratio between these two values (“Historical Trends in Federal R&D” 2014). OSTP may more successfully coordinate some agencies than others, for example because a large, bureaucratically powerful coordinator already exists in the Pentagon to manage Department of Defense R&D expenditures, providing an additional buffer against presidential agenda-setting. Additionally, as each agency’s R&D budget decisions are divided into basic, applied, and development accounts, OSTP could be providing input on tradeoffs made between these categories rather than at a programmatic level. Or even after considering direct tradeoffs across agencies and between spending at various stages of R&D, specific demand signals in technology end users may be emphasized by priorities, such as space or manufacturing, resulting in funding boosts for related areas, like materials, energy, or optics, as opposed to areas not seen as applicable to a specific end-user, like ecology. These phenomena

are of high importance to understanding the contextual underpinning of R&D budgeting but are not the primary empirical goal of this work. (To the extent that presidential agendas may operate directly against this backdrop, the potential influence of agendas is characterized in Chapter III.)

### Constraints to Responsive Competence

In S&T policy, potential constraints on presidents obtaining responsive competence in their Administrations loom large. Especially crucial limits are suggested by the traditional literatures on the presidency and the federal bureaucracy outlined above, including the interests and procedures shaping federal agency behavior (Wilson 2000), information asymmetries (Moe 1989; Miller 2005), and the tradeoffs inherent to politicization of staff (Lewis 2005; Lewis 2008). An additional but understudied phenomenon in S&T policy that poses a potent threat to responsive competence is the existence of epistemic communities. Just over twenty years ago, the *Review of International Studies* devoted an entire issue to epistemic communities, using the following definition and conceptualization:

An epistemic community is a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue-area. Although an epistemic community may consist of professionals from a variety of disciplines and backgrounds, they have (1) a shared set of normative and principled beliefs, which provide a value-based rationale for the social action of community members; (2) shared causal beliefs, which are derived from their analysis of practices leading or contributing to a central set of problems in their domain and which then serve as the basis for elucidating the multiple linkages between possible policy actions and desired outcomes; (3) shared notions of validity—that is, intersubjective, internally defined criteria for weighing and validating knowledge in the domain of their expertise; and (4) a common policy enterprise—that is, a set of common practices associated with a set of problems to which their professional competence is directed, presumably out of the conviction that human welfare will be enhanced as a consequence. (Haas 1992, 3)

The S&T policy community is a particularly prime target for the argument that its constituent members operate on shared normative principles, causal beliefs, and notions of validity, which constrain, shape, and alter the policy actions that the OSTP takes on behalf of presidents. Though scholars traditionally employ the analytical unit of epistemic community as an international actor that confounds realist state-relations (Adler and Haas 1992, 368), Thomas (1997) has in fact applied epistemic community theories to inter-agency cooperation in U.S. domestic politics. The applicable literature on epistemic communities for the OSTP would suggest that political motivations do not adequately explain budgeting behavior. The root of this disjunction between expected political outcomes and actual outcomes would be strong normative principles seeping into the policymaking process. Literature on climate change has already proven that such behavioral patterns exist in the international system (Gough and Shackley 2001). The difference here between S&T policy sub-domain epistemic communities—that is, policy communities arising in specific scientific or technical domains—and one occurring at the White House OSTP, would be that the shared normative or causal principles driving behavior must jointly exist across the many constituent scientific or technical domains represented at the OSTP. Some of the principles applied in the S&T policymaking process should be derived from the impartation of normative and causal beliefs inherent to the scientific or technical training that the OSTP staff members undergo in higher education prior to entering their respective S&T policy roles.

## CHAPTER II

### ORGANIZATIONAL HISTORY OF OSTP

Understanding the formation of an agency is crucial for understanding its current relationships with other elements of the bureaucracy. These relationships inform the context in which the interview subjects operated during their tenures in S&T policy. The OMB, which Katz (1978) considers all-powerful in R&D budgeting, factors into this context considerably and its story is interwoven at least as it pertains to the OSTP. Meanwhile, the number of R&D funding agencies grew considerably after the resolution of World War II, from just a few players, to encompass the entire list included in Appendix B by the end of the Cold War.<sup>1</sup> As the nation's R&D enterprise grew, so did the White House apparatus – though the White House apparatus may have grown due to trends of the presidency more broadly realized rather than through any purposeful attempt to wield presidential authority in S&T policy.

The OSTP emerged in 1976 due to a series of Cold War events that simultaneously shaped the structure of a modern, presidential science advisory apparatus as well as federal research and development activities. These events intimately linked the histories of a 'Presidential Science Advisor,' the federal science agencies, and the OSTP. The forces shaping science advice ultimately yielded in OSTP a modern agglomeration of prior attempts at an Executive Branch science coordinator. Alongside presidential failures to coordinate R&D, the federal R&D apparatus fragmented heavily after World War II and froze in place in same the system employed today. Like most agency histories, a history of the OSTP features interagency competition at the outset, a fragile beginning, and relies on the relationships between its leaders and presidents to color the story.

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<sup>1</sup> Holding aside the Department of Homeland Security, which did not yet exist. It too, formed its own R&D funding entity through its founding statute.

In the spirit of Zegart's interpretation of new institutionalism, the focus here will be on how the events created the structure of the institution existing today (2000). Although most historical accounts contextualizing research typically indicate only the events occurring before the research window of interest, OSTP's structure has not been all that stable until recently, and like most agencies in the Executive Office of the President, is reexamined on a regular basis with the changing of Presidential Administrations. Significant weight, however, will be given to the events leading to the 1976 statute that made OSTP a relatively permanent fixture in the EOP, because the more recent changes do not substantively alter the structures of the modern OSTP.

The OSTP's predecessor organizations arose, at first, due to the validation of R&D as an essential component to national defense in World War II. The explicit linkage of R&D to vital national goals, specified with policy actions favoring defense during the subsequent Cold War years, shaped the resulting structure and distribution of federal R&D management and expenditures, which through American bureaucratic inertia, remains largely intact at present. During World War II, the federal government located a vast majority of those wartime R&D efforts within the National Research Defense Council and then the Office of Science Research and Development (OSRD) within the Department of War, under the care of Vannevar Bush (Blanpied 1950, 10–11). Bush is often regarded as the first true 'Science Advisor' to a president, though he did not formally wield this title in an official capacity.

Bush – previously an MIT administrator, founder of Raytheon, and President of the Carnegie Institute – leveraged the OSRD to command significant influence in R&D funding (Wiesner 1979, 97). His influence in the shaping of the R&D system, rooted originally in convincing President Roosevelt to bridge the gap between civilian scientists and the military while protecting the scientific autonomy of those scientists, only grew more so as the OSRD

became credited with the dissemination of notable technological advances like radar defense systems and the atomic bomb (Bush 1945, 239–240). As the war neared its end, President Roosevelt created a commission to recommend the structure of federal science & technology efforts during peacetime. Bush, as head of the commission, published his findings in 1945 in a now famous and highly regarded article in the S&T policy community entitled “Science – The Endless Frontier.” (1945, 231) In it, he champions the contributions of science towards important national goals in order to (1) justify federal support of extramural research at the universities and (2) motivate the creation of a central, civilian federal science agency to coordinate the distribution of that support (Blanchard 1950, 10). The foundational concepts for two distinct government entities began to emerge from his article and gain political momentum – a coordinating agency for scientific research as well as an advisory mechanism for the President.

Although Bush’s conclusions became widely influential and provided the intellectual basis for establishing a peacetime, Jeffersonian system of widely distributed yet centrally managed R&D funding mechanisms, both the legislative and executive branches took quite some time to formulate policy actions corresponding to these suggestions (Holton 1993, 109–125). The initial flurry of activity occurred in negotiations over a bill stuck in Congress for over two long years – from the spring of 1945 until 1947. Ultimately, legislators realized a compromise between Senator Harley Kilgore’s bill, which favored applied research, and Senator Warren Magnuson’s bill, which was a proxy for Bush’s vision. Despite the lengthy negotiation, President Truman vetoed the bill because he found unacceptable its provision that the National Science Board would maintain appointment rights over the director rather than he himself. Later, Bush would convince Truman to sign another version if Congress were to pass it, but this first veto created a delay in the NSF’s creation and provided opportunities for other parts of the

bureaucracy to take on some of its originally intended functions and funding (Wiesner 1979, 99–100).

A significant portion of the delay in executing Bush's advice was also due to the territorial protection of existing R&D budgets within the federal agencies, as the agencies themselves saw a new science agency as a potent threat to their ability to possess R&D funding efforts relevant to their own respective missions.

In the meantime, a debate also arose as to whether centralized R&D could actually work, with this debate featuring rival Executive Branch reports. One of them, the Steelman report, considered the government response to the Bush report, mostly agreed with Bush, suggesting the creation of the National Science Foundation (NSF) for fundamental research investments and also a science liaison to the president (Blanpied 1950, 10). In contrast, the Stewart committee internal to the Department of Defense (DOD), in "Plans for Mobilizing Science," called for a reconstitution of the OSRD and the creation of a science advisory function internal to the recently organized Department of Defense (Blanpied 1950, 11–12).

It is unclear how influential either of these reports truly was, whether because Truman and his political staff did not pay much attention to them or because they ultimately do not seem to have been used directly in the decision process spawning the NSF or a science advisor. Neither landed on Truman's desk. The Stewart and Steelman reports both recommended a science advice component, but differed as to the location of that component in relation to the rest of the bureaucracy. The Steelman report, as a task taken on by DOD staff, naturally suggests placing the location of science advice within the DOD, but with a stipulation of direct presidential access, while the Stewart report makes no such recommendation and would place the liaison outside of existing bureaucracy but potentially at the NSF.



The delay in establishing the NSF and implementing a science policy at a new agency cleared the way for a flurry of jockeying by other entities in the federal government to obtain science-related funds in the interim, both shrinking the resulting budget available for the NSF at the outset, and also calcifying a decentralized structure of R&D funding despite the centralized check-writing vision of the bill. These other federal entities included the Office of Naval Research (ONR), the Atomic Energy Commission (AEC), and the National Institutes of Health (NIH) – each offering their own specific mission justifications for research budgets aligned with the broader public defense and health public interests outlined by the Bush report (Blanpied 1950, 10). Each also was able to leverage more easily manipulated constituencies in the Congress, making it less likely for the fundamental research upstart to garner significant funds when finally created.

The heating up of conflict in Korea created a political impetus for action on both the science advice and the R&D management issues, forcing President Truman to decide how to manage science or risk ineffective incorporation of defense-related R&D as part of the broader Cold War effort (Blanpied 1950, 30). The memory of the centrality of the atomic bomb to a quick resolution to the war in Japan and OSRD's vital contribution surely reemerged in Truman's mind. This logic can be seen at play as Truman turned to seek the advice of William Golden, assistant to the Atomic Energy Commissioner, on how to proceed (“White House OSTP 25th Anniversary Symposium” 2001, 9). He did this by asking the Bureau of the Budget, the predecessor to the Office of Management and Budget (OMB), to contract Golden consult on how to mobilize science for the Cold War effort.

In fulfilling his consulting duties for the Truman Administration, Golden conducted an incredible array of interviews in 1950 and 1951 with leaders of academia, industry, and

government to arrive at recommendations (Blampied 1950, 2–3). Using these interviews Golden first formulated the idea for a scientific advisory *committee* to the president. Prior to recommending this advisory construct, Golden engaged in difficult negotiations with the academic and industrial science communities to find a suitable chairman, while also facing a threatening opponent in the Office of Defense Mobilization (ODM). Ultimately, in order to appease the DOD and garner bureaucratic support for the committee, Golden agreed to recommend that the committee be placed under the purview of the ODM while remaining available directly to the needs of the president (“White House OSTP 25th Anniversary Symposium” 2001, 10). The organizational chart thus showed two links, one to the head of the ODM and one to the president, representative of this compromise and reminiscent of the Steelman Report. In a separate memorandum, Golden also recommended the establishment of the National Science Foundation, which Truman would later sign into law, even though this particular recommendation may not have been necessary or even influential due to the efforts of Bush to persuade Truman in years prior.

In 1957, the Soviet launch of Sputnik into orbit heightened the sense of urgency for the White House to obtain quality science advice. Eisenhower elevated the Science Advisory Committee (SAC) to the President’s Science Advisory Committee (PSAC), thereby removing the advisory construct from the ODM and heeding Golden’s original intent in his memorandum (“White House OSTP 25th Anniversary Symposium” 2001, 10). Underlying this decision to elevate the SAC was the relative disuse of the SAC in the remaining duration of the Truman Administration – although the Cold War had in theory provided an impetus for the SAC’s creation, it took an additional perceived crisis to obtain any true relevance within the existing policymaking apparatus. Some hints exist that Bush even expected this of the Truman

Administration.

The relative importance of an Administration's science advisor often hinges on the quality of the personal relationship between the president and the advisor himself. The first time this contrast is obvious arises when comparing the willingness of Eisenhower to rely on Killian with the irrelevance of the SAC in the Truman administration. Indeed, Eisenhower even referred to the new PSAC as "my scientists," meeting with them personally on a regular basis (22). Most of the time, however, it is almost impossible to tease out whether or not the quality of the relationship is due to the political skill of the Science Advisor or the value that the president already places on S&T expertise. This may impact the Science Advisor's ability to influence the presidential agenda.

The Eisenhower Administration's reliance on the PSAC due to the external shock of Sputnik continued well into the Kennedy Administration. Indeed, the Space Race was set out as a top priority in Kennedy's famous first inaugural address: "Let both sides seek to invoke the wonders of science instead of its terrors. Together let us explore the stars..." (*President John F. Kennedy's Inaugural Address* 2011). Rather than rely solely on the PSAC, Kennedy chose also to create the Office of Science and Technology to expand his personal capacity to manage the competitive Space Race, a federal expenditure of vast proportions. Indeed, this was not unique to science within the Kennedy White House, as "Kennedy was determined to gain control of the bureaucracy and developed a powerful White House staff with the intent to do so." (Golden 1993, 266) The institutionalization of science advice by executive order served not only to expand presidential capacity over the bureaucracy, but also, for the time being, served to solve other debates as well. It put to rest fights over the privilege status of presidential science advice, as well as the ability for Congress to gain testimony from an executive official rather than

creating a separate federal science agency in order to do so – though this debate would resurface again from time to time.

After the growth of science advice into an EOP institution due to the Korean War, the Space Race, and other pressing national concerns like nuclear proliferation from the Roosevelt to Kennedy Administrations, this progress came to a grinding halt in the Nixon Administration. The institutionalization of science advice in the OST expanded the science advice function into an R&D coordinator across all stages of R&D rather than restricting it to the basic research funded by the NSF, but this additional mission placed the OST increasingly at odds with Presidents Johnson and Nixon, who saw these activities as symbolic of a science policy staff operating with their own agenda in mind. Adopting the R&D coordination role, in their view, essentially placed the OST staff at odds with the central purpose of any EOP staff – possessing technically competent people who would work to exclusively serve the president's interests.

Although Johnson's tenure in the White House saw basic research increase disproportionately to the rest of the federal R&D budgets, suggesting a reasonable level of influence by Hornig his advisor, this development solidified Nixon's belief that the OST would be unresponsive to his presidency because it represented advocacy for the academic research community rather than an alignment of goals to presidential priorities (Golden 1993, 267–269). This opinion, no doubt held by top aides to Nixon, strengthened yet again when his first advisor DuBridge, took the wrong side of the 'SST issue' and then aired his grievances with Nixon on the issue publicly during Congressional testimony, breaking with typical protocol for EOP participation in hearings (Golden 1993, 271). After winning the 1972 election and no longer concerned over enduring political backlash driven by the science community, Nixon removed the Science Advisor, OST, and PSAC from the White House complex entirely (Golden 1993, 272).

Nixon simultaneously executed efforts to politicize budgeting directly during his tenure as well. Similar to the criticized foreign policymaking efforts performed solely by him and Kissinger, Nixon created an additional layer of political appointees in the OMB. These positions, entitled Program Associate Directors (PADs), control each division of the OMB and are intentionally political operatives, a link between the White House policy staff and the non-politicized accountant and economist-types on whom the OMB typically relies. This action was met with comparable outrage to removing the OSTP, but in actuality had the effect of elevating the importance of the OMB in presidential budgeting influence (Katz 1978, 62–98).

To the extent that he had to keep some science advisory function alive within the bureaucracy, Nixon placed the civilian aspects of science advice at the NSF with its Director, Stever (Golden 1993, 272–273). He allowed the National Security Council to absorb the most important aspects of defense science advice and let the rest fall by the wayside. The sum of his actions split the overall apparatus in two and reduced its policy capacity substantially (“White House OSTP 25th Anniversary Symposium” 2001, 10).

The destructive outcome in 1973 for the Science Advisor, OST, and PSAC was only possible because Kennedy had created these entities through an Executive Order rather than by pursuing enactment of a Congressional statute. Following the Watergate scandal, President Ford was eager to place science advice back in the White House, and immediately took actions to lobby Congress to place it there for the long-term, while relying on the assistance of Stever at the NSF to suffice for the time being – especially helpful were Stever’s strong relationships with staffers at the Office of Management and Budget (OMB). Ford did not want a future Administration’s potential ignorance of the value of science advice to render future executive access to such advice crippled. He worked with a pre-existing group of supportive Congressmen

seeking a re-establishment of the OST, adopted the plan politically as his own, and spent considerable personal political capital to make it happen – with the ultimate result being the passage of “The National Science and Technology Policy, Organization, and Priorities Act of 1976” just after his Administration came to a close (Golden 1993, 274).

The statute in 1976 placing science in the White House, absent further Congressional action, remains the primary legal basis of the OSTP entity in place today. It provided for the Executive to establish an Office of Science and Technology Policy, an interagency coordinating mechanism called the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), an Intergovernmental Council for Science, Engineering, and Technology (ICSET), and also for a PSAC-like external advisory body called the President’s Council of Advisors on Science and Technology (PCAST). Notably due to concerns that the provisions of the Freedom of Information Act (FOIA) would enable the public to discover the prioritization of political goals over scientific advice, neither Carter who signed the act into law, nor his successor Reagan established a PSAC, preferring to rely only on the advisor, who possessed simultaneously a duty to testify to Congress while also maintaining executive privilege (Golden 1993, 23). Ultimately though, the creation of an EOP entity with political appointees who have testimony obligations to account for the nation’s S&T policy represented a significant compromise between the Presidency and Congress.

Until the creation of the OSTP in 1976, the OMB had continued managing the nation’s R&D budgets and policies in spite of potential gaps in technical expertise. Though certainly some of its staff members must have had some expertise, this was not the emphasis of the organization, nor was it considered to much matter in the Nixon Administration (Katz 1978, 62–98). Katz (1978) even notes that the OMB did not have nearly enough staff to examine all R&D

activities and thus resorted to targeting their efforts to those perceived to matter the most to the president. This mirrors quite closely with the staff of the OSTP today. Crucially, the statute establishing the OSTP provided a role for budgeting as part of its testimony requirements. The OMB and OSTP directors both now testify to various Congressional oversight committees on behalf of the nation's R&D activities and this practice has its roots in the statute.

The years following Carter and the establishment of the OSTP have not seen many permanent changes in the structure of the OSTP, although each Administration has introduced its own minor variations on how the office should be run and what it should look like. A few developments between Reagan and Obama do, however, warrant mention, though perhaps are not as traceable to any particularly compelling political impetus as the Sputnik or Korean crises moments.

The most significant changes occurring since the Carter Administration, much at the discretion of incoming presidents, has been what to do in regards to having an external advisory body of the nation's most respected scientists and engineers, and this has occurred due to a loose interpretation of the statute providing for PCAST. Reagan Science Advisor Keyworth, managed to avoid the issue of politicized science advice by sidestepping it altogether. At the outset of the Administration he created the 'White House Science Council', which only reported to him and not at all to the president – an organizational trick to ensure that the President's interpretation of such advice received would be covered as a communication between him and his science advisor under executive privilege (Golden 1993, 23–24). Unfortunately, it seemed that receiving sound science advice in general was on the backburner in Reagan's administration. Keyworth would later be used exclusively as a political advocate for the Strategic Defense Initiative rather than as a trusted advisor on issues more generally ("White House OSTP 25th Anniversary Symposium")

2001, 22–24). To this day the science policy community considers him a ‘single-issue’ Science Advisor. The White House Science Council lived on for the duration of the Reagan Administration, producing quality work but without much involvement in policy decision-making, according to one of its members – Bromley, who would later become Science Advisor in his own right and write some of the best available scholarship on OSTP during its formation (Golden 1993, 24).

The OSTP developed in tandem with the haphazard creation of decentralized R&D funding through the mechanisms managed by many federal agencies. Yet, much of this system’s development depended upon defense investments made due to the threat of the Soviet Union during the Cold War. The end of the Cold War and the subsequent reductions made in defense spending, termed the “Defense Conversion” in R&D (Nostrand 1997) presented an opportunity to shift the status quo of R&D funding structure but did not do so due to the entrenched interests of so many agencies in preserving their own control over R&D funding mechanisms relevant to their missions. Instead, the Bush I Administration created the PCAST for the first time in fulfillment of the original 1976 statute in order to obtain quality science advice for the president himself rather than through the Science Advisor alone at the urging of Bromley. Bromley successfully convinced President Bush to meet with the PCAST at Camp David (Golden 1993, 38).

The Clinton Administration then pursued a revitalization of the inter-agency coordinating mechanism at the White House by changing the FCCSET, sometimes jokingly referred to as the “fix-it,” into the National Science and Technology Council (NSTC). This new entity serves largely the same function as the FCCSET once did, with about 20 federal agencies participated in its various committees and subcommittees. Since the replacement of the FCCSET, presidents



have not made any other institutional changes outside the staffing process in the OSTP and sub-committee process in the NSTC. Within the staffing process, the past four Administrations have altered the structure of the divisions of OSTP; with a particularly inconsequential debate occurring about how many political appointees is an appropriate number to manage its operations. The 1976 statute provides four slots for individuals holding assistant director senate-confirmed positions, while some of these Administrations have chosen to only fill two such roles.

### Conclusion

Two long-term trends in S&T policy are apparent. The first is that without significant shocks to the structure of R&D budgeting interactions, the R&D system will continue to be permanently decentralized. Though the scientific community is quick to protect such decentralization on the basis of the Bush arguments for Jeffersonian R&D funding mechanisms, it is unclear if this is optimal beyond the context of fundamental research occurring at the universities. The second trend is that while the OMB retains most of the R&D budgeting and policy authority given to it during Nixon's efforts to exercise political control, the OSTP has in fact acquired some of these over time. The expansion of the OSTP into the budgeting context has roots in the requirement that the Science Advisor to the President be one of the individuals held accountable by Congress for the nation's R&D activities. It is hard to imagine how someone could adequately fulfill this requirement without a stronger role in budgeting than the OSTP had had in its OST iteration. Over time, the OSTP has expanded its budgeting role through formal and informal mechanisms discussed elsewhere in this thesis, but especially through issuance of a joint R&D Budget Priority Memorandum as well as participating in review periods in technological areas of presidential interest. Katz's (1978) account of the presidential organization for science prior to this development provides a picture that places OST prior to this as

solely an extension of OMB abilities and to some extent this may shape the way the OMB views the OSTP even today.

## CHAPTER III

### THE EFFECT OF PRESIDENTIAL AGENDAS

Presidents and their advisors decide what the Administration should focus on and whom it should hire. They do this through a process that takes into account a multitude of political factors. Prior to the selection of a Science Advisor, the President may or may not already possess strong policy preferences in S&T policy. Even if not, the President may possess influential political linkages to those who do. Both of these will inform both the selection of the Science Advisor as well as the resulting agenda. The Science Advisor, of course, has a strong role in shaping the agenda by marshaling technical expertise once confirmed by the Senate to the position. He or she may exercise significant discretion in selecting the staff members who contribute to informing the agenda. More importantly, though, is the Science Advisor's place at the table when final decisions are made, and the ability to select not just political but also scientific evidence to advocate for a certain course of action.

Epistemic communities may impair the ability of the Presidential agenda to be realized in S&T policy. The policy communities or sub-communities that inform the S&T policy agenda of the President may possess preferences adverse to the interests of the President. These may weaken the ability of the President to obtain responsive political staff because those experts operating within a policy area on the behalf of the Administration are also likely to be a part of the epistemic community themselves.

In the particular case of the White House OSTP, the staff beneath the political appointees harnesses significant technical expertise. Almost all have PhDs credentials. Some have managed large R&D portfolios at the federal agencies prior to working at the OSTP, while others arrive straight from academia, the national laboratories, or industry. The appointees and staff perform

critical agenda setting, as each year the OSTP and OMB collaborate to develop a joint R&D budget priority memo.

The Administration's R&D Budget Priority Memorandum as a practice began during the early 1990s but did not occur every year until the Bush II Administration. The OSTP issues the memorandum during the summer as the result of negotiations between the OMB and OSTP. The OSTP staff calls the memorandum a "consensus document" – indicating that its contents onto the represent full agreement between both EOP offices. Some interviewees indicate that the document includes a modicum of agency input. The content remains at a "high level" because it sets out priorities of a national character – those that infiltrate presidential politics. The memorandum acts as the most visible and concrete statement of presidential priorities in S&T policy. OSTP staff can point to this memo during budget negotiations to drive the political behavior of other entities.

That the presidential priorities of individual Administrations do have an effect on R&D budgeting is not an assumption. This chapter proves that the priorities of Presidential Administrations have a meaningful impact. As the R&D Budget Priority Memo is a clear signaling of the Administration's pre-existing priorities, just as the budget is representative of its final decisions, the existence of such a presidential effect would at a minimum indicate that the priorities matter.

If the OSTP anticipated the preferences of Congress prior to establishing its own priorities, then the causal link would not be clear. However, Presidents wield significant *ex ante* influence in budgeting due to proposer power (Yildirim 2007). Largely, the President and his agents in the bureaucracy under the careful monitoring of the OMB dominate *ex ante* budget behavior with little regard towards Congress, and perhaps even shape the Congressional dialogue

due to their provision of the status quo for budget negotiation framing (Berry, Burden, and Howell 2010). Berry, Burden, and Howell (2010, 786) additionally argue that “the president’s ability to influence the distribution of funds ex post through executive agencies complements his proposal power ex ante.” As presidents influence implementation after the budget process is complete, a clear signal of presidential interests may be a powerful method of obtaining those interests within the budget process himself. Congress may be constrained by presidential proposals because the priorities that are most clearly disfavored are those also least likely to be well implemented.

Effects specific to distinct time periods and individual presidencies show up in the R&D budgeting process as tradeoffs are made across federal science agencies. This conclusion is reached through the use of the four empirical models enclosed in Appendix C, which use fixed effects regressions and interaction terms to arrive at meaningful coefficients. Historical R&D funding and debt datasets originally available from the Office of Management and Budget serve as primary observations. The time sample includes the fiscal years ranging from 1976 to 2012 and the Presidential Administrations of Ford to Obama, coincidentally providing full coverage since the beginning of the White House OSTP’s modern existence.

This rest of the chapter continues in the following way. First, I discuss the budget data analysis performed to prove the existence of an effect by individual presidents on R&D tradeoffs. Regression tables, model specification, and discussion of substantive results are enclosed in Appendix C. I then examine the implications of these findings and take efforts to describe how the OSTP says it uses the R&D Budget Priority Memo to stimulate this effect. I conclude by setting out a crucial relationship in the causal link: the relationship between the President and the senior-most OSTP appointees, especially the President and the Science Advisor himself.

Budget funding values demonstrate high consistency in the literature (Joyce 1993, 42). The values of agency budgets in the U.S. government change only slowly and incrementally. One would expect changes in the budget process induced by each presidency to occur during the entire length of their four or eight year tenure. This insight indicates that the relationship between one period time-lagged, log funding and log funding should be very strong – far closer to 1 than to 0 because they are not independent draws.

Republicans should spend more on defense than non-defense R&D activities because Republicans in the time period studied care more about defense (Russett 1982, 767). This would suggest that controlling for party identification in both the executive and legislative branches during the time period would be intuitive. Additionally, Republicans might prefer to cut non-defense spending more readily as a trade-off in times of fiscal constraint, especially when the federal debt is high. Party affiliation should have an effect through this logic.

Reasons in the literature exist for why period effects might occur due to strategic threat environments. Samuels argues that “Cold War America defended territory but acted as if its economic interests were a subordinate component of national security,” leading it to abandon non-defense R&D missions in comparison to defense specific R&D missions (Samuels 1996, 3). Having established that a general threat environment can drive public motivation for R&D spending in that case, at least in the defense component, it is not hard to postulate that other threat environments could also spur public R&D investments. The War on Terror, as the major conflict of the past decade and since the end of the Cold War, stands out as the obvious other period to examine much in this same way, as a period for a new trend to emerge. Finally, the “Defense Conversion” was a noticeable downward shift in defense spending generally; including the R&D account, after the success of 1980s Cold War spending that resulted in the fall of the

Soviet Union (Nostrand 1997). The three time periods, which are both obvious in this body of work and also in motivating figures shown below, are the Cold War, post-Cold War, and War on Terror periods.

**Table 2**

Statistics	Debt as % of GDP	Congress Party
N	481	481
Mean	39.2	.42
Standard Deviation	10.7	.41

Congressional party affiliation is measured by coding the majority party of each congressional chamber per year and then analytically combining these variables together so that the variable is equal to 0 when both are controlled by the Democratic Party, 0.5 when each chamber is controlled by a different party, and 1 when both chambers are controlled by the GOP. As reported in Table 2, the average control of Congress sits at 41.9% but with a high standard deviation of 41.2%. Congressional party affiliation thus tends to be more often Democrat than Republican during the time sample, but demonstrates, more often than not, large swings between 0 and 1 rather than sitting at the 0.5 values.

Federal debt as a percentage of GDP each year is recorded according to OMB historical records (“Table 7.1 Federal Debt at the End of the Year: 1940-2019 | Historical Tables | The White House” 2014). Debt, on average, is at 39.2% of GDP, and has a relatively large variation over the time sample of the observations, with a standard deviation of 10.7%, as shown in Table 2. Both Congressional party affiliation and federal debt as a percentage of GDP are reported in a single table because they are the only variables that may be reported in a meaningful way without distinguishing between agency.

**Table 3**

Agency	N	Mean	Standard	Defense
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			Deviation	
DHS	11	1010	363	1
DOC	37	1110	328	0
DOD	37	60700	16800	1
DOE	37	11000	1600	1
DOT	37	869	154	0
EPA	37	736	144	0
HHS	37	19700	9830	0
Interior	37	849	125	0
NASA	37	11400	2400	0
NSF	37	3550	1170	0
USDA	37	2220	364	0
VA	37	625	313	0
Other	37	1400	282	0

Tables maintained by the American Association for the Advancement of Science (AAAS) R&D Budget & Policy Program measure R&D funding by the agency-year and provide the data for the dependent variable in the analysis (“Total R&D by Agency, 1976-2015 | Historical R&D Data” 2014). The number of observations, mean, and standard deviation of the agency funding level (adjusted for inflation) each year are reported in Table 3. Additionally, the rightmost column in Table 3 reports whether the agency identified is considered a defense or non-defense agency in my analysis. The Department of Defense (DoD) has the largest average budget allocation per year, with a mean of 60.7 billion dollars. The agency that has the second highest average budget allocation per year is the Department of Health and Human Services, at a much lower 19.7 billion dollars. This is consistent with the historical reality that most R&D funded by the federal government prior to the end of the Cold War was channeled through the DoD rather than other agencies and also that budgets demonstrate a high year-to-year consistency. Non-defense R&D is spread more evenly across many mission agencies, with the National Science Foundation and National Institutes of Health funding basic research in all



disciplines and health disciplines, respectively. Other spectrums of R&D that occur after basic research grants are primarily funded by mission agencies relevant to the discipline funded.

A dummy variable for each president was created, holding a value of 1 when the respective president is in office during the corresponding budget proposal for the fiscal year, and valued at 0 otherwise.

Three dummy variables corresponding to three respective time periods were created according to three strategic threat environments identified in the literature. The first period in the analysis is the Cold War, which lasts from the beginning of the time horizon, 1976, until 1989. The second period in the analysis is Post-Cold War, which includes the fiscal years from 1990 until 2001. The final period in the analysis is the War on Terror, which lasts from fiscal years 2002 until 2012, the final fiscal year accounted for in the dataset. Each variable has a value of 1 when an observation lies within the period's year range, and 0 otherwise.

Presidential party identification was coded as a binary variable of 0 or 1, with a value of 0 corresponding to a Democrat party affiliation and a value of 1 corresponding to a GOP party affiliation, matching the party identification rule applied to the Congressional party control variable.

Taking the absolute value of 1976 subtracted from the observation's year value generated a counter variable in order to measure any systematic time trends affecting R&D spending.

A breakdown of federal R&D spending into defense and non-defense categories, pictured in Figure 1, displays the variation, which this analysis attempts to explain. The general upward trend of total R&D spending by the federal government between 1976 and 2013 is apparent, yet tradeoffs between defense and non-defense allocations are occurring throughout the panel data.

The theoretical relationship of interest is the ratio between defense and non-defense spending rather than the absolute levels of each, because large trade-offs are made despite the upward trend of both. Figure 2 depicts this ratio plotted over the time range of the panel data. Three broad trends are evident. Clear, large magnitude swings in the ratio occur, with the first being a rise from about 1.0 to a bit more than 2.2 in the 1980s. The second shift moves the ratio from above 2.2 in the 1980s to 1.0 in 2000, which represents the sample minimum value. The final shift is a rise from 1.0 in 2000 to a local maximum of approximately 1.4 in 2008. These shifts were the motivation, besides that found in the literature, for examining the period-specific effects of the Cold War, post-Cold War, and War on Terror.

Besides broader time period effects, inspection of Figure 2 yields noticeable kinks in the plot which occur at possibly the four year term frequency. The effect of each presidential Administration may be playing out in these patterns as an intercept shift, but it seems to be on a much lower order of magnitude as an effect than the time periods. Having identified these two patterns as important stories to explain within the data, the following conclusion was reached.

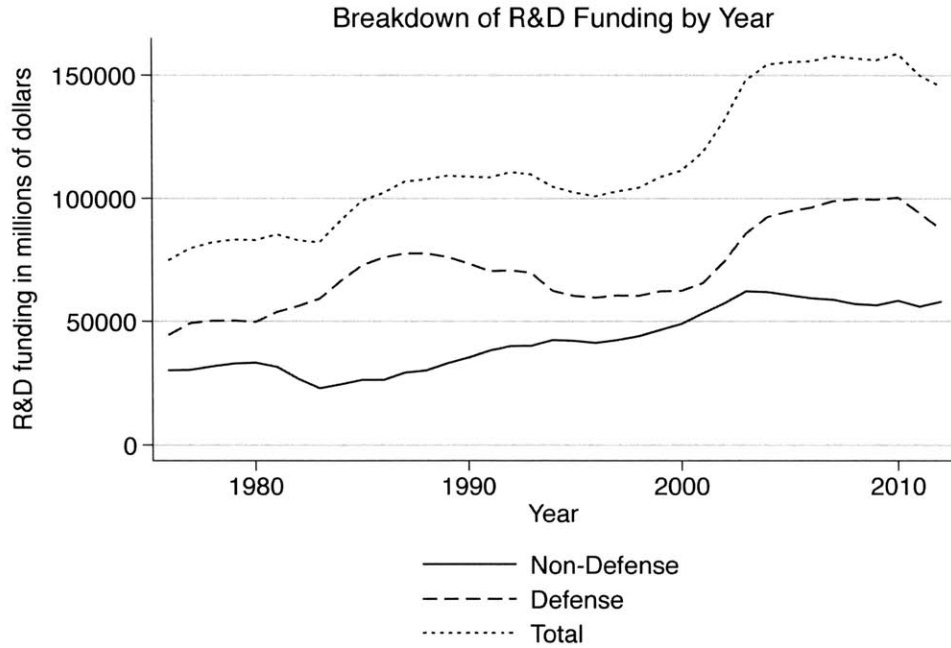


Figure 1

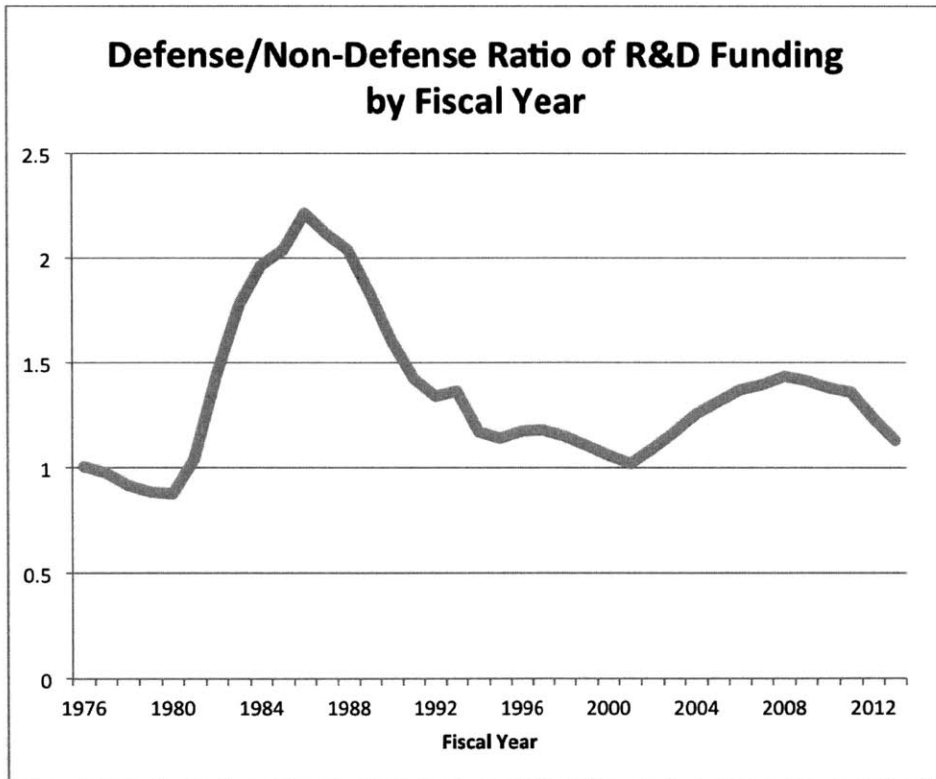


Figure 2

Two different types of models were necessary in order to examine the effect of both broad time period effects and effects specific to individual Presidential Administrations on R&D spending patterns in sum and between defense and non-defense.

Table 1

<b>Average Annual R&amp;D Funding by Partisanship of President and Congress</b>						
FY 1976-2012 in millions of FY 2013 constant dollars						
	<b>President</b>					
	Republican			Democrat		
<b>Congress</b>	<b># FY</b>	<b>Total</b>	<b>% Defense</b>	<b># FY</b>	<b>Total</b>	<b>% Defense</b>
Republican	4	155,756	57.17%	6	107,856	52.61
Divided	8	105,457	61.61%	3	151,460	56.99
Democrat	10	112,250	58.94%	6	90,139	50.22

Table 3 portrays the relationships of interest, total spending and relative prioritization of defense spending in a given year's budget, against the political context. No pattern is apparent in the total spent on R&D, but clear patterns do exist between the percentages spent on defense in various scenarios. The most obvious conclusion is that Presidents matter much more than Congress in determining the percentage spent on defense. Republican Presidents spend strictly more as a percentage on defense than Democrat Presidents. Meanwhile, the only effect Congress seems to have on this tradeoff is that divided Congresses spend more on defense than a unified one. The difference between Republican and Democrat Presidents defense spending percentages across identical Congressional contexts is sizable, with a magnitude of at least 4.56 percentage points in all cases. Interestingly, the difference between Republican and Democrat Presidents is least when the Congress is divided; perhaps suggesting that more Congressional bargaining between parties does not advantage the President's priorities in R&D accounts, or at least not the defense ones.

Across all models, the prior year's funding value highly determines the present year's funding value, consistent with the literature, as demonstrated by regression coefficients clustered around the 0.9 values for each model. Most of the in-sample variation may be explained by this lagged effect, and the strong influence of this explanatory variable causes the R-squared to become artificially high and consistent after adding further controls, rendering subsequent iterations of the regressions difficult to compare for fit across this baseline. This finding remains consistent with traditional expectations and suggests that the analysis is internally valid and does not suffer from any major specification error, though this property makes a causal finding challenging.

Although it is encouraging to find expected results for the lagged independent variable, the more captivating questions motivating this research center on the comparison of defense and non-defense agency funding values. The crucial finding of the analysis is that the large and stable effects in Models 1 and 2 that time periods characterized by different strategic threat environments do indeed cause changes in funding levels. In discussing the results, I use the coefficient values provided by the final iteration of Model 2. Non-defense agencies, in both the post-Cold War and War on Terror periods and holding other variables constant, receive boosts in funding in the following year on average at approximately 6 percent during the time period, fitting closely with the expectation that the Defense Conversion was occurring after the Cold War as R&D policymakers felt that more of the technology enterprise should be shifted towards non-defense activities to spur long-term productivity growth. Defense agencies during the post-Cold War period lost on average about 3 percent of their budget compared to non-defense agencies in the period. The swing in the defense over non-defense ratio may be explained by both a period effect increase in non-defense R&D spending and a period effect decrease in

defense R&D spending. The increase in non-defense R&D spending clearly dominates as total R&D grows during the time period. Unfortunately, it is impossible to draw conclusions about the period effect of the War on Terror, but this non-finding is likely due to the relatively stagnant total R&D expenditure during the period in real terms, as well as the inflection point which occurs in 2008 as the War on Terror is de-emphasized and force deployment begin to be reduced in a war-weary fiscal climate, yielding little variation on the dependent and independent variables of interest in that time period as specified.

The Model 3 and 4 results add to the depth of the analysis because they are able to capture time trends in a more parsimonious fashion. The presidential Administration of H.W. Bush, Clinton, and Obama each negatively affect defense agency R&D budgets in a noticeable manner, with regression coefficients reported in Table 7 at -0.168, -0.191, and -0.269. These coefficients are quite large in magnitude, with President Obama having the largest individual effect on defense verse non-defense R&D spending. The first Bush and Clinton Administrations have relatively similar coefficients and also uniquely identify the post-Cold War time periods, leading to the conclusion that those large presidential effects are dominated by the effect of the time period trend in general. These coefficients would likely be an order of magnitude smaller if time periods could be controlled properly without co-linearity issues between time period and presidential term indicators.

The results of the Chow test reported are exciting because they lend conclusive support to the hypothesis that says Presidential Administrations have an independent effect on agency R&D budgets. This finding allows this data analysis to combine the results from both Model 1 and Model 2 into a combined framework for understanding agency R&D budget variation. Major time period trends drive most of the incremental variation in budgets not explainable by the prior

year. Presidential Administrations cause minor, yet statistically significant shifts in the average agency budget not explained by broader period effects. The party of Congress in any given budgeting cycle is shown not to matter much relative to these other effects.

#### Priorities over specific domains

So given that Presidential Administrations meaningfully impact R&D budgets and that the R&D budget priority memo is the most concrete reflection of their priorities, what do these memoranda actually look like? A few central characteristics emerge from inspection of these documents over time. The most important one is that R&D budget priorities demonstrate the greatest changes between Administrations rather than during Administrations. This fits closely with the idea that new Administrations pay attention to the issues areas that interest themselves and their coalitions. In fact, according to interview subjects formally involved in the transition teams for the past few Administrations, these issue areas precisely inform their hiring practices.

Table 2

<b>FY 2009 R&amp;D Budget Priorities</b> (Final Year of Bush Administration)	<b>FY 2010 R&amp;D Budget Priorities</b> – in the American Recovery and Reinvestment Act and its corresponding R&D Budget Memo (First Year of Obama Administration)
Homeland Security and National Defense	Basic Research
Energy and Climate Change Technology	Clean Energy
Advanced Networking and Information Technology	Biomedical and Health Research
National Nanotechnology Initiative (NNI)	Homeland Security (Especially Biodefense and Nuclear/WMD Detection)
Understanding Complex Biological Systems	Networking and Information Technology
Environment	Nanotechnology
Next Generation Air Transportation System	Climate Change
Federal Scientific Collections	Science, Technology, Engineering, and

	Mathematics (STEM) Education
Science of Science Policy	Next-Generation Manufacturing Technologies

Table 8 presents the changes in the priority memorandum for the fiscal years of 2009 and 2010, which were the final budget cycle of the Bush Administration and the first budget cycle of the Obama Administration, respectively. Though some interview subjects report that priorities are not specified in order of importance because they are the product of consensus, the order in which they are reported does seem to reflect how important these priorities are to the White House itself. These comments might be attempts to protect the OSTP from agency backlash if they were to confirm this. On similar grounds, priorities are kept at a reportedly abstract level on purpose.

Priorities in these memoranda move up and down. This behavior especially occurs in presidential transitions, for example the Bush Administration lists ‘Homeland Security and National Defense’ first in the document whereas ‘Basic Research’ more broadly is the first mentioned by the Obama team and Homeland Security is moved down to the fourth slot. Even in presidential transitions, the priorities of the prior Administration do not completely fall off. Four of the nine priorities in FY 2009 are preserved in the FY 2010 document, including Homeland Security, Energy and Climate Change, Networking and Information Technology, and Nanotechnology. These preserved priorities also happen to be the ones at the top of the list in the last Bush memo, which may suggest that their inclusion during years of the Bush presidency had generated institutional support at the agencies. This discovery also matches with the consistency in public budgeting. De-prioritizing the successful priorities of the prior Administration against the will of the agencies may require an outflow of political capital.



New priorities of the Obama team that were not included on the FY 2009 memorandum include Basic Research, Biomedical and Health Research, STEM Education, and ‘Next-Generation Manufacturing Technologies.’ Priorities of the Bush team that fell off the memorandum in this transition were the ‘Next Generation Air Transportation Systems,’ the ‘Federal Scientific Collections,’ and the ‘Science of Science Policy.’ These areas represent a trade-off between pet projects of the respective Administrations. Although basic research funding is almost always a goal of the OSTP, the Obama Administration has made this an explicit goal well beyond the norm. The STEM Education area’s statement as a priority in the Administration’s first budget cycle has led to a proposed and partially implemented reorganization of STEM Education activities across the federal agencies in 2013-2015. The ‘Science of Science Policy’ was reported in interviews to be a primary goal for Bush Science Advisor Jack Marburger and led to an NSF research posting that still remains available almost ten years later. Presidential priorities in R&D have meaningful possibilities for impact and become institutionalized over time.

Table 3

<b>FY 2015 R&amp;D Budget Priorities</b> (Sixth year of Obama Administration)	<b>FY 2016 R&amp;D Budget Priorities</b> (Seventh year of Obama Administration)
Advanced manufacturing	Advanced manufacturing and industries of the future
Clean energy	Clean energy
Global climate change	Earth observations
R&D for informed policy-making and management	Global climate change
Information technology	Information technology and high-performance computing
R&D for National-Security Missions	Innovation in life sciences, biology, and neuroscience

Innovation in Biology and Neuroscience	National and homeland security
Science, technology, engineering, and mathematics (STEM) education	R&D for informed policy-making and management
Innovation and commercialization	

Table 9 instead shows the priorities during the sixth and seventh years of the Obama Administration. The priorities of an Administration are strikingly similar across years as that Administration nears the end of two full terms. Eight of the ten priorities remain stable across these two documents. Notably, the two documents show Advanced Manufacturing as a top priority. Over time, this priority has risen from the bottom of the list in FY 2010 to the top of the list by FY 2016. On the other hand, the first slot in FY 2009, Homeland Security, has fallen down to the eighth slot in the intervening period. Bush's top priority is one of Obama's lowest, though it does not fall off completely.

The R&D Budget priority memoranda do drive the patterns that show up in R&D budget data. One obvious pattern is the relative prioritization of defense versus non-defense related R&D spending. This makes intuitive sense following a discussion about the Obama Administration's downgrading of Homeland Security or National Security as a priority. The tradeoff between defense and non-defense is the most measurable and high-level phenomenon recognized. Other kinks in the budget data exist due to the changes in priorities, but are less demonstrable without facing methods challenges. For example, it is difficult to prove a statistically significant presidential effect on a single agency's R&D budget because the  $n$  is far too small if broken up by indicator variables for each president's term in a regression model. Additionally, the priorities do not match one-to-one to agencies explicitly and benefit only smaller, sub-components of many agency budgets rather than benefitting any single agency as a

whole. Therefore, while the effect of priorities exists generally, exactly proving that effect at a fine-grained level is difficult.

Even though some of the priorities in the discussed memoranda may remain at the same rank over time, this does not necessarily imply that the nature of the Administration's priority is constant. It would be extraordinary if priorities remained exactly the same during constantly shifting fiscal, political, and security climates. It would similarly be a mistake to conclude that Administrations only represent their coalition's interests during the initial transition period and do not listen to ongoing input from that coalition. The way that these two challenges to stable priorities manifest themselves in the memoranda is by OSTP and OMB altering the explanations of the priorities over time without changing the priority's presence or relative importance. An interview subject commented that although the climate change priority has remained on the memoranda, the explanations for that priority have shifted over time due to continuous negotiations with the interest groups and agencies that support that priority. These modifications happen on a much smaller time scale and suggest nuanced agenda setting by the OSTP staff. This fits nicely with the description of OSTP as a pipeline of knowledge between the scientific community and the White House. Because the R&D behind climate change is a domestically oriented enterprise, this also connects to Zegart's proposition that a non-defense agency serve interest groups much more closely than a defense-oriented agency.

Interviewees described the ways in which the OSTP utilizes the memoranda. The first way is that as a consensus document, gaining the OMB Director's approval generates political utility because it allows OSTP staff to act as if the OMB is behind them in discussions without requiring them to re-negotiate directly with the OMB staff. This by itself makes the document useful enough to warrant production because the OMB commands significant respect, and even

fear, in budget matters from agency officials. The alternative to this explicit agreement of priorities would require continuous escalation of disagreements up to the higher-level political appointees.

The second use of the memoranda is that the OSTP staff can point out a priority when negotiating, especially during OMB review. If for example, an agency's drafted request doesn't adequately serve the applicable priorities, then the OSTP tries to persuade that agency to commit more funds towards the relevant activities in its own R&D portfolio. Or if an agency resists inclusion of a priority, then the OSTP may choose to withhold help from the agency program managers in persuading the OMB with scientific or technological arguments.

Some of the OSTP staff members say that the memoranda does not enable agencies to do packaging because it is not released at the same time each year. Most of the time, it does not even come out before agencies have completed the bulk of their planning. This would mean that the memoranda's only pathway for impact would be OSTP interactions during budget negotiations rather than through any agency-driven attention to the priority memoranda. Whether or not the OSTP has the capacity to drive full incorporation of the priorities without the agency officials already anticipating the potential for this activity by modifying their planned budget requests is a reasonable question up for debate. Instead of operating on any assumption about how information flows between the various actors in the budgeting process, it is more valid to conclude that the priorities for each fiscal year may have effect over a longer time period than just for that particular fiscal year alone. Each agency is operating through the mechanics of two or three budget cycles at any given time as they implement a previously authorized budget, negotiate the next proposal, and engage in forward planning.

The President's Science Advisor can obtain significant opportunities to shape the presidential agenda pertaining to R&D in three ways: by his direct personal dealings with the President, by connecting issues in S&T to issues on the political agenda, and by selecting the staff members who join the OSTP team.

Beyond any bureaucratic authority inherent to the position, the Science Advisor can cultivate a personal relationship with the President with crucial implications for shaping agenda-setting behavior. Though the process of selecting the Science Advisor at the beginning of the President's term may be just as guarded as any other presidential appointment, the track record of chosen Science Advisors suggests selection criteria. Recent advisors hail from the constituent parts of the existing science policy community and hold credibility as leaders in S&T. Neil Lane, one of the interview subjects, was selected as a replacement Science Advisor by the Clinton Administration based upon his work at the National Science Foundation. Jack Marburger served as Director of the Brookhaven National Laboratory prior to his selection by the Bush Administration. And John Holdren, the current Science Advisor, worked diligently on S&T issues during his tenure on the PCAST for the Clinton Administration, which laid the foundation for his selection.

Although all of these individuals have obvious pedigrees for the role, none of them have the type of pre-existing personal relationship with the President or his most senior advisors that a member of the cabinet or the President's inner political circle might have. The President may not appreciate the value of the nation's science and technology enterprise, nor do the President and his team necessarily trust the Science Advisor as representing their interests as opposed to the interests of the S&T community at large. Compared to others at the top of the Executive

Branch, the Science Advisor has greater pressure to forge a relationship with the President and his team only after he has taken up the role.

This matters because largely the Science Advisor's impact on the presidential agenda may be dependent on persuading the President and his political team on the merits of a given course of action. Issues in science and technology are dispersed throughout the many federal agencies, and agenda items have the potential to place the Science Advisor, and OSTP more broadly, in a confrontational role with a subset of a cabinet agency. Such confrontations will only be 'won' by OSTP if the staff members can escalate the matter up to the Science Advisor. The Science Advisor then must work through the matter with the relevant cabinet secretary, and if the conflict persists, present the decision to the President in the appropriate method respective to that particular Administration. The Science Advisor's ability to persuade the President on a course of action based on the best available scientific expertise may thus depend entirely on his ability to cultivate a successful personal relationship with the President. This dynamic generates an interesting dichotomy between the uppermost appointed elements of the OSTP with the rest of the staff, as the Science Advisor may only be expected to escalate a limited number of important issues to maintain a positive working relationship with other high-ranking members of the Administration.

The Science Advisor also can shape the agenda by linking S&T issues directly to the political strategy of the Administration. By doing so, he is able to demonstrate the added political value of an OSTP coordinating action. For example, in the Obama Administration, coordinated research efforts in Advanced Manufacturing and Clean Energy have both been successfully linked to potent political motivations for economic recovery and environmentalism, respectively.

The final method by which the Science Advisor may shape the agenda is by selecting OSTP hires in order to marshal technical expertise in anticipated agenda items. The OSTP cannot possibly possess experts in each discipline of S&T at all times, but it can select experts both within and without the federal bureaucracy as issues arise on the agenda. The staff members of the OSTP contribute to the R&D Budget Priority Memorandum each year. It is not much of a leap to expect that the memo's elements are somewhat predetermined by those chosen to contribute to it. They carry with them unique relationships within the bureaucracy and the science community that can be tapped for information in shaping the priorities.

The dichotomy between the political appointees of the OSTP and the rest of the staff is crucial for understanding its budgeting actions. Each agenda item is operative over many budget cycles – the translation of a priority into policy actions requires the hiring of an OSTP staff member, in addition to significant intervening policy actions prior to implementation. These actions will be discussed further in the ensuing chapters, but the timeline at which this occurs is worth noting here. As staff is hired to fill a certain expertise and effectuate policy actions within a specific agenda item, they are not necessarily prepared with sufficient political experience necessary for operating in the highly politicized environment of the White House. The learning curve starts only once the OSTP brings these individuals into the staff. On the other hand, the senior-most appointees at the OSTP possess pre-existing political experience that may make them much more highly skilled at navigating the inter-office and inter-agency dynamics inherent to their White House positions. Such a difference in political skill may influence the ability of the technically expert staff to successfully execute coordinating activities or shape the agenda in comparison to the political appointees.

## CHAPTER IV

### LINKING BUDGETING BEHAVIOR TO POLICY IMPACT

Presidential Administrations establish priorities that influence R&D budgeting. The established priorities are considered by this research to be the ones informing the daily activities and actions of the White House OSTP staff. To measure these priorities I asked questions of interview subjects within the categories of: What are these individuals in the OSTP trying to accomplish? What are they succeeding to do? How they do interpret and apply high-level priorities in their respective budgeting domains?

The dependent variable, on the other hand, is a far more measurable concept. In order to determine the role of a presidential Administration on a continuous basis, I examined year-to-year changes in the President's budget request. These changes may be observed using publicly available data made possible by the American Association for the Advancement of Science (AAAS) R&D Budget Policy program's website, which not only collects yearly presidential budget request data from the OMB website, but also organizes this data historically dating back to 1976, the beginning of the OSTP's modern existence ("Historical Trends in Federal R&D" 2014).

The changes on a yearly basis in R&D budget requests within my analysis are seen as the output of the work performed by, and interactions between, OSTP & OMB staffers and officials at the federal agencies. Every year these individuals bargain over trade-offs in R&D budgets between items including: individual agencies; defense and non-defense missions; basic, applied, and developmental stages; and performers. Determining what actions occur relied on the theoretical framework – whether they are adding big or small programs, killing big or small programs, modifying or packaging pre-existing programs to align with priorities.



As mentioned by a recent organizational review by an outgoing OSTP staff member and policy academic (Hart 2013), constraints on data availability make assessing OSTP's role difficult to meet high empirical standards. Although information about the end result of budget proceedings is made available each year, no off-the-shelf dataset exists that would illuminate OSTP's portion of input into that process. As the annual budget proceedings between OMB and the federal agencies are closed to outside influence in order to guard against external influence in Executive decision-making, it is not possible to directly examine the evolution of R&D budgets from priority guidance to final budget request. The best information available is (1) the R&D budget priority memo issued by OMB and OSTP prior to each planning cycle, and (2) the requested funding levels in the President's annual budget request.

The primary data collection relied on interviews with individuals with roles at the OSTP or corresponding agencies. This method was designed to qualify the treatment effect of interest, which is the behavior of members of the OSTP organization. The ideal interview sample is exemplified by the organizations and individuals depicted in Figures 3 and 4. Figure 3 displays the current organizational structure of OSTP in the Obama Administration, with the titles of individuals currently holding leadership positions in its divisions. These positions are the ones that during the planning stages of the project were considered of interest and only exemplify those who would be relevant for the ideal sample and is not inclusive over time. Figure 4 presents a stylized organizational chart of the federal government's organizations that the sample is drawn from. Most of the interviewees are from OSTP, but OMB and agency officials were necessary in order to provide some control for institutional bias.

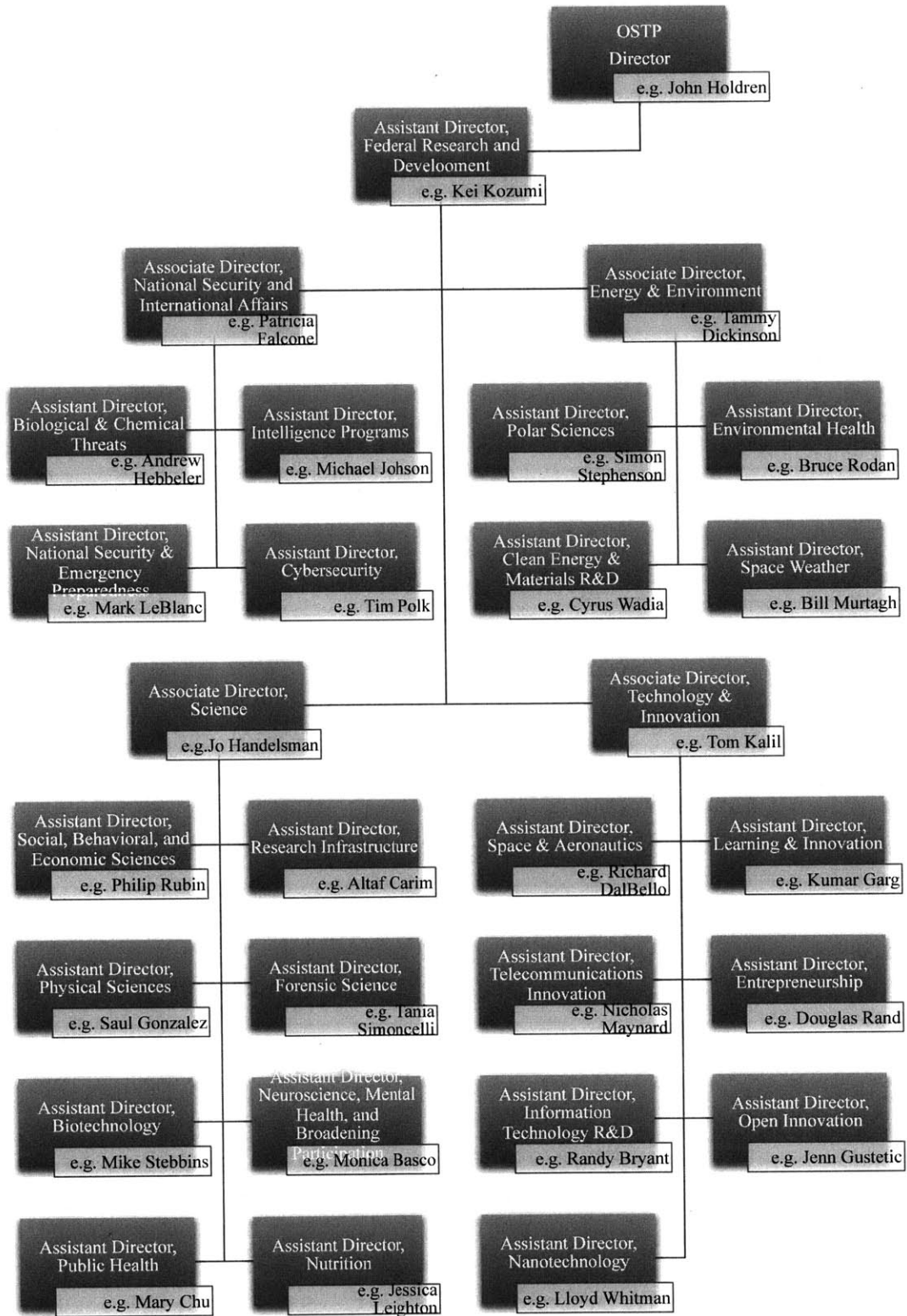


Figure 3

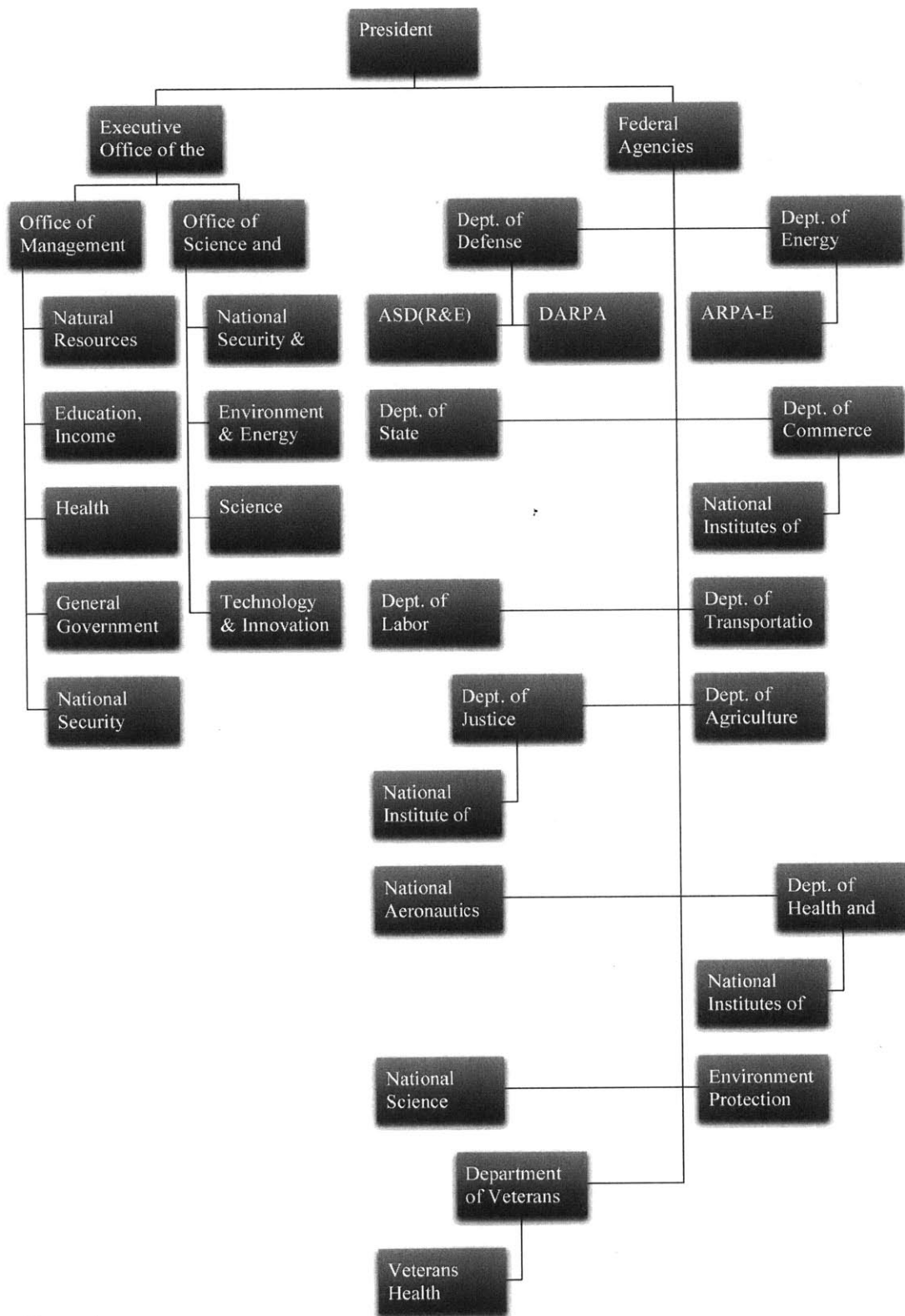


Figure 4

Additionally, individuals at some of the organizations shown in Figure 4 in positions at the same time as OSTP interviewees were interviewed in order to create validity in results by controlling for institutional perspective.

Interviewees were asked a battery of questions about their job functions at OSTP, science and technology priority setting, and the budget process. Their responses are then mapped onto this set of activities. The time period of study for interviews, due to concern for availability of subjects need to cover the entirety of the OSTP's existence as an organization, was instead set from 1989 to the present. Chapter II sets the stage for an analysis of the organization's role by covering the gap in interviewees prior to the chosen scope of data collection.

Individuals were chosen in an attempt to reach a representative sample from each of the boxes in Figure 3, as it was not possible to achieve a random sample due to access constraints and the relatively small set of people in this policy community. Efforts were made to gain coverage across organizations identified in Figure 4 to the best extent possible, but coverage across organizations in Figure 4 was considered less important than coverage over time periods of people operating at OSTP of the type in Figure 3. Ultimately, 22 individuals were interviewed, but many of the interviewees in the earlier time frame occupied high-level positions in the OSTP and I believe should inherently provide more than adequate coverage given the high-level nature of the findings presented in Chapter V. These senior individuals include one of President Clinton's Science Advisors, a proxy for President Bush I's Science Advisor, as well as Senate confirmed political appointees in the second Bush Administration. A list of interview subjects is included in Appendix A for review.

Each year the White House OMB and OSTP issue to the federal science and technology agencies the R&D Budget Priority Guidance Memorandum, which lists the high-level goals for

their budgetary planning. This document is archived on the White House website and available for the past twenty year period and will act as a secondary indication of an Administration's priorities during the budget-year in question, with interviews as the primary authority. Taken as a collective, the set of documents corresponding to the years in which an interview subject was at the OSTP was considered as the measurement of this variable. Prior presidents certainly had R&D budget priorities as well and I made efforts to ascertain these priorities through an examination of documents issued by the PCAST apparatus, though this analysis did not provide reason to believe those documents would render any difference compared to the analysis presented here and thus is not reported explicitly. Even without a priority document, interviewees at the White House prior to the memoranda becoming common practice were still be able to evaluate presidential priorities during their time in public office because I could ask them to clarify what they understood the priorities to be and if any other documents exist that they might refer me to examine afterwards.

Each year by February the President is expected to issue a single budget request to Congress for all federal activities in the subsequent fiscal year after addressing Congress in the State of the Union. This budget request is the culmination of a year's worth of planning between the federal agencies and the White House and is the point at which the President's control over the budget process ends prior to the authorization and appropriation bills in Congress. As such, it is also the output in a system in which the input is the initial priority documents issued by the White House. The interim consists of interaction between agencies and the White House, which is the process at the heart of study.

The President's Budget Request for the federal R&D portfolio is available across the entire scope of inquiry, between 1976 and the present. For the supporting quantitative aspects of

the research, the unit of analysis is the agency-year, and I consider changes in the requests between years as potential indicators of action in the R&D portfolio by the White House or agency officials.

Although the variation in budget requests captures the role of OSTP actions, this acts as supporting evidence for my primary data collection effort, interviewing individuals working in OSTP. This allowed members of the organization to describe the role of that organization in the budgeting process and what actions the organization members perform. By examining individuals across Presidential Administrations and job functions, I create a relative understanding of how much each type of potential action they performed, why they did each, and what reasons motivated them. I use this data generated from the interviews in order to assess the role of these staffers in Chapter V based on the analytical framework generated from the literature in Chapter I.

In order to isolate the actions of OSTP staffers vis-à-vis agency officials and OMB staffers in the necessarily complex, multi-actor budgeting process, I interviewed actors in other capacities order to both verify solid, non-biased observation reporting by OSTP interview subjects and also to control for the actions of these other actors. I did this by incorporating non-OSTP individuals into the interview sample. They were asked a similar battery of questions to the OSTP staffers, with some modifications to accommodate the change of perspective. By characterizing their own role in the budget process they also added to the ability of my analysis to control for other actor inputs into the budgeting process besides the OSTP staffers. OSTP is only one small part of a nuanced budgeting process. Some interview subjects who were also OMB staffers, as direct budget operators, were interviewed in order to incorporate their perspective on how much say OSTP staffers actually had in budgeting. Agency officials also

were able to characterize the extent to which OSTP staffers interacted with their budget planning efforts during the budgeting process and what role they perceived them to fill.

An idealized interview sample would be all individuals overseeing an R&D funded policy area at the White House OSTP and OMB, along with the corresponding heads of federal agencies engaged in R&D activities. This ideal sample would stretch from the entire time sample of the OSTP's existence, from 1976 to the present and would represent the full spectrum of public official actors engaged in the annual budget request process.

Assuming that these officials serve in office for an average of four years, there might be approximately three to five hundred people filling roles during the entire scope of inquiry. Even if I did interview every single person in the ideal sample, the number of non-OSTP staffers interviewed would likely be far higher in this estimate than necessary because interactions between staffers and agencies might not be heterogeneous across all agencies. My goal was to achieve coverage across as many agencies and time periods as possible, but for example, if the type of interaction between the OSTP and domestic agencies as opposed to defense agencies is consistent across agencies, then the role of the OSTP captured by those agency official's perspectives may have been highly redundant. The perfect study on this subject would probably interview at least the estimated two hundred individuals, but I planned to interview as many as possible within the time constraints for the thesis while hoping to achieve a total on the order of 20-30 individuals to yield a tractable set of data to answer the questions. The limitations of the set of interview subjects are relatively small.

I accessed interview subjects by email via both direct and indirect sources. The size of the potential subjects contacted was large enough to support the conclusion that my amount of access to interviewees was replicable by a non-insider conducting an identical research agenda.

Although I have prior professional experience in the field that provided me with indirect access to some of the people I interviewed in the sample, access to the people in the sample would also have been possible through publicly accessible searches for email addresses or via professional social media websites like LinkedIn, as the names of these individuals are publicly available.<sup>2</sup> In order to make contact with potential subjects, I sent the following message to all of them, including to those whom I have referral type access.

Dear [Name],

I am conducting interviews during the next few months as research for my thesis in political science at the Massachusetts Institute of Technology (MIT). The title of the study is “The Role of the White House in R&D Budgeting” and seeks to assess the role of White House OSTP staffers in priority setting and budgeting in federal research and development activities. My interest in technology policy and familiarity with OSTP is based on work experience at the MIT Washington, DC Office and the IDA Science and Technology Policy Institute in policy analysis positions. The interview questions I ask will be related to: (1) Your job functions while working at OSTP; (2) Presidential R&D priorities; and (3) Your interaction with actors in the budgeting process. Would you be available during [time period] to be interviewed for an hour?

The battery of questions that I asked OSTP staffers and that served as a model for the modified set of questions I asked OMB staff members and agency officials are set out below. The ensuing section explains the reasoning behind these questions and how the answers map back onto my analysis.

Please describe your job role while working at OSTP:

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<sup>2</sup> I came into contact with science and technology policy professionals during internships at the MIT Washington Office, the IDA Science and Technology Policy Institute, and Booz Allen Hamilton; as well as in my capacity as student coordinator of the MIT-DC Summer Internship Program where I organized seminars with professionals similar to the interview subjects on behalf of undergraduate MIT science and engineering students.



What was your background before OSTP?

How did your background before OSTP relate to your work at OSTP?

How were you brought into your job at OSTP?

Which part of OSTP did you operate within?

What did that part of OSTP try to do while you worked there?

What federal agencies did you interact with for your job?

Who did you report to within OSTP?

What major programs or initiatives did you work on?

How did you start working on a given program or initiative?

What role did you have in the program?

Who did you work with on the program?

What was a typical day like at OSTP?

What was the best/worst part of your job?

Who did you spend the most time working with?

What did you spend the most time working on?

Is there anything else that we didn't talk about yet that could help me understand at a general level what your job was like as an OSTP staffer?

Please describe your interactions with other actors in the budgeting process.

Please describe your interactions with OMB staffers.

How often did you interact with OMB staffers?

For what reasons might you interact with OMB staffers?

How do you think OMB staffers would describe their job?

Do you think you had different motivations than OMB staffers?

Please describe your interactions with agency officials.

Could you list some reasons that you would contact or be contacted by an agency official?

Could you rank how common each of those might be?

Could you describe the types of conversations you might have with agency officials?

Could you rank how common each of those might be?

What federal agencies did you interact with during the budget process?

Were you assigned to one or many agencies?

What role did you play in the development of an agency's initial budget proposal?

Did you advocate for any specific programs within a single agency?

Did you advocate against any specific programs within a single agency?

Did you put agency officials in touch with other science and technology community stakeholders?

To what extent was your advice political or technical when dealing with an R&D budget decision?

Please help characterize your role in the budget process.

Did you ever add or suggest large programs to agency R&D budgets?

For what reasons did you do so?

How did you go about doing this?

Were you successful?

Did you ever add or suggest small programs to agency R&D budgets?

For what reasons did you do so?

How did you go about doing this?

Were you successful?

Did you ever try to kill a program from an agency's R&D budget?

For what reasons did you do so?

How did you go about doing this?

Were you successful?

Did you ever try to consolidate a program from an agency's R&D budget with another?

For what reasons did you do so?

How did you go about doing this?

Were you successful?

Did you ever try to modify an existing program from an agency's R&D budget?

For what reasons did you do so?

How did you go about doing this?

Were you successful?

Did you ever try to create talking points about an agency's R&D budget for the president?

Please tell me which of these informed talking points the (most/least):

- Big additions
- Small additions
- Existing programs
- Eliminated redundancies
- Priority driven modifications

What logic did you apply in selecting these talking points?

Of the budget-related activities we've discussed, which do you think is the most important? What about the least important?

How did you interact with presidential priorities while working at OSTP?

How did you feel that priorities were set for R&D?

Could you describe how R&D priorities are determined?

What factors do you think are considered when setting R&D priorities?

Who do you think sets priorities for R&D budgets?

Could you describe the relative importance of the actors you named in that process?

How was information about priorities communicated to you?

Could you point me to any documents other than the annual budget guidance that has information about priorities?

How did you communicate priority information to others?

How important do you think that setting R&D priorities is for budgeting?

How difficult do you think setting R&D priorities is for those involved?

How did you interpret and apply presidential priorities?

How important were R&D priorities for your work activities?

Could you describe R&D priorities that most affected your job functions?

Besides explicitly stated R&D priorities, what other types of information did you use to inform your actions in your job?

How often did you make reference to presidential priorities during your work?

What factors might make you pay more or less attention to an established priority?

Could you distinguish between the most and least important established priorities during your time at OSTP?

Who else do you think I should talk to for my research?

Would you be willing to do one additional follow-up interview, if necessary, to clarify anything we've discussed?

The first set of questions focused on building a rapport with the interview subject while gathering background knowledge on their career. These questions helped to set the stage for the questions that followed, while also starting to gather general knowledge on how the interviewee viewed their role at the OSTP. A central goal of this set of questions was to understand what kind of pre-existing experiences the individuals brought to their work, as it may have impacted answers by the interviewee provided to the rest of my questions or revealed recruitment differences across individuals which impact how I might have interpreted their day-to-day actions. Additionally, answers to these questions developed an understanding of the individuals' location within the organizational structure of OSTP and helped to generate knowledge about divisions of labor within OSTP over time.

The next set of questions focused on the presidential priority process. I asked these individuals about how priorities are set for the R&D portfolio at a high level and how that process actually works. This allowed me to support the data collection of the R&D budget priority memoranda issued annually by OMB and OSTP, while also learning about how the staffers view presidential priorities and how it should impact their job functions. By asking about actors in the priority setting process, I also ensured a comprehensive picture was developed of the actors in both ends of the priority setting and budget processes. This allowed me to analyze the relative influence of the actors and also how these staff members perceive them. By asking

about priorities at that point in the interview, I also hoped to prime the subjects to mention possible programs or initiatives that they performed work on during their tenure that match up to presidential priorities which I had already reviewed myself. I used the programs they discussed at this point in the interview as framing for questions later. This was done in the hopes that I could link up specific priorities with their work to evaluate the role they played between the two endpoints of the budgeting process.

After asking about the priority setting process to collect data on my explanatory variable, I moved to asking about the interactions of the interviewees between the other actors during budgeting. The questions sought responses with details about the range of interactions the individual might have with these actors. An example of this would be if the interviewee describes a list of non-budgetary actions, then I might be able to conclude that for this person a strong budgetary role might not exist or might be relatively less important than others. If the interviewee suggested items that directly apply to the budget process and fit into my framework than that was obviously preferable. Besides just how much of their interaction composed of budget-related activities, answers to this might also have helped explain what types of budget interactions were occurring and which types were most central. Later questions accessed the content of these conversations rather than the topical content by asking for qualifying descriptions, like whether the actions were more political than technical in nature, or if they thought about other parts of the science and technology community in making choices.

The final set of questions in the interview guide directly asked about possible actions that I believe OSTP staffers might have taken during the budget process. These questions were generated from the central theoretical framework detailing that these staffers could be performing adding, deleting, modifying, or packaging activities in the budget process, each of

which, depending on the explanations given by the interviewees, could have validated theories about OSTP as a political organization. The goal with these questions was to have interviewees provide examples in which they performed such an action and contextualize these examples for me. Their characterization of the examples given was instrumental in interpreting year-to-year changes in the president's budget request and flagging items for follow-up with other interviewees in the time period and policy sub-domain. Potentially, the interviewees might have suggested which activities they believe are performed by OSTP to validate a theory of OSTP's role in the budgeting process. At worst, these individuals would have been able to suggest activities ones not well incorporated by my framework. If they opposed the question framework but did not adequately suggest other types of actions then I would be able to conclude that, at least from the perspective of that one person, they did not play a significant budgetary role.

The framework developed in Chapter I serves two purposes – to (1) generate testable hypothesis to collect interview data around and to (2) act as a tool for analyzing OSTP's role against a range of potential theories. I use the framework to build supporting arguments from the interview data for each potential role and then evaluate the relative strength of these arguments in order to create findings as an output from the research process. For each of the boxes in my theoretical framework, I hoped to find not only compelling evidence of some activities but also the prioritization of one activity over another. It is important to note that compelling evidence for one activity does not preclude the existence of other activities. The findings from the analysis were intended to create an understanding of the relative importance of these activities.

## CHAPTER V

### WHAT OSTP ACTUALLY DOES IN BUDGETING

Interviews captured OSTP behavior in R&D budgeting. Its behavior is presented in this Chapter and then employed to discuss the coordination role actually performed by the OSTP in S&T policy.

Table 1 shows the theoretical framework that drove the selection of interview questions. This framework links budget activity to the aforementioned coordinating role. The following are the tested activities set out by this framework, linked to their respective hypotheses about the OSTP's organizational role:

1. If the OSTP were 'adding' large, multi-agency programs, it would suggest the organization is attempting to act as a central coordinator.
2. If the OSTP were 'adding' small, single-agency programs, this would suggest that the OSTP is acting as an internal 'mole' or lobbyist for the agencies within the White House to support their internal missions.
3. If the OSTP were to 'delete' ineffective programs that were founded as the result of bad science or technological foundations, it would suggest that the OSTP is serving as an empowered assessor of knowledge in the budgeting process.
4. If instead the OSTP were to 'delete' redundancies rather than bad ideas, then the OSTP would be supervising efficiency in the dispersed R&D system, which would be a central coordinating action of the negative type.
5. Modification of existing budget activity conducted by the agencies and OMB would indicate that the OSTP is serving as a credible knowledge pipeline between budgeting and the scientific community.



6. Packaging behavior would indicate that the OSTP does little in budgeting because the agencies actually dominate what is funded and not funded.

Interview responses provided positive support for some of the theorized hypotheses of the OSTP behavior in budgeting, while disproving others. Thirteen of the total twenty-two interview subjects indicated that the OSTP does not engage in deletion. Findings for modification and packaging were mixed with eleven and nine respectively supporting those, but are also found by almost all of those as not central to OSTP behavior. Modification proved difficult to measure through interview questioning due to their high-level focus and how the interviewees responded with narratives of specific, programmatic expertise. Packaging activity does indeed occur, however, this most frequently occurred as a direct result of additive behavior. The creation of talking points in line with presidential priorities was shown to be equivalent with the packaging done by agencies in the budgeting process by twelve subjects. Additive behavior in the single-agency form is highly constrained, but does occur. Additive behavior in the multi-agency form also faces some constraints but occurs more frequently than single-agency addition. It is seen as a primary function of the OSTP.

When taken together, the comprehensive result of these findings proves the concept of limited responsive competence in OSTP budgeting behavior. OSTP coordination largely operates constructively rather than destructively. Though opportunities for policy entrepreneurship exist, these are restricted to those cases where the policy entrepreneur correctly identifies both the presidential and agency interests to place an initiative at the intersection. Other than these behaviors conducted by OSTP staff, the agency interests dominate the R&D budgeting process.

Deletion as an activity of the OSTP staff in budgeting surprisingly did not find adequate

support. Three refused to discuss deletion as something that the OSTP does at all, while six others suggested that deletion occurs only within the R&D budgets. These six subjects put forth the view that if the OSTP tried to propose cuts in programs under the purview of others in order to fund its own programming, then it might face immediate and unwanted political backlash that would be harmful in the net to its activities. These individuals also pointed out that in doing so, their non-science agency counterparts whose R&D funds are small as a percentage of total agency expenditures could suffer top-line funding blow-back from their higher-ups as a result of such OSTP actions. According to one of these subjects, OSTP is not looking at individual line items, but rather helping navigate tradeoffs between high-level priorities.<sup>3</sup> Another group of interviewees, three of the six, clearly stated that every addition that is made requires a proposal of deletion in order to maintain OSTP's internal credibility with OMB counterparts. Their view is that no matter what other interview subjects would indicate, this is a 'fact of life' in dealing with OMB. Not pushing for cuts within these budgets may erode the credibility of OSTP for other policy inputs.<sup>4</sup> Although it was not possible to generalize across specific deletion proposals and participants were unwilling to make reference to specific deletions for political reasons, they insisted that such deletion exists. When asked about deletions of a technical nature due to their ability to leverage discipline-oriented expertise to identify 'bad science' in budgeting, an overwhelming seventeen interviewees either did not agree that such deletion was something the OSTP should be trying to perform or did not think it took the form of advocating against anything at the programmatic level. Of those seventeen, thirteen suggested that this type of coordinating activity is far more sophisticated and largely takes place as smaller modifications in

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<sup>3</sup> Interview Subject A

<sup>4</sup> Interview Subject R

what the agencies are doing, in the form of input provided throughout program activities, planning, and budgeting.

A negative finding in the deletion category supports the notion that the OSTP does not engage as a supervisor of the R&D system with an eye towards efficiency or as an empowered knowledge assessor in the budgeting process – neither of these activities were found. This implies that the OSTP is not placing downward pressure on any potential inefficiency inherent to the decentralized system. This type of downward pressure may exist elsewhere in the R&D budgeting environment, such as in Congressional appropriations or internal players in the agency management. A consequence is also that agency officials do not necessarily have to fear the OSTP as much as other actors in the budgeting process. This may erode influence from other attempted activities that the OSTP pursues that rely on fear, or it may make the agencies more likely to rely on the OSTP for a more positive-type of engagement. In fact, the OSTP does not perform the most negative aspect that a coordinator must perform. Its coordination of the entire R&D system seems to be incomplete, at least when considered in isolation to other actors.

In regards to how much the agencies are packaging their budgets to fit presidential priorities, nine responses indicated positively that this occurs; however, three point out that it is difficult to estimate how much and whether or not it makes a significant impact in comparison to the counter-factual if the priority had not been stated. By considering the responses altogether, the conclusion is that packaging is not an intentional behavior of OSTP, but rather occurs as a result of other activities, namely addition. In response to these questions, interviewees almost always, sixteen of twenty, reverted to framing their answers in reference to the multi-agency initiatives, where presidential priorities are seen to be most in play.

The relationship between the stated presidential priorities and each agency's budget

request is heterogeneous across agencies, with some priorities previously representing the interests of only a handful of agencies. These include items like health or climate change goals, which already correspond to some of the agency's budgeted programs and require no further packaging effort. Other priorities have broader applicability and arise from OSTP staff advocacy during their creation. One such area is the convergence of the life sciences and engineering which has garnered policy attention during the most recent budgeting cycles, as suggested by four interview subjects. This type of area is meant to spur broad corresponding budget activity because it can apply to many different accounts, these subjects report. Certainly agencies adopt the language of the priorities stated in the annual budget memo; however, a wide sample of agency interview subjects would be required to adequately address the realistic intent and whether or not the language is matched with meaningful changes in the budget plans and is outside the scope of this work. Additionally, as thirteen of the staffers stated, the annual R&D budget priority memo is an overly broad consensus document, the implication of which being that the OSTP enables agencies to package their activities to fit with the Administration's priorities rather than actually forcing this process through budgeting behavior. One subject summarized this view well by saying that "it was more like once the agencies know what the priority is likely to be... (They) could see how they could fit into that." Yet the subject also claimed that presidential R&D priorities are "sending (a) signal that it's a priority area for the scientists themselves."<sup>5</sup>

The more convincing interpretation, also supported by fifteen interview subjects, is that staffers reserve the right to use the memo as a political tool in dealing with OMB and the agencies during late budgeting stages to impact the issues that OSTP cares about the most. This

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<sup>5</sup> Interview Subject B

view is also supported by comments made in the interviews that suggest the timing of the priority memo, during the late spring and early summer, is too late to impact advanced budget planning.

In consideration of how much packaging activity occurs within large, multi-agency initiatives, thirteen subjects confirm that packaging occurs while simultaneously eleven push back on the relevance of the question. To these eleven subjects, almost all of the interviewees supporting the activity of packaging, the important question is whether or not the program garners support in future budget cycles as a result of the initial packaging. Some explained further that packaging is necessary to provide the flexible, venture capital-like funds to the programs which the OSTP proposes, and without packaging and re-purposing unused funds, the large, multi-agency addition would not be able to gain political momentum. Successful programs can generate sizable momentum, and once this momentum exists then agency officials running the programs in future years demand “ambitious growth” in budgets.<sup>6</sup>

Another line of questioning in regards to budgeting activity was the role of OSTP in creating talking points for the president as a result of budget interactions. Twelve responses indicate that the development of talking points was not sufficiently distinct conceptually from the packaging activity. Presidential speechmaking was certainly referenced as a useful tool for the OSTP to foster support for a program on the agenda: at least ten suggested speechmaking without prompt. Likewise, the President's political team might need science and technology to feature on President's speaking agenda. The President sometimes presents initiatives to the public, recent examples including in the Advanced Manufacturing, BRAIN, and Climate Change programs.<sup>7</sup> Surprisingly little support was found in the interviews for public relations oriented

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<sup>6</sup> Interview Subject T

<sup>7</sup> Interview Subject T

budget behavior by the OSTP, only five subjects acknowledged such an effort. An additional confounder is that R&D budgets, holding aside recent political controversies like climate change and social science research support, do not typically generate much explicitly partisan debate and thus such a public relations effort may not be necessary for the Administration to include R&D budgets in the front and center of its political speaking agenda.

The weak findings for the packaging and talking points function runs counter to the intuition expected by a lack of deletion. A strong finding for packaging activity would have suggested that agency officials operate solely on their standard operating procedures and in pursuit of their individual mission interests; while the OSTP act as if it has effective influence on behalf of the president's priorities. Instead, packaging only seems to occur consistently as a result of additive failures by the OSTP, or as a phenomenon in which agency officials try to appear more desirable as funding recipients towards OMB and Congressional appropriators. The contrasting implications of responses for these activities would indicate that the OSTP does have influence in R&D budgeting; however, this influence is technically nuanced, and more likely of a constructive nature rather than a destructive one.

Some support was found for modification with eleven confirming the activity, yet review of discussions indicated that this behavior is unable to be substantiated at a high level due to the need for specific programmatic information, which is difficult to compare across subjects. The interview subjects reported levels of deep engagement in the programs within their own area of expertise under their purview while at the OSTP. Of the interview subjects, ten of the twenty worked in positions using their topical expertise rather than in general areas of purview. The rest maintained positions as high-level political appointees across the Administrations covered by the subjects. This level of topical engagement included collaboration on white papers, working

directly with academia in a given scientific discipline, talking over implementation details with agency officials, running summits with an entire policy community, and other related activities. The modification behavior as described by subjects is not truly a budgeting behavior, but rather a more general coordinating function based on the OSTP's broad set of expertise that can be harnessed toward the relevant agency programs. Programs that OSTP staff attempt to modify are those for which OSTP staff members have been hired directly, given their individual expertise, to interrogate. This finding reconciles with reports that deletion does not occur, because interviewees claimed that the coordination that the OSTP performs is far more nuanced than the ousting of specific programs. Given a finding that deletion does not necessarily occur, the modification function would be the logical alternative with the potential for destruction in the budgeting process; however, it is apparently rooted solely in the science and technology expertise of the exact OSTP staff members most likely to be favorable towards those programs.

This finding in regards to modification, though it lies slightly outside the realm of budgeting actions, has serious implications for the role that the OSTP fills in the R&D system. It suggests that the OSTP's management of the R&D system has the capacity for nuance. Yet, the OSTP's staff is limited by its own set of technical expertise. Since it is small in comparison to the agencies, this would suggest that whom the OSTP is hiring is highly important to understanding their actions. Discussion with subjects intimately involved in the Clinton, Bush, and Obama transition teams suggested that the OSTP selectively hires individuals based on their policy track record at specific agencies. These hires are referred to as "hot-shots" in specific disciplines that match the priorities of the Administration, as the decision to hire a given person

will result from the actions that the OSTP decides it wants to perform.<sup>8</sup> The result is that the OSTP does indeed harness what would be considered responsive competence for the President. The primary concerns of the President not only receive the most attention, but the OSTP also captures the best staff in those areas from their home agencies to work to advance the President's interests.

All interviews support the conclusion that the OSTP does engage in some amount of small, single-agency additive behavior in budgeting; however, this behavior is highly limited in a number of ways. First, the input that the OSTP has in the process is limited by its staff's ability to develop relationships with the OMB. The OSTP provides support to federal agency employees in presenting the scientific or technological case to the OMB in order to justify any given budget request. Without making a convincing additive case to the OMB, the R&D budgets within any given agency would typically expect a reduction that the other competing top-line considerations that an OMB staff member must face. The OSTP provides input into these justifications and later converses with the OMB during the pass-back process. This input is not structurally ensured and sometimes can be rather difficult for an OSTP staff member to obtain the relevant data. If OSTP is not able to convince an agency to include an item in their budget prior to its submission to OMB, then it becomes very difficult for them to convince them to include it at the pass-back stage.<sup>9</sup> A few interviewees complained that the OMB does not go to any great lengths to provide them with the aforementioned data. One reported that it is frowned upon by OMB when agencies call up the OSTP elevator."<sup>10</sup> Thus, the OSTP is limited in its ability to advocate for larger R&D budgets within a single agency because in doing so it has the potential to erode its influence in

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<sup>8</sup> Interview Subject K

<sup>9</sup> Interview Subject R

<sup>10</sup> Interview Subject A



the White House if it cannot credibly link that budget advocacy to a presidential interest. This limitation is also supported historically by certain Administrations' distrust of the Science Advisor on similar grounds.

The OSTP's influence relies on proximity to the President and the ability of the Science Advisor to escalate if necessary conflicts at lower levels up to the senior staff level. If the OSTP is seen as engaging in additive activity for all R&D budgets without offering proper justification, the office places its credibility as an agent of the president's interests at risk. The only exception to this would be if the Administration has explicitly stated higher overall R&D budgets as a primary interest. Such activity has the potential to induce heightened political opposition due to aggravating more politically savvy cabinet secretaries and their budgeting teams.

Nearly all interview subjects indicate that OSTP's single agency influence is small when the target agency is large. This effect is closely related to the OMB's capacity to manage the budgets of the agencies as well. The OMB does not have nearly enough resources to provide the same attention to an agency as large as the DOD or the HHS as it might an agency like the NSF. This effect becomes more pronounced when considering that the smaller agencies have also enjoyed historical connections with the OSTP, as the NSF and NASA have done. A final limitation is the availability of 'new money' on a year-to-year basis. Agencies with a heavier basic research focus provide a larger portion of their funds through revolving grant programs. Due to the expiration of these grants on a fixed timetable, new money becomes available annually that the agency may allocate at its and Congress's discretion. Additive behavior is easier using such funds in comparison to additive behavior requiring a reallocation from sources outside the existing R&D budget of a given agency. This distinction concerning 'new money' does not imply that the additive behavior violates peer-review, only that the discipline area at

which the funds are focused can be more easily manipulated by OSTP efforts.

Large, multi-agency additive behavior is the area in which the most 'policy entrepreneurship' is performed by the staff. Nine OSTP staffers, a surprisingly high number, recognize and use this term frequently in interviews as a frame by which they describe their job function. This type of activity as a potential role began during the Clinton Administration due to the successes of the National Nanotechnology Initiative and has been replicated in a number of programs 'spun up' since then. Modern examples include the National Network of Manufacturing Institutes and the BRAIN Initiative. Congressional support for certain types of research may make certain types of initiatives more likely, as with Alzheimer's research.<sup>11</sup>

Multi-agency initiatives are intended either to help agencies align their resources in cross-cutting technology areas that some of the agencies are already investing in, or to spur investment in technology areas that are systemically important to the nation's technological and economic progress as a whole but lie not in the lane of any single agency. OSTP staffers do not originate the ideas for these initiatives; however, they do in fact crystallize the ideas for them through their broad engagement with the office's many constituent scientific communities. This particular behavior takes on a highly fluid form in any given budget cycle, but the general process is to (1) host a convening workshop concerning the technological area, (2) build both a budget and technological case for a potential initiative (often by linking it to its economic impacts), and (3) convince agency decision-makers and OMB staff to support the initiative in present and future budget cycles. Sometimes a (4) final occasional step is to create an official coordinating body for the initiative, which is typically hosted by one of the agencies. It is more likely to occur in Democratic Administrations but also occurs in Republican Administrations to a lesser extent.

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<sup>11</sup> Interview Subject A

The variation in this behavior between political parties is rooted in a difference of interpretations about what type of coordination activities are appropriate for a White House office to perform. Interviewees who worked in Republican Administrations did not necessarily believe that proposing many initiatives was a valuable task for OSTP to be performing, and had a much more nuanced impression of what coordination should entail, with particular attention to maximizing the utilization of R&D facilities and sustainability of budget growth.<sup>12</sup>

The successful multi-agency additions are those that fit the following two criteria: (1) the OSTP is able to link the initiative to presidential priorities as a way to gain support for the initiative, and (2) the required potential contribution for an agency to participate in the initiative is seen as beneficial towards fulfilling the agency mission. The latter point is crucial. If an agency does not think the initiative sufficiently resides in its own 'wheel-house,' making the contribution worthwhile, then it will not agree to contribute the necessary, sizable additional funds at the outset. Failed attempts at large, multi-agency additions may result in “initiative fatigue.”<sup>13</sup> It may also make it less likely for the OMB to support the initiative in that fiscal year’s budget request.

Despite the positive finding that addition occurs in both cases, the limits on both indicate that the OSTP falls short of providing the coordination that might occur in a centrally managed system (such as the OMB or the National Security Council staff). The requirements for small, single-agency addition are so great that it would be hard to conclude that this behavior is important or central to their impact on budgets. This finding dispels the notion that the detailees from the agencies who work at the OSTP are actually internal lobbyists for their home agencies,

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<sup>12</sup> Interview Subjects O and Q

<sup>13</sup> Interview Subject A

or ‘operational agency moles.’ The political environment in which the OSTP engages is highly attuned against such a tendency, though it may have occurred historically at the level of the Science Advisor himself.

The findings for the large, multi-agency additive behavior, on the other hand, are a bit more promising. The limits of large addition are rooted in agency interests and presidential priorities. If an agency does not like a proposed multi-agency program, it would not feel much pressure to contribute funds towards that program. The president’s agents in the OSTP do not propose programs that are inconsistent with the president’s priorities. In other words, the OSTP’s central role in R&D budgeting is to provide an attempt at responsive competence to the President. This is done by cherry-picking the individuals from the agencies with the most relevant and respected technical expertise to the areas, which the Administration cares about. In dealing with the OMB, the OSTP must harness technical arguments to convince them of the merits of both small and large additions. As another White House entity is making the actual decision, it is clear that the OSTP’s input is more limited, and that this limitation is mostly rooted in the question they are expected to be able to answer. Ultimately, the OSTP is not asked by the OMB to make a tradeoff between R&D budget decisions, the OSTP is asked to make the science and technology case for the budget proposals of others.

## CHAPTER VI

### INHIBITED PRESIDENTIAL CONTROL OVER S&T POLICY

The White House OSTP is a unique organization within the EOP. OSTP staff members harness science and technology expertise, while simultaneously serving as operatives of the president's political agenda. However, the coordination they provide is far less centralized than that of other EOP agencies, despite careful selection of the OSTP staff members based on presidential priorities. The OSTP's primary role in budgeting is to find ways to add to the budgets of willing agencies whose work can reflect presidential priorities.

Policy entrepreneurship is not only active within the OSTP, but also many staff members perform it conscientiously. Nevertheless, despite the presence of this entrepreneurial behavior, the type of OSTP involvement in budgeting is almost entirely of a constructive nature. It is politically targeted through structural mechanisms, such as through the interagency hiring process: OSTP takes those who exactly fit the Administration's agenda and also happen to be the best available people existing in the bureaucracy who could do so.

Despite this, there are severe limitations to OSTP's budget input. Agency interests largely dominate the relationship between OSTP and the bureaucracy. Whether or not the presidential agenda aligns with an agency interest determines whether or not OSTP is able to add the programs it wants to those budgets. Many attempts at policy entrepreneurship do fall flat on the bureaucracy. Agency interests seem to be the dominant contribution to determining that outer-bound, with OMB's top-line budget considerations being the second most powerful one. OSTP has limited staff resources, and must prioritize areas of interest for centralized coordination. Therefore, only the areas squarely on the presidential agenda get proper attention, though some historical evidence suggests that this was never any different when the OMB exercised primary

control over the R&D enterprise. Finally, OSTP does not have much capacity to institute downward pressure on the budget values in the bureaucracy, nor does it seem to really want to do so. This destructive capacity lies elsewhere, and this reality may ultimately erode OSTP's ability to create impact in other ways.

The 'qualified' nature of OSTP responsive competence is related to the role of the OMB. Although the OMB was not the focus of this research, it is clear that OSTP provides technical uplift to OMB decision-making capabilities. At the same time, OSTP's scientific expertise does not drive the bulk of the budgeting process for science and technology. This is concerning if one believes that centralized technical expertise is required to most effectively direct budgeting decisions within R&D activities.

In short, the White House OSTP does not itself provide true centralized coordination to the presidency for the entire R&D system. It has no statutory authority in R&D budgeting, operating instead on the basis of traditions such as the R&D Budget Priority Memoranda now institutionalized across multiple Administrations. A true central coordinator would need to include both constructive and destructive elements – that is, the ability to perform both cross-agency addition and deletion of budget items. True central coordination in R&D budgeting would also require a much larger number of staff members. It is unclear, though, if co-locating the constructive and destructive coordination abilities would be preferable, because it may leave coordination more susceptible to interference on political grounds. A policymaker's opinion on this structure is thus dependent on whether he or she would desire politically neutral or responsive competence.

OSTP does add meaningful value to the presidency in that it acts as a pipeline to the S&T community of the nation and the world. Presidential interests in S&T policy are informed and

influenced by national and international academic dialogues alike. Their staff members in the OSTP are aware of the cutting edge of their respective science and technology domains and leverage this expertise into their political roles at an EOP office. Policy entrepreneurship, though limited in ways already enumerated, is informed by the S&T community and executed only when presidential interests are convincingly at stake. The modern OSTP would not concern President Nixon nearly so much for its R&D coordination attempts, though President Nixon may indeed still concern the modern OSTP.

The most puzzling finding that emerges from interviews is that the OSTP staff performs additive policy entrepreneurship but does not exercise similar policy entrepreneurship in deletion. The explanation lies in the development of epistemic community norms for policy behavior in science policy participation. People who become S&T policymakers come from particular backgrounds and share common normative beliefs about the utility of R&D funding for future human welfare. They also employ common evaluation rules when interpreting R&D budget trade-offs. This leads them, for the most part, not to pursue deletion because the S&T policy community believes in the funding of redundancies and supporting the S&T enterprise as much as possible. Advocating for tradeoffs between preferred and out of favor R&D budget accounts would uncomfortably violate the common operating standards of the OSTP staff as it is built upon an epistemic community in science policy.

The OSTP provides additive input under significant constraints. Agency interests and presidential priorities must align in order for the OSTP staff to exercise any meaningful impact on budgets. Not surprisingly, limitations to OSTP influence are almost entirely structural because their input is entirely determined by how much the OMB pays attention to its S&T input as a decision tool for the unavoidable budgetary trade-offs within and across agency budgets. The

results of my qualitative work assessing OSTP staff roles within the budgeting process complement my quantitative attempt to measure the potential influence that a presidential Administration may wield in any given budget cycle. Presidential agendas do in fact matter.

The personal relationship between the President's Science Advisor and the President and his inner circle is influential as a confounding variable to OSTP R&D coordination across Administrations. This occurs in spite of a research design intended to study the OSTP as an institution. The power of this relationship includes both an opportunity to shape the presidential agenda as well as effectuate policy change in the face of parochial interests. A strong relationship thus may generate an increase in the relative value of technical expertise within the policy decision-making process. Yet if in order to cultivate this relationship the Science Advisor must compromise the evaluative norms of the S&T policy epistemic community of which he is a part, then he may also undergo considerable criticism for his actions. The unique demands of being a Science 'Advisor' may place successful political input directly at odds with beliefs formed on the basis of 'scientific' logic considered correct by the epistemic community. This tension, unlike any other position in the U.S. bureaucracy, implies that the OSTP's coordination is partially dependent on both institutional constraints, as well as the disjunction between the political beliefs of the President's constituencies and the S&T community.

The personal relationship is most influential in agenda-setting and policy coordination execution when the Science Advisor is willing to escalate conflicts at the cabinet level. This requires significant political discretion on the part of the Science Advisor as repeated escalations likely suffer diminishing returns. Only so many S&T issues will be considered worthy of presidential or cabinet attention.



The White House OSTP is constrained by all the well-documented obstacles that a bureaucratic pessimist might reasonably expect it to face, and then some additional ones arising from the inclusion of technical expertise. Yet nevertheless, multi-agency additions perpetuated by OSTP policy entrepreneurship have generated significant budget funding and successful technological outputs during the most recent Presidential Administrations. Although this trend has not yet materialized across enough Administrations to conclude that it will be a permanent fixture of R&D coordination, a future Science Advisor might seek to focus on such actions in order to maximize the OSTP's impact on the nation's R&D enterprise.

Ultimately, the design of the OSTP represents a choice that must balance the simultaneous inclusion of political responsiveness and technical expertise into the S&T policymaking process. This choice is not an easy one, because it requires consideration of normative trade-offs as well as the roles performed by all of the other actors in the S&T policy arena. Holding judgments aside, a number of actions are available to manipulate the balance.

If policymakers wish to obtain further political responsiveness from the OSTP, they should consider the following changes to the institution:

1. Increase the size of the OSTP relative to the OMB
2. Rely on more political appointees as opposed to existing agency officials and university researchers
3. Bestow the OSTP with additional, formal powers in R&D budgeting
4. Select a Science Advisor with a close, personal relationship with the Administration
5. Engage Congress more intimately in the formation of S&T policy

On the other hand, if policymakers desire a focus on high-quality, scientific advice, they should instead:

1. Rely on more university researchers and existing agency officials rather than political appointees
2. Focus on utilizing the convening power to obtain technical input from the S&T community on budget trade-offs and policy considerations
3. Commission independent, technical analyses to support advisory functions
4. Select a Science Advisor that is well-established in a constituent part of the scientific community

## Appendix A: List of Interview Subjects

Subjects are listed with the titles held for their most relevant positions discussed in their interviews. The Presidential Administration in which time period they held this role is identified in parentheses. Direct references to interview comments are withheld due to the terms of human subjects approval.

Robbie Barbero... Assistant Director, Biological Innovation (Obama)

Jennifer Bond... Senior International Policy Analyst (Bush I)

Daniel Correa... Senior Advisor for Innovation Policy (Obama)

Thomas Furhman... (Clinton)

Gerald Hane... Special Assistant for Policy and Plans for National Security & International Affairs (Bush II)

David Hart... Assistant Director for Innovation Policy (Obama)

Daniel Hastings... U.S. Air Force Chief Scientist (Clinton)

Mike Holland... Senior Policy Analyst (Bush II)

Tom Kalil... Deputy Director for Technology and Innovation (Clinton/Obama)

Henry Kelly... Principal Associate Director for Environment and Energy (Obama)

Jim Kohlenberger... Chief of Staff, Transition Team (Obama); Senior Domestic Policy Advisor to Vice President Gore (Clinton)

Kei Koizumi... Assistant Director, Federal Research and Development (Obama)

Neil Lane... Science Advisor to President Clinton (Clinton)

Alan Leshner... President, American Association for the Advancement of Science

Mark Lewis... Director, IDA Science and Technology Policy Institute (STPI)

Kathie Olsen... Deputy Director for Science (Bush II)

Mayra Montrose... Program Manager of the Presidential National Medal of Science; Executive Secretary of the Committee on Science of the President's National Science and Technology Council (NSTC) (Obama)

Richard Russell... Deputy Director for Technology (Bush II)

Arun Seraphin... Assistant Director for Defense Programs (Obama)

Belinda Seto... Deputy Director of the National Eye Institute, NIH (Obama)

Reed Skaggs... Staff Director, National Security & International Affairs Division (Obama)

Cyrus Wadia... Assistant Director, Clean Energy & Materials R&D (Obama)

## Appendix B: List of U.S. Federal R&amp;D Funding Agencies

2015 Enacted Budget Authority for R&D activities (dollar amounts in millions)<sup>14</sup>

Defense	67,451
Health and Human Services	30,475
Energy	11,736
NASA	12,145
National Science Foundation	5,999
Agriculture	2,446
Commerce	1,5090
Veterans Affairs	1,090
Transportation	900
Interior	904
Patient-Centered Outcomes Research Trust Fund	506
Homeland Security	1,032
Environmental Protection Agency	523
Education	333
Smithsonian Institution	245
Other	758

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<sup>14</sup> Available on the OSTP website at the following link:  
<https://www.whitehouse.gov/sites/default/files/microsites/ostp/rdbudgetchapter2016.pdf>

## Appendix C: Supporting Analyses

Table 4

VARIABLES	(1) log_funding	(2) log_funding	(3) log_funding	(4) log_funding
L.log_funding	0.87*** (0.022)	0.87*** (0.022)	0.88*** (0.022)	0.87*** (0.022)
P2	0.046*** (0.014)	0.051*** (0.014)	0.052*** (0.015)	0.067*** (0.016)
P3	0.050*** (0.016)	0.057*** (0.017)	0.056*** (0.017)	0.079*** (0.020)
congress_party		-0.021 (0.014)	-0.020 (0.015)	-0.030* (0.015)
pres_party			0.0024 (0.012)	-0.0044 (0.013)
debtovergdp				-0.0014** (0.00066)
Constant	0.99*** (0.17)	0.99*** (0.17)	0.98*** (0.17)	1.06*** (0.18)
Observations	442	442	442	442
R-squared	0.99	0.99	0.99	0.99

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5

VARIABLES	(1) log_funding	(2) log_funding	(3) log_funding	(4) log_funding
L.log_funding	0.87*** (0.022)	0.87*** (0.022)	0.87*** (0.022)	0.86*** (0.022)
P2	0.064*** (0.015)	0.069*** (0.016)	0.069*** (0.016)	0.085*** (0.018)
P3	0.060*** (0.017)	0.066*** (0.018)	0.066*** (0.018)	0.089*** (0.021)
defXP2	-0.099*** (0.036)	-0.099*** (0.036)	-0.098*** (0.036)	-0.099*** (0.036)
defXP3	-0.040 (0.037)	-0.039 (0.037)	-0.039 (0.037)	-0.040 (0.037)
congress_party		-0.020 (0.014)	-0.020 (0.014)	-0.030* (0.015)
pres_party			0.0017 (0.012)	-0.0052 (0.013)
debtovergdp				-0.0014** (0.00065)
Constant	1.1*** (0.17)	1.0*** (0.17)	1.0*** (0.18)	1.1*** (0.18)
Observations	442	442	442	442
R-squared	0.99	0.99	0.99	0.99

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 6

VARIABLES	(1) log_funding	(2) log_funding	(3) log_funding	(4) log_funding
L.log_funding	0.87*** (0.022)	0.87*** (0.022)	0.87*** (0.022)	0.87*** (0.022)
pres_carter	0.0015 (0.037)	-0.0068 (0.038)	-0.0079 (0.038)	-0.0095 (0.038)
pres_reagan	-0.029 (0.035)	-0.058 (0.039)	-0.055 (0.039)	-0.044 (0.043)
pres_bush1	0.048 (0.039)	0.00013 (0.048)	-0.0057 (0.048)	0.0096 (0.053)
pres_clinton	0.025 (0.036)	-0.045 (0.054)	-0.040 (0.054)	-0.021 (0.062)
pres_bush2	0.037 (0.036)	-0.055 (0.065)	-0.057 (0.065)	-0.042 (0.068)
pres_obama	0.0074 (0.039)	-0.11 (0.078)	-0.11 (0.078)	-0.073 (0.099)
counter		0.0034* (0.0020)	0.0038* (0.0021)	0.0039* (0.0021)
congress_party			-0.017 (0.018)	-0.027 (0.023)
debtovergdp				-0.00096 (0.0015)
Constant	1.0*** (0.18)	1.0*** (0.18)	1.0*** (0.18)	1.1*** (0.18)
Observations	442	442	442	442
R-squared	0.99	0.99	0.99	0.99

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 7

VARIABLES	(1) log_funding	(2) log_funding	(3) log_funding	(4) log_funding
L.log_funding	0.87*** (0.022)	0.86*** (0.023)	0.86*** (0.023)	0.86*** (0.023)
pres_carter	0.023 (0.040)	0.014 (0.040)	0.013 (0.040)	0.012 (0.040)
pres_reagan	-0.016 (0.038)	-0.045 (0.042)	-0.042 (0.042)	-0.030 (0.050)
pres_bush1	0.077* (0.041)	0.030 (0.050)	0.024 (0.050)	0.040 (0.055)
pres_clinton	0.058 (0.038)	-0.0095 (0.055)	-0.0050 (0.055)	0.016 (0.063)
pres_bush2	0.050 (0.038)	-0.039 (0.065)	-0.041 (0.065)	-0.025 (0.069)
pres_obama	0.064 (0.042)	-0.048 (0.078)	-0.054 (0.078)	-0.012 (0.098)
defXpres_carter	-0.12 (0.098)	-0.12 (0.098)	-0.12 (0.098)	-0.12 (0.098)
defXpres_reagan	-0.078 (0.093)	-0.077 (0.093)	-0.077 (0.093)	-0.077 (0.093)
defXpres_bush1	-0.17* (0.10)	-0.17* (0.10)	-0.17* (0.10)	-0.17* (0.10)
defXpres_clinton	-0.19** (0.093)	-0.19** (0.093)	-0.19** (0.093)	-0.19** (0.093)
defXpres_bush2	-0.083 (0.092)	-0.083 (0.092)	-0.083 (0.092)	-0.083 (0.092)
defXpres_obama	-0.27*** (0.099)	-0.27*** (0.098)	-0.27*** (0.098)	-0.27*** (0.098)
counter		0.0033* (0.020)	0.0038* (0.0020)	0.0038* (0.0020)
congress_party			-0.018 (0.017)	-0.027 (0.022)
debttovergd				-0.00010 (0.0014)
Constant	1.1*** (0.17)	1.1*** (0.18)	1.1*** (0.18)	1.1*** (0.18)
Observations	442	442	442	442
R-squared	0.99	0.99	0.99	0.99

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1



The first model examines period effects on total R&D spending. The second model is designed to capture the period effects on defense and non-defense R&D spending. In both cases, the dependent variable is the log of an agency's yearly funding. A fixed effects regression, absorbing the effect of each individual federal agency, was used to measure the average of effects across agencies. The independent variables included in the regressions were the one-year lagged, log of the agency's yearly funding, period 2 and 3 dummy variables, and in Model 2 interaction terms between the period dummy variables and an indicator accounting for defense agencies. Subsequent iterations of both models add in control variables one-by-one in order to capture swings in substantive variables for sensitivity analyses. The control variables added to the fixed effects regressions were the party control of congress, the party affiliation of the president, and the federal debt liability as a percentage of annual GDP.

The third model in the analysis is designed to capture the effects of individual Presidential Administrations on total R&D spending. The fourth captures this effect instead against defense and non-defense R&D spending. Each presidential dummy variable is included except for the variable corresponding to President Ford's term, which acts as the baseline omitted value. Each of these dummy variables is then interacted with the dummy variable identifying the agency as defense or non-defense and included in the regression. The one-year lagged, log of the R&D spending is included to account for consistency in budget values. The partisan control of Congress is included as a control in order to make Models 3 and 4 as similarly controlled in comparison to Models 1 and 2 as possible, but presidential party affiliation could not be included because it may be linearly expressed by summing presidential dummy variables, which rendered the control redundant to the relationship of interest here. Federal debt as a percentage of GDP is likewise included in the same method across models.

The results of the first iteration of the Model 1 regression are presented in the first column of Table 4 and discussed here. Subsequent iterations are shown in columns two through four. The lagged, log value of funding is found to have a quite substantial effect on funding in the following fiscal year during the Cold War in agencies, with a coefficient of 0.873, as expected. A one percent increase in funding in the prior year causes a 0.873 percent increase in the present year, holding other variables constant. This coefficient is well beyond the 99 percent confidence level. The post-Cold War and War on Terror period effects are also both statistically significant beyond the 99 percent level, allowing for a separate interpretation for each of these time periods as a comparison against the reference period, the Cold War. In the post-Cold War period, the period effect yields a 4.60 percent increase in total funding for the average agency compared to the Cold War. Likewise in the War on Terror period, the period effect yields a 4.99 percent increase compared to the reference.

The second iteration of Model 1 yields effectively the same results after adding the party of congress as a control. The individual period effects actually grow slightly in both magnitude and significance. The party control of congress coefficient cannot be interpreted meaningfully because it does not meet any typical standards of statistical significance with a t value of 1.58.

The third iteration of Model 2 adds the party affiliation of the president in the present year into the regression. This control variable also is not significant, and the coefficient is virtually zero. Although little value was added to the regression by this iteration, the results remained stable regardless of the party identification of the president.

The fourth iteration of Model 1 incorporates the federal debt as a percentage of GDP into the regression. Similar to the other controls, this variable adds little value due to low statistical significance, but results remain stable throughout the model. Now, the control variable added in

the second iteration, party control of congress, has reached significance at the 90% confidence level, which although slightly weak, certainly is worthy of mention considering the potential relationships between congress and debt rhetoric in the budgeting process. The coefficients of the period effects have now grown to their largest values without sacrificing any significance.

The Standard Error of Regression (SER) for all of these iterations of Model 1 is 0.116; in-sample predictions miss observations by about 11.6 %. The R-squared value of 0.994 is artificially high due to the nature of the model – budgets are so heavily determined by the prior year's budget value that R-squared no longer is useful for comparison across iterations of the model or interpretation of the results motivating this analysis.

Model 2 results are presented in Table 5 above and the following discussion is based on the final iteration included in column 4. It is important to note that the explanatory power of Model 2 is restricted to comparison between the experiences of the average defense agency against the average non-defense agency, while preserving all other aspects of Model 1. The Model 2 lagged, log-funding coefficient remains stable in comparison to Model 1 but just slightly lower than 0.870 at 0.863. Control variables here also have similar values and significance to Model 1 controls.

Meanwhile, period specific values have grown substantially in both size and significance. Non-defense agencies on average experience 8.49 percent and 8.91 percent higher funding levels during the Post-Cold War and War on Terror periods compared to the Cold War reference period. On the other hand, the defense agencies in the Post-Cold War period receive 9.88 percent less than the non-defense group. Though Model 1 proves that the cohort as a whole is increasing in these two latter time periods, non-defense agencies demonstrate a significant budgeting advantage at the expense of defense agencies. This pattern is much weaker in the War

on Terror period, as the defense interaction term does not achieve any level of significance with a t value of 10.7. Defense agencies demonstrate a similar funding trend to non-defense agencies during this final period, though still may be at a slight disadvantage. Ultimately, Models 1 and 2 together prove that time periods drive changes in both the total R&D budgets and in some cases have the potential to modify the relative status of defense R&D.

The results of the Model 3 and 4 fixed effects regressions are listed in Tables 6 and 7 respectively. The coefficients produced by these regressions are much smaller than the coefficients of interest produced in Models 1 and 2. The lagged, log funding still demonstrates a similar relationship in both magnitude and significance, with an interpretation that a one percent increase in the prior year's funding causes a 0.871 percent increase in the present year's total funding. The counter variable, which is meant to capture general time trends not accounted for by the president dummy variables, is significant at the 90 percent confidence level and has a very small increasing effect on the average agency's R&D budget over time. A one-year increase in time leads to a positive 0.39 percentage point increase in funding for the average agency. There is no impact of Presidential Administrations on the average agency level of total R&D spending that is statistically significant. As an outer-bound, the results of Table 7 in column 1 would suggest that presidents may have at most a 4.8 percent impact on the total amount spent on R&D at the average agency during their term of office. Only the dummy variables in Model 4, accounting for the President George H.W. Bush, President Clinton, and President Obama, interacted with defense agencies, are statistically significant and worth interpreting. President George H.W. Bush induces a 16.8 percent drop in defense spending compared to non-defense spending during his term. President Clinton has a term effect of negative 19.1 percent against defense agency R&D budgets. Finally, President Obama's first term triggered a 26.9 percent

drop in defense R&D funding compared to the non-defense R&D funding baseline. Column 1 of Table 9 shows that presidents have the opportunity to influence budget trade-offs based on their own priorities at as much as 27.0 percent level during their terms, even in relatively large categories like defense. When accounting for all non-defense agencies, presidents had the opportunity to dictate up to a 7.67 percent shift in R&D funding.

These presidential term effects were consistently stable and significant including all controls: the counter variable, party control of congress, and federal debt as a percentage of GDP.

Besides interpreting the magnitude and significance of the coefficients in this regression, an additional step in the analysis for Models 3 and 4 is to determine if presidents generally have an effect on R&D budgets. A Chow test was performed following the Model 4 regression on the presidential dummy and defense interaction terms to check if the null hypothesis could be rejected. The test was successful – the null hypothesis can safely be rejected and it is fitting to conclude that presidents do each have a non-negligible effect on funding levels for the average defense agency budget compared to the average non-defense agency budget.<sup>15</sup>

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<sup>15</sup> The Chow test has a P-value of 0.0009 and there are 414 degrees of freedom.

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