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April 5, 2019

No Friends, No Foes: How Ideological Disparity in the Executive Branch Incentivizes Policy
Valence and Careerist Effort

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Political Science

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Abstract

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By Thomas Archibald

Ideology is at the center of political decision-making, and public administration is no exception. This paper seeks to uncover how ideological dynamics in the American Executive Branch affect careerist effort incentives and policy quality. Situated in the broader principal-agent literature, I develop a new game theoretical model of bureaucratic policymaking to explain ideological and policy valence decisions. I test the model empirically using ideological measurement techniques from the literature, which derive individual ideal point estimates from campaign contribution data. This new and innovative approach to ideal point estimation allows us to quantitatively test claims previously reserved for qualitative research.

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Acknowledgements

I want to thank Dr. Bolton for his assistance, patience, and infectious enthusiasm for the study of Executive Branch politics, my father for his selfless investment in my education and for instilling in me a deep love of learning, and my mother for her unyielding inspiration, encouragement, and wisdom.

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I. INTRODUCTION

“Morale has never been lower.” It was 2017 and Tony Reardon, the president of the National Treasury Employees Union, was expressing concerns about how bureaucrats were responding to the newly inaugurated Trump Administration.¹ Across the Executive Branch, disgruntled careerists made their opposition to the new President’s agenda crystal clear. Over 1,000 State Department employees signed a dissent cable in opposition to Executive Order #13769, the Administration’s controversial “travel ban,” which barred travel to and from several majority-Muslim countries. In response, White House Press Secretary Sean Spicer said of the bureaucrats, “they should either get with program or they can go.”² As a means of circumventing the new administration’s control over traditional means of communication, anonymous bureaucrats set up “Alt” or “Rogue” agency Twitter accounts to voice dissent from within.³ The account @altUSEPA, for instance, describes itself as “The Unofficial ‘Resistance’ team of the U.S. Environmental Protection Agency” and routinely criticizes the administration for its position on Climate Change and other environmental issues.

The several weeks of chaos following President Trump’s inauguration, driven substantially by policy disagreements between bureaucrats and the new President, was hardly an environment optimized for quality policymaking. However, even those opposed to the President acknowledged the value of policy debate and disagreement within the Executive Branch. During an interview with the New York Times, a State Department diplomat and a signatory of the EO

¹ Ba Tran, Andrew, and Lisa Rein. “How the Trump era is changing the Federal bureaucracy.” *The Washington Post*. 30 December 2017.

² Tracy, Abigail. “An anti-Trump resistance movement is growing within the US Government.” *Vanity Fair*. 1 February 2017.

³ Davis, Wynne. “It’s not just the Park Service: ‘Rogue’ Federal Twitter accounts multiply.” *NPR*. 27 January 2017.

#13769 dissent cable insisted “Policy dissent is in our culture. We even have awards for it.”

Disagreement is a natural part of any collective policymaking endeavor, but it follows naturally from the diplomats’ claim to ask, “how much disagreement is too much disagreement?” While policy dissent can improve policy outcomes by facilitating nuance and consensus building, it can also sabotage working relationships by breeding mistrust and ill-will.

The principal-agent problem is nothing new amongst scholars of the Executive Branch. However, newer research methods allow us to empirically answer questions that have typically been reserved for the theoretical realm. This paper seeks to uncover how, in the American federal bureaucracy, ideological disparity between politically appointed agency heads and the careerists they oversee affects agency performance. While this question is debated at length in the theoretical sphere by public administration scholars, empirical analyses are scarce in the existing literature. Using data from Adam Bonica’s Database on Ideology, Money in Politics, and Elections (DIME), I quantify the ideal points of individual bureaucrats, allowing intra-agency analysis of the preferences of particular actors. I operationalize agency performance using Program Assessment Ratings Tool (PART) scores, a George W. Bush era performance evaluation tool administered by the Office of Management and Budget.

The significance of this research to the literature is threefold. First, I seek to empirically test the assertions of a litany of public administration scholars, who offer a variety of theoretically-driven assertions regarding the optimal ideological composition of bureaucracies. Second, drawing on many existing themes in the literature, I propose a new theory of how ideological dynamics influence agency performance by understanding agency performance as a function of employee effort. I offer a unique set of theoretical predictions based on a game theoretical model of Executive Branch policymaking. Third, I add to the burgeoning literature

utilizing quantified ideological measures. While ideal point estimation presents substantial challenges for researchers, it has the potential to offer meaningful insight into questions that were previously difficult to study empirically. Bureaucratic capacity is a central feature of good governance. Inasmuch as this paper demonstrates how an agency's ideological composition maps onto its performance, this research may allow us to better understand how hiring and appointment decisions in the bureaucracy will affect the quality of the agency's work.

II. LITERATURE REVIEW

Bonica, Chen and Johnson's (2015) seminal work "Senate Gate Keeping, Presidential Staffing of 'Inferior Offices,' and the Ideological Composition of Appointments to the Public Bureaucracy" analyzes how appointee ideology affects presidential appointment decisions and, in the case of PAS⁴ appointees, senate confirmation outcomes. In the paper's conclusion, the authors note the lack of research on how appointee ideology interacts with the broader ideology of the agency to affect policy outcomes: "Our current research focuses solely on ideology and does not consider how ideology translates into policy outputs. To understand how ideology shapes policy outputs, future scholars will need to examine how appointee ideology interacts with the broader ideology of the agencies in which appointees work" (36-37). This paper seeks to fill that gap.

Waterman and Meier (1998) explain the principal-agent framework in terms of contracts. In the political realm, a principal contracts an agent to perform some sort of task, such as rulemaking, interpreting a statute, or conducting oversight. However, properly enforcing this contract is difficult. For states, punishing individuals for failing to fulfill their obligations is fairly straightforward. States can fine lawbreakers, imprison them, or otherwise deprive them of liberty. However, punishing political institutions for failing to meet their obligations is more complicated. The EPA, for instance, is teleologically different than an individual—it cannot be "imprisoned" and levying costly sanctions would impose externalities on the constituents it serves. Further complicating the matter, the US Government's system of separation of powers is such that the branches of government are designed to police each other. However, no actor has perfect coercive authority over another. Principal agent problems arise when political actors of

⁴ Presidentially Appointed, Senate-Confirmed. For a detailed explanation of the types of Presidential appointments to the bureaucracy, see Lewis (2008, Ch. 2).

this nature rely on one another to perform some function. Principals' lack of clear coercive power over their agents gives agents latitude to renege on their contractual commitments with limited fear of retribution. Thus, principal-agent relationships are characterized by a principal, armed with imperfect authority, attempting to coerce its agents into alignment with its interests. These agents, with interests of their own, desire to exact their own ideal outcomes while minimizing any costs imposed by their principal.

Due to its nature, bureaucratic administration is fraught with principal agent problems. It is useful for us to understand Congress, the President, and the Courts, all of whom retain some degree of authority over the bureaucracy, as political principals seeking to assert influence over the administrative state (Miller 2005). Given the bureaucracy's size and power, overseers who can successfully "tame the beast" stand to more easily and successfully exact their preferred policies. Scholars also understand intra-agency interactions through a principal-agent lens (see, e.g. Lewis 2008, McCubbins, Noll, and Weingast 1989; Moe 1982; Wood 1989). Generally speaking, a bureaucracy is comprised of high-ranking officials, who are, in most cases, politically appointed. These appointees delegate tasks to careerist employees who exact most of the agency's day to day operations. This relationship has all of the defining characteristics of a principal-agent problem. Principals oversee large, powerful swaths of careerists with diverse interests and motivations (Gailmard and Patty 2007; Prendergast 2007). As political representatives of the President, appointees have the difficult task of harnessing the power of the unwieldy bureaucratic rank-and-file in pursuit of the administrations' policy agenda (Gaertner and Gaertner 1983). Hierarchical power sharing, merit system safeguards, and information problems make coercing careerists into compliance with appointee policy priorities difficult. Additionally, turnover is high (Wood and Marchbanks 2008), and appointment ideology varies

substantially across administrations (Bonica, Chen, and Johnson 2015). Constant change makes establishing lasting organizational norms difficult. For its difficulty, this particularly acute iteration of the principal-agent problem presents interesting and consequential puzzles. Arrangements that even marginally increase a principal's ability to exact his ideal stand to substantially alter policy outcomes.

Ideology is ubiquitous across politics. It animates, to at least some extent, every relevant actor in American politics, including Congress (see, eg., Ansolabehere, Snyder, and Stewart 2001; Bonica 2013, Poole and Rosenthal 1985), the President (see, eg., Treier 2010), the Courts (see, eg., Martin and Quinn 2002; Schubert 1965; Segal and Cover 1989), and bureaucrats (see, eg., Epstein and O'Halloryn 1999; Lewis 2008; Prendergast 2007). Public administration scholars have invested significant time in writing about how ideology affects interactions between agency bureaucrats. A substantial portion of the literature emphasizes intra-agency preference homogeneity. Herbert Kaufman's (1960) oft cited case study on the US Forest Service lauded the agency's emphasis on organizational unity and ritualistic conformity. The success of the Forest Service, he argues, emanates from the agency's ability to recruit Forest Rangers with preferences similar to the agency's principals. The agency then further inculcates these values through a highly routinized training program designed primarily to cultivate shared norms. This organizational cohesiveness curbs the principal-agent problem by employing agents most likely to want to act in accordance with the preferences of the principal. William J. Resh (2015) analyzes organizational effectiveness through the prism of intra-agency trust. He holds that shared preferences foster trust between principals and agents. This trust leads bureaucrats to share more information with one another, communicate more effectively, and craft better policy. This organizational trust also makes principals, many of whom initially approach their

subordinates with skepticism, more open to delegating tasks across actors. Such an arrangement allows for a more efficient division of labor within the agency (Van den Steen 2010a, 2010b). Broader preference homogeneity also cuts down on transactions costs by making intra-organizational decision-making quicker and easier (Van den Steen 2010a).

There are also good reasons to believe that ideological heterogeneity might offer an agency certain advantages as well. Agencies are dynamic and are typically responsible for addressing a litany of complex tasks. Ideological heterogeneity in an organization more effectively ensures that every potential perspective on an issue is represented in the policymaking discussion. In many instances, this lends itself to more informed policymaking decisions that better reflect the actual state of the world (Cyert and March 1963; Downs 1967). Overly homogenous organizations are susceptible to a sort of informational drift—a process by which broadly accepted, yet false beliefs about the world go unchallenged in the organization and are allowed to persist (Krause, Lewis, and Douglas 2006; Van den Steen 2010a, 2010b).

Krause, Lewis, and Douglas (2006) and Van den Steen (2010a) in particular elucidate theories of bureaucratic and organizational culture that hold that organizations may benefit in different, yet non-competing ways from ideological diversity. Van den Steen (2010a), for instance, holds that, while organizations will benefit from higher worker enthusiasm, more cooperative work environments, and more efficient distributions of labor when workers share preferences, the organization will suffer information and creativity deficiencies as a result of a lack of viewpoint diversity. Hence, he argues that there is an ideal tradeoff between heterogeneity and homogeneity for a particular agency such that they minimize overall utility loss. In the following section, I will develop a theory that predicts a similar relationship, but focuses on how ideology affects agent effort and, consequently, agency performance.

Given ideology's powerful role in shaping political outcomes, scholars have dedicated substantial effort to quantifying the ideal points of political actors to assist in studying political behavior (Bailey 2007; Bailey and Chang 2001; Poole and Rosenthal 1985; Bonica 2013). However, the study of ideology is difficult. As an inherently qualitative concept, quantifying it is treacherous and difficult. Since policy issues often differ substantially across institutions, it is difficult to compare actors from different institutions based on observational data.

Bureaucracy scholars have devised several ideal point estimators specific to Executive Branch actors (Bertelli and Grose 2011; Clinton and Lewis 2008; Nixon 2004). These estimators are creative and employ a variety of strategies. Bertelli and Grose (2011) attempt to cross reference statements made by administrators with roll call votes in Congress, coding the administrator's ideology as how they likely would have voted as a member of Congress based on the content of their statement. Clinton and Lewis (2008) rely primarily on surveys of experts to ascribe an ideal point to agencies based primarily upon the ideological orientation of their mission. These estimates, however, are unchanging and do not account for intertemporal variation in the individual bureaucrats staffing a particular agency. Nixon (2004) estimates the ideal points of appointees that had previously served in Congress. This assumes, however, that the preferences expressed in their roll call voting behavior carry over to their service in the Executive Branch. Each of these methods are subject to fairly substantial practical limitations and are open to broad criticism on grounds of validity. In the "Data" section of this paper, I will discuss, defend, and ultimately employ, a more promising approach to measuring bureaucratic ideal points. Several scholars, including Bonica (2013), Chen and Johnson (2014), and Bonica, Chen, Johnson (2015), use campaign contribution data to operationalize political ideology. This

method, I will argue, offers researchers a substantially more valid (both internally and externally) ideological metric.

III. THEORY

Agencies, like all organizations, are dynamic, near-infinitely complex entities. Thus, the number of factors contributing to their performance is substantial and beyond the reach of any one theory. In this section, I propose a means by which to understand performance through agent effort. In the bureaucracy literature, authors routinely identify effort incentives as a crucial determinant of agency success (Durant 1987; Lavertu, Lewis, and Moynihan 2012; Lewis 2008; Prendergast 2007). Lavertu, Lewis, and Moynihan (2012) specifically identify intra-agency ideological dynamics as one of careerists' considerations when they choose whether or not to exert effort at work. In the often ideologically charged policymaking space, a bureaucrat with strong ideological persuasions has incentives to make certain work-related choices based on whether or not they support the broader cause of the agency for which they work (Golden 2000). Below, I develop an agency-level theory of how ideology interacts with agent effort to impact agency performance.

We can generally understand agencies as hierarchically organized, with a leadership structure primarily consisting of politically appointed principals. These principals oversee a much larger apparatus of careerist agents. The principals delegate policy-oriented tasks to careerists, who research, write, and propose policies in accordance with the tasks they are assigned. Principals, however, retain absolute discretion over the implementation of policy proposals. Both groups have ideologically-based policy preferences that affect the types of policies that they would like the agency to implement, and experience utility commensurate with their ability to closely exact their ideal points. These ideological preferences are expressed in the content of the proposed policies and the principals' decision to implement or reject the careerists' proposed policy.

Principals strive to improve their own popularity, both with respect to the president and the public at large. Maintaining a reputation of competence increases the likelihood that they retain their job in the administration and aids future political prospects after leaving office (Wood and Marchbanks 2008). Administrative competence and meeting constituents' needs also help the public perception of the administration writ large. Thus, in addition to ideological concerns, principals derive utility from implementing high valence policies, defined as policies that, independent of ideological concerns, improve social welfare. The concept of ideology-neutral policy valence is prevalent in the literature and captures key features of implemented policies that are universally desirable, like clarity, completeness, and efficiency (see, eg., Bueno de Mesquita and Stephenson 2007; Hirsch and Shotts 2011; Lax and Cameron 2007). Principals experience utility from valence independent of their ideology. Thus, policy valence is exogenous to the principals' ideology in their utility calculus. From the perspective of the principals, high quality policies⁵ can help to offset lost utility from implementing a policy relatively disparate to their ideal point. Principals make decisions on the margins, hence their choice to implement or reject a policy depends upon whether the policy improves their utility relative to the alternative. Below I develop a formal model of agency policymaking based upon the interaction of ideology and effort investment.

Policy is made in a given agency as follows:

Principals task careerists with creating a policy in policy space a left-right policy space in the set \mathbb{R} . Both actors have ideal points, p and c , respectively. Careerists generate a policy proposal, b , that varies along two dimensions: its ideological orientation on and its valence (v).

⁵ "Policy valence" and "policy quality" will be used synonymously in this paper.

Careerists choose and exact both points with absolute accuracy. Valence investment, x , is chosen *ex ante* and carries a flat, up-front cost to careerists of 1. In other words, where careerists choose to invest in valence, $x = 1$. Otherwise, $x = 0$. Valence is realized as a known value, v , that fulfills the condition $v \geq 1$, meaning investment always carries a neutral or positive payoff. If careerists choose to forgo valence investment, the realized valence outcome is 0. All actors have perfect knowledge of the other actors' preferences throughout the game. Without loss of generality, p is normalized at 0 and c is located to the right of 0.

Principals experience utility according to the following quadratic loss function, where b is the realized policy outcome:

$$U_p(b, v) = -b^2 + v$$

Careerists experience utility according to:

$$U_c(b, x) = -(c - b)^2 - x$$

Principals have two choices with respect to policy. They can accept the careerists' proposal and implement c with full certainty, or they can set their own policy. However, principals lack the policymaking expertise of careerists and will incur additional implementation costs for choosing their own policy (e.g. careerists engaging in sabotage or foot-dragging). To reflect this uncertainty, policies created by principals carries a random shock of $\pm w$, where w is

a positive number and $w < \sqrt{\frac{1}{2}}$.⁶ Principals' lack of policymaking expertise means that they lack the technical knowledge to produce valence. Therefore, all principal generated proposals carry a realized valence of 0.

This model assumes careerists always propose policy at their ideal point, since they cannot credibly commit *ex ante* to exacting any other policy. Careerists possess several systemic advantages over principals in policymaking that make this commitment problem particularly acute. First, careerists are primarily responsible for implementation of the chosen policy. This offers them wide discretion to actualize their preferences, even where the adopted policy itself fails to meet their ideal (Lipsky 1980). Second, careerists substantially outnumber principals and are necessary to exacting any policy the leadership choose to pursue. In instances in which they are dissatisfied with a policy, bureaucrats have a number of ways of inhibiting change that they don't support. Golden (2006) documents cases of bureaucrats employing opposition tactics that range from intentionally dragging their feet on policies they do not support to engaging in outright sabotage. The implication is that, absent evidence that they will whole-heartedly exact their proposal, principals have reason to doubt the careerists' resolve. Third, careerists enjoy a decided advantage over principals with respect to technical expertise (Gilmour and Lewis 2006). This deficit creates an information problem for principals, who never know when policy-motivated careerists are trying to pull the proverbial rug over their eyes. The threat of careerists providing intentionally misleading data, sneaking a subtle change into a policy, or outright lying about their behavior without principals knowing gives the principals a reason to assume that

⁶ The ranges developed in this framework are contingent upon the uncertainty generated by w being sufficiently small. As w grows beyond $\sqrt{\frac{1}{2}}$, principals' incentive to accept careerist proposals grows to the point of collapsing the ranges as constituted. Proof of this cut point is in the Appendix.

careerists will seek to obtain their ideal policy irrespective of any prior agreement. Given that principals assume them to be pursuing their ideal point, careerists have no incentive to propose any policy other than their ideal point.

It is worth noting that careerists do *not* derive utility from valence in this model. The rationale for this choice is based primarily on the analysis in the third paragraph of this section. As a function of their position, appointees bear uniquely large costs and benefits associated with agency performance. As part of the leadership apparatus, they are held disproportionately accountable in the public and political sphere for the performance of careerists. The highest-level PAS appointees, such as Department Secretaries, are often well-known political figures with carefully managed and delicate reputations. Poor performance under their supervision can substantially undermine their political future. Furthermore, PAS and Schedule C appointees serve at the pleasure of the President, meaning that they lack the sorts of removal protections that many careerists enjoy. While an individual careerist is unlikely to face substantial consequences for failing to excel on a particular assignment, an appointee that, for any reason, falls short of delivering on one of the President's key agenda items is likely in jeopardy of being fired. The absence of a v term in the careerist utility function is not intended to suggest that careerists do not derive any benefits from making good policy. Rather, this model seeks to isolate the benefits of valence that are uniquely experienced by principals.

An evaluation⁷ of $U_p(w)$, where the principals choose to set their own policy yields a utility return of $-w^2$, which follows directly from the directional uncertainty of the policy shock. The shock ensures a minimum utility loss. Hence, principals stand to benefit from the precision

⁷ Full proofs can be found in the Appendix at the conclusion of the paper. This section will lay out the conclusions and basic intuitions of the model.

of careerists, but only inasmuch as their proposals are of sufficient valence and/or ideological proximity. This general principal undergirds the following implications of the model.

Proposition 1: Where the ideal points of careerists and principals are sufficiently proximate, careerists lack the incentive to invest in valence, and principals will always accept the careerists' proposal.

Evaluating $U_p(b)$ and holding v at 0 returns a utility of $-b^2$. From here, it follows that where $-b^2 > -w^2$ (or $b < w$ in its simplest form), principals will prefer to accept the careerists' policy proposal. The intuition behind this outcome is straightforward. As c and p converge, the principals are made strictly better off, since the careerists' proposal offers a certain and increasingly ideologically proximate outcome. Where $b < w$, the uncertainty of setting their own policy outweighs any cost of ideological disparity. Hence, even with zero valence, the principals will choose to accept the careerist proposal.

Under the aforementioned condition, careerists lack the incentive to invest in valence. Where $b < w$, the principals will always accept an outcome at c . Valence investment would constitute an unnecessary and self-imposed cost. Acceptance of c , the utility maximizing outcome (where $U_c(b) = 0$), is guaranteed irrespective of valence investment. Where actors are situated in a manner that allows them to mutually reinforce one another's preferences, the incentive to debate the merits of differing approaches and invest in neutral, ubiquitously desirable policy quality to procure their preferred policy subsidies.

Proposition 2: When careerists and principals have substantially disparate preferences, careerists will not invest in valence and principals will retain the authority to set their own policy.

As c and p substantially diverge, they eventually become sufficiently disparate such that $b > \sqrt{w^2 - v}$. At this point, the acceptance condition is violated irrespective of any conceivable valence outcome, and the principals will always choose to set their own policy. Knowing that exerting effort is both costly and futile, careerists will not invest in valence so as to mitigate their own utility loss. Principals will set policy at 0, and the ensuing policy outcome will be: $b = \pm w$. Principals accept a utility outcome of $U_p(w) = -w^2$.

Careerists' hands are, in effect, tied. From the perspective of the careerists, one might reasonably understand valence investment as a means of purchasing additional ideological latitude from the principals. Where $b > \sqrt{w^2 - v}$, careerists are incapable of producing enough valence to fully cover the principals' losses at c . Knowing this, careerists never invest in valence to save themselves the investment costs. Careerists' utility outcome is $U_c(w) = -c^2 - w^2$.

This prediction is consistent with observed careerist behavior in drastically ideologically disparate agencies. This model elucidates a threshold at which intra-agency cooperation becomes unproductive, namely where $b > \sqrt{w^2 + v}$. At this point, preference disparity is so sharp that careerists lack any manner of recourse to reassert themselves in policymaking. Both groups are forced to accept outcomes with fairly substantial utility losses. In the face of administrators with whom they substantially disagree, careerists often become discouraged, engage in intra-agency sabotage, or quit altogether (Golden 2000; Lewis 2008).

Proposition 3: There exists an intermediate range of ideological disparity that incentivizes careerists to invest in valence so as to procure policy at their ideal point. In this range, principals will always accept careerist proposals. However, this range is restricted by careerists' willingness to incur valence investment costs.

Solving $U_p(c)$, but removing the assumption that $v = 0$, return $U_p(c) = -b^2 + v$. Inserting this into the previous inequality and simplifying generates an acceptance condition of the form derived in Prediction 1: $b < \sqrt{w^2 - v}$. From the principals' perspective, adding a valence quantity widens the range of acceptable policies by the magnitude of the valence..

The investment incentive itself, however, is contingent upon how these outcomes affect the careerists' utility. The cost of valence investment to the careerists is 1. Thus, where careerists invest in valence and successfully procure their ideal point, their overall realized utility is -1. Thus, the net payoff of investment must be greater than 1 to successfully animate careerists to pursue. This is reflected in the inequality $c^2 + w^2 < 1$. In other words, in order to invest in valence, the careerists' utility loss from the principals' retaining policymaking authority must exceed the cost of valence itself. Simplifying the previous inequality to $c < \sqrt{1 - w^2}$ clarifies this relationship. Thus, in the range $b = (\sqrt{1 - w^2}, \sqrt{w^2 + v})$, careerists will invest in valence and principals will accept the proposal, since the gains from valence will successfully offset additional ideological disparity. However, where $b = (w, \sqrt{1 - w^2})$, careerists will not invest in valence, and the principals will reject the proposal, instead setting their own policy with an outcome of w .

The practical implication is that where there is modest disagreement between the careerists and principals, careerists have the strongest incentive to exert effort. Where ideal

points are not too disparate, principals remain persuadable. Thus, careerists will be most likely to exert costly valence investment as a means of convincing principals to accept a high quality, yet somewhat ideologically disparate policy. Where this moderate ideological disparity exists, incentives suggest that we ought to observe higher levels of effort exertion and higher policy quality. Figure 1 and Table 1 below summarize the full policymaking implications of the framework.

Figure 1: Inflection Points Along Policy Space \mathbb{R}

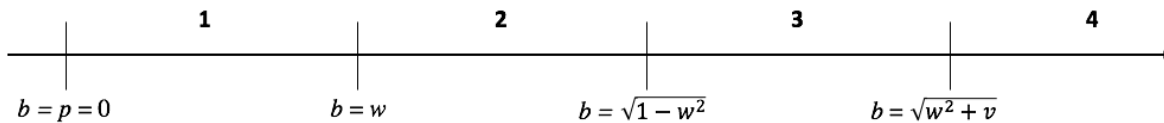


Table 1: Policy and Valence Outcomes Along Policy Space \mathbb{R}				
Segment	Range	Valence?	Principal accepts c?	Policy Outcome
1	$[0, w]$	No	Yes	$b = c$
2	$[w, \sqrt{1 - w^2}]$	No	No	$b = \pm w$
3	$[\sqrt{1 - w^2}, \sqrt{w^2 + v}]$	Yes	Yes	$b = c$
4	$[\sqrt{w^2 + v}, \infty)$	No	No	$b = \pm w$

IV. HYPOTHESES

I propose the following hypotheses, which follow directly from the predictions of the previous section:

H1: Careerists will exert the most effort where preference disparity is moderate.

H2: Agencies with the most extreme levels of ideological homogeneity will perform worse relative to agencies with modest preference disparities.

H3: Agencies with the most extreme levels of ideological heterogeneity will perform worse relative to agencies with modest preference disparities.

H4: Agencies with modest levels of preference disparity will perform better than extremely homogenous/heterogeneous agencies.

The unit of analysis is agency-year, as I will quantify disparity based on the mean ideal points of careerists relative to the mean ideal points of appointees for a particular agency in each year of the George W. Bush Administration from 2003-2008.

V. DATA

I operationalize the independent variable using data from Adam Bonica's DIME, a part of Stanford University's SSDS Social Science Data Collection project, and DW NOMINATE, a scaling method for estimating Congressional ideal points based on roll call voting (Carroll et al 2009). DIME employs individual PAC donations to build a common space ideological spectrum for a litany of actors in American politics.⁸ This approach is attractive for several reasons. First, contributing to PACs is an ideologically motivated behavior that large portions of the electorate engage in. This allows researchers to observe a vast and diverse body of individuals operate in a common, ideologically driven marketplace that generates quantifiable behavioral outputs. Second, these data allow ideal point estimations for any US citizen who has made a PAC contribution. This allows comparison between actors across time and institutions by measuring their ideological behavior in a shared space. Such a comprehensive metric does not exist elsewhere in the literature. Employing such a generalizable measure maximizes external validity by offering future researchers the ability to easily apply findings to the study of different institutions. Third, a well-established literature defends the measure's validity by asserting that PAC contributions represent a sincere expression of an individual's ideology (Ansolabehere, de Figueiredo, and Snyder 2003; Fuchs et al 2000; Mutz 1995). Where donations are primarily reflective of support for a candidate's policy positions, contribution data is indicative of individuals' actual preferences. Though references to such behavior abound in American political discourse, evidence of *quid pro quo* or rent seeking via individual PAC donations is scarce (McCarty and Rothenberg 1996).

⁸ Contribution and ideal point data for a litany of actors is accessible at: <http://web.stanford.edu/~bonica/data.html>

I gather ideal points from two different sources. First, I gather a list of PAS and Schedule C appointees from Bonica, Chen, and Johnson's (2015) replication data. While PAS appointees typically occupy the uppermost strata of the agency hierarchy, Schedule C appointees are presidentially-appointed, but not Senate confirmed, and typically occupy leadership roles further down the bureaucratic chain of command. These two classes of appointees retain the lion's share of the influence among political bureaucrats and far outnumber the several other classes of appointees. They also bear substantially more relevance in the literature. Hence, I restrict my analysis to these two groups in the political bureaucracy. I estimate ideal points in a manner that is identical to Chen and Johnson (2014). I gather contribution data from Bonica's DIME, then subset the data by the appointees in Bonica, Chen, and Johnson (2014). Then I take a weighted average of the DW-NOMINATE scores of the Congressional candidates to whom each appointee donated between 1980-2008. I assign weight based on the contribution amount, with larger contributions receiving more weight. I base this decision on the assumption that larger contributions signal more enthusiastic support.

Second, I gather agency-level, aggregated DW NOMINATE scores for career bureaucrats from replication data for Chen and Johnson (2014). This dataset is at the agency-level and assigns a single ideal point for the career members of a particular agency based on an average of the weighted ideal points of all individual members making contributions. To calculate ideological disparity, I will simply assign each agency a score based on the absolute distance between the mean ideal points of their appointees and their careerists.

I operationalize the dependent variable using scores from the Program Assessment Ratings Tool (PART). PART is a since discontinued measure of agency performance implemented during the George W. Bush Administration for budgeting decisions. Beginning in

2003, PART was conducted annually by OMB and assigned performance scores along multiple dimensions to approximately 200 programs in the federal bureaucracy. The evaluations were observational in nature and attempt to capture non-ideological, valence-based outcomes in program administration. Programs received a numerical score from 0 to 100 and were graded in four categories, each with different weights: Program Purpose and Design (20%), Strategic Planning (10%), Program Management (20%), and Program Results (50%). The program ended at the outset of the Obama Administration due primarily to normative objections to performance budgeting. PART is routinely used in the existing literature as a valid and useful measure of agency performance (see, eg. Lewis 2007, 2008; Lavertu, Lewis, and Moynihan 2012). While there is some evidence suggesting PART may slightly favor programs traditionally supported by conservatives, the observed trend is only slightly statistically significant on a few indicators and is unlikely to meaningfully bias results after controlling for agency fixed effects (Gilmour and Lewis 2006).

I exclude agencies that do not fit the organizational descriptions I have outlined thus far. I exclude agencies without political appointees in their leadership structure, such as the US Forest Service. All agencies included are comprised of a primarily appointed leadership with politically appointed heads that oversee a number of subordinate careerists.

VI. METHODS

First, I will test the primary underlying assumption of my theoretical framework—that ideological dynamics affect careerist effort exertion. I operationalize careerist effort using survey response data from the 2007 Career Advancement Survey administered by the Merit System Protection Board.⁹ I isolate a particular question, which asks respondents to estimate, on average, how many hours per week they had worked in the previous year. Effort is an intrinsically difficult concept to quantify. While quantity of hours worked may not perfectly capture all facets of the concept of “effort,” it provides the most consistent and observable basis from which to measure how much careerists invest in their work product. This question is part of a broader survey on employee attitudes about their professional workplace. Hence, respondents are likely to understand the question in relation to the agency around them—namely how those factors influence their work decisions. While data does not exist about how the ideology, in particular, of bureaucrats’ coworkers affect effort output, this survey provides a consistent lens through which to estimate the effort exertion of thousands of career bureaucrats.

I include a term for raw ideological disparity, calculated as the absolute difference of the ideal points of careerists and appointees, and a term in which this quantity is squared. This tests for the curvilinear relationship that I predict in the theory section.

I sort these responses by the agency at which the individual respondents work. I include a litany of controls, listed below.

⁹ I obtained this data via a FOIA request through the process outlined at: <https://www.mspb.gov/foia/request.htm>

Table 2: Variables for Test of Hypothesis 1		
Variable	Source	Measure
Ideological Disparity	Bonica et al (2015); Chen and Johnson (2014)	Difference between average ideal points of agency careerists and appointees
Ideological Disparity ² (IV)	---	Accounts for non-linearity of the hypothetical relationship
Effort (DV)	2007 Career Advancement Survey	Hours worked per week
Politicization (CT)	OMB's FedScope database	Proportion of careerists/appointees in the agency's SES
Budget (CT)	US Government Printing Office's GovInfo database	Scaled annual budget

Lewis (2008) finds that politicized agencies (i.e. agencies comprised of a higher proportion of appointees) receive systematically lower PART scores, likely due to less institutional competence. Politicization is canonically understood as a tool of Presidents seeking to exert influence over a particular agency, either because the agency bears unique significance for their agenda or is particularly opposed to their preferences. (Lewis 2008; Moynihan and Roberts 2010). For this reason, politicization is typically considered strategic and endogenous to the preferences and priorities of the administration. I control for agency politicization by including the proportion of the Senior Executive Service (SES) that is made up of non-careerist appointees for each agency-year in the analysis.¹⁰ I also include a control for program budget to offset any observed differences in performance due to budget constraints rather than agent

¹⁰ I obtain this information from the OPM's FedScope database on federal employment. This can be found here: <https://www.fedscope.opm.gov/>

effort.¹¹ Since PART ratings only took place between 2003 and 2008, my analysis restricted to this timeframe. Obviously, a larger timeframe would afford greater statistical power, but this data does not exist. With that being said, PART scored around 200 programs annually—enough such that results will be statistically significance.

Second, I will use an OLS regression to test the predicted relationship between ideological disparity and policy valence. As previously discussed, I operationalize the independent variable using the contribution-generated ideal point data—namely the absolute difference between the average ideal points of an agency’s careerist and appointee bodies. As in the previous analysis, the dependent variable is represented by the mean PART score of the agency’s programs for the given year. Here again, I include a squared term in the second regression equation for the ideological disparity coefficient. I include the same controls as for the previous regression, plus time and agency fixed effects to account for path dependency. In both regressions, I cluster standard errors by agency to account for intra-agency similarities that may manifest as violations of the assumption of independence.

¹¹ I gather budget data from the US Government Publishing Office’s GovInfo database, accessible at: <https://www.govinfo.gov/app/details/BUDGET-2018-DB/context>

Table 3: Variables for Test of Hypotheses 2-4		
Variable	Source	Measure
Ideological Disparity (IV)	Bonica et al (2015); Chen and Johnson (2014)	Difference between avg ideal points of agency careerists and appointees
Ideological Disparity ² (IV)	---	Accounts for non-linearity of the hypothetical relationship
PART Scores (DV)	Office of Management and Budget (OMB)	OMB administered performance metric from Bush Admin.
Politicization (CT)	OMB FedScope Database	Proportion of careerists/appointees in an agency
Budget (CT)	US Government Printing Office	Natural log of program budget (budget likely affects program efficacy)
Agency-fixed effects (CT)	---	Accounts for performance path dependency
Time-fixed effects (CT)	---	Accounts for time-based path dependency

I consider the prospect of reverse causality, that performance is conditioning the ideological makeup of agencies and deem it unlikely. This phenomenon would have to do so through one of two processes. Good or bad PART feedback would have to substantially alter the future beliefs of bureaucrats by communicating the desirability of some sort of policy change. Beyond seeming intuitively improbable, this contradicts a large body of research that suggests ideology is substantially resistant to change (Jost et al 2009). A second pathway for reverse causality would be through conditioning institutional decision-making. Namely that high/low performing agencies make substantially different hiring and firing decisions based on ideology, such that their performance drives their ideological orientation over time. There is no existing research that suggests such a relationship. While PART scores played a meaningful role in

budgeting, they were largely unknown to the public and did not play a substantial role in day to day decision-making at agencies (Lavertu, Lewis, and Moynihan 2012). That principals or employees were making employment decisions of an ideological nature based on an agency's PART outcomes is highly unlikely.

Another potential endogeneity problem arises out of election consequences. Ideological disparity between certain careerists and an incoming administration may induce political opponents of the President to quit at a disproportionate rate (Golden 2000), resulting in non-random attrition. This phenomenon, paired with the fact that agencies with lower proportions of careerists perform worse in PART evaluations (Lewis 2008; Lewis and Gallo 2013), suggests a potential common cause—that quitting would bias careerist ideal points in one direction and the ensuing shortage of careerists would concurrently bias agency performance. However, empirical evidence suggests that the observation of “protest quitting” is largely limited to the most senior careerists. These openings serve to induce more lower level careerists to stay in hopes of obtaining a promotion (Bolton, de Figueredo, and Lewis 2016). Thus, the intra-agency job market substantially corrects for this bias. Second, the data's observations begin in 2003 and end in 2008, a time period without a change in the party controlling the Executive Branch. Since most ideologically-based departures occur immediately following a change in the party controlling the government (Boyne et al 2010; Christensen et al 2013), the likelihood of statistically significant attrition-based bias is low. Third, controlling for agency fixed effects would capture the impact of any non-random shift in the ideological composition of an agency.

VII. RESULTS AND ANALYSIS

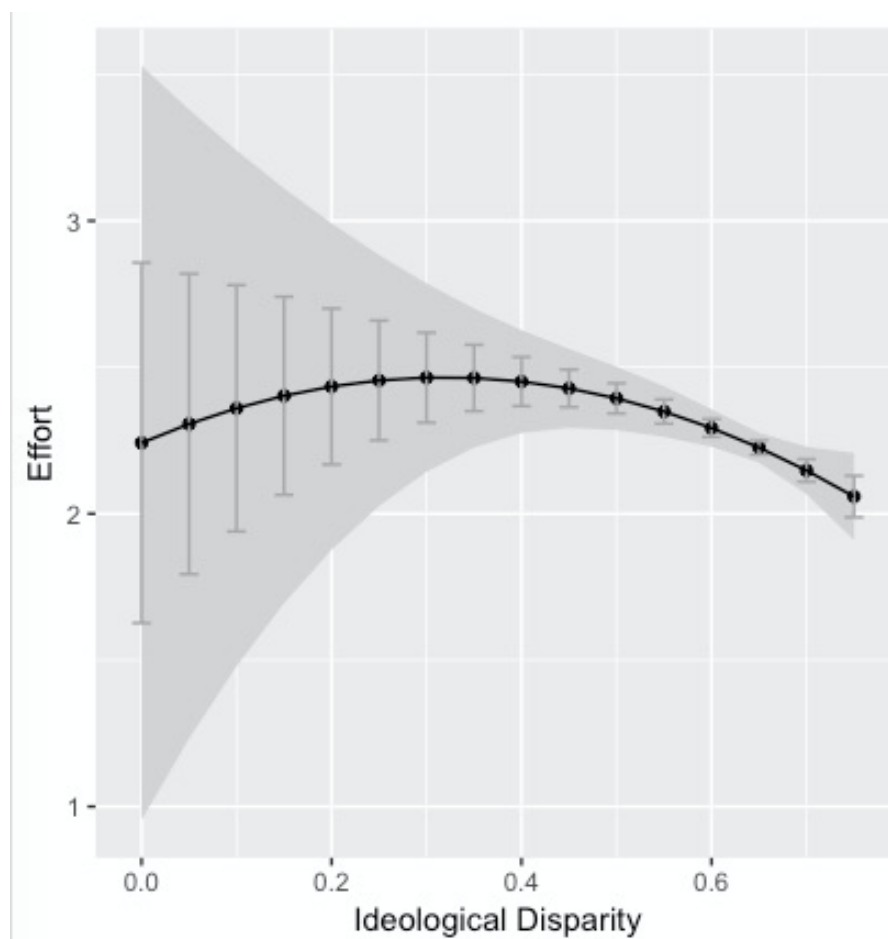
Table 4: Results from Test of Hypothesis 1

	<i>Dependent variable:</i>	
	Effort (Hours worked per week)	
	(1)	(2)
Ideological Disparity	1.401 (2.101)	-1.123 (2.355)
(Ideological Disparity) ²	-2.193 (1.838)	0.237 (2.247)
Politicization		0.373 (0.793)
Budget		-0.003** (0.001)
Constant	2.242*** (0.602)	2.859*** (0.587)
Observations	6,409	6,409
R ²	0.006	0.016
Adjusted R ²	0.006	0.015
Residual Std. Error	1.170 (df = 6406)	1.165 (df = 6404)
F Statistic	20.307*** (df = 2; 6406)	25.301*** (df = 4; 6404)
<i>Note:</i>		*p<0.1 **p<0.05 ***p<0.01

I test Hypothesis 1 with and without controls, yet neither returns statistically significant results. Thus, I cannot verify the hypothesis. It is, however, worth noting that the fitted regression model roughly matches the predicted relationship, as illustrated below in Figure 2. The highest levels of predicted effort exertion occur where absolute ideological disparity is

between 0.2 and 0.4. This lends some support for the paper's theoretical argument, albeit not enough to draw causal inference without additional evidence from future research.

Figure 2: Predicted Effect of Ideological Disparity on Careerist Effort



Given the relative scarcity of observations in the highly ideologically homogenous range, the standard errors and confidence intervals are large. This gives additional reason to resist drawing firm inferential conclusions from these observations. However, this phenomenon is inescapable given the nature of the available observations. During the George W. Bush Administration agencies with highly ideologically proximate bodies of careerists and appointees were relatively few. Subsetting this data to a particular year, 2007, in accordance with the

available survey data exacerbated this problem. As discussed earlier in the paper, operationalizing careerist effort, an inherently nebulous concept that resists quantification, poses a persistent challenge for researchers. Future research will have to be innovative in pursuit of overcoming these particularly acute barriers to reliable inference.

Table 5: Results from Test of Hypotheses 2-4

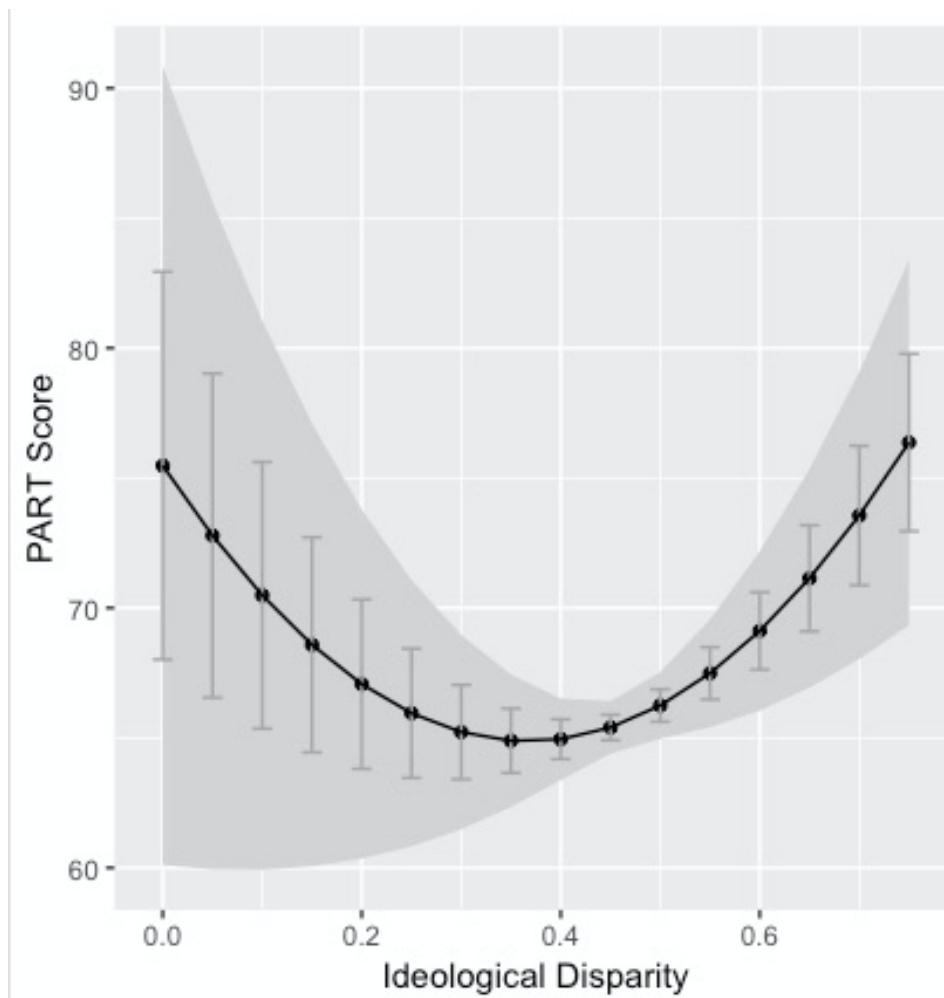
<i>Dependent variable:</i>			
	PART Scores		
	(1)	(2)	(3)
Ideological Disparity	-65.402 (45.373)	-57.427** (26.682)	-57.588** (27.296)
(Ideological Disparity) ²	54.629 (47.890)	78.943*** (24.499)	76.600*** (26.566)
Politicization			-6.590 (22.041)
Budget			0.244 (0.450)
Agency Fixed Effects		x	x
Annual Fixed Effects		x	x
Constant	84.618*** (9.660)	75.565*** (6.954)	76.669*** (8.577)
Observations	875	875	875
R ²	0.022	0.246	0.246
Adjusted R ²	0.020	0.217	0.215
Residual Std. Error	18.012 (df = 872)	16.107 (df = 841)	16.122 (df = 839)
F Statistic	10.032*** (df = 2; 872)	8.319*** (df = 33; 841)	7.841*** (df = 35; 839)

Note:

*p<0.1 **p<0.05 ***p<0.01

The results from the second test are significant, yet surprising. There is a statistically significant relationship between an agency's PART performance and the ideological disparity of the agency. However, the shape of the fitted regression line is diametrically *opposite* to the relationship I projected. Rather than a negative parabolic relationship, with the most homogenous and heterogenous performing poorest, the observed relationship is a positive, U-shaped parabola. Agencies with moderate levels of ideological disparity performed poorest on PART evaluations. Figure 3 shows this relationship.

Figure 3: Predicted Effect of Ideological Disparity on Agency PART Scores



The observational data is intriguing insofar as it is not easily explained, either by intuition or the existing scholarship. As I discuss earlier in the paper, the existing literature is dominated by two predominant theories on the role of ideology on bureaucratic performance. Most public administration scholars adopt perspectives best characterized by Kaufman (1960) and Resh (2015). These scholars hold that, through various mechanisms, organizations that broadly share values and preferences maximize their own efficacy. Beyond the evidence they present in their works, this perspective is intuitively persuasive. When people share preferences and values, conflict is seemingly less likely, trust is easier to build, and the transaction costs of collaboration are minimized. Assuming this to be true, one would expect to observe a negative and linear relationship, with PART performance decreasing as ideological heterogeneity increased.

The second prevailing view, which more closely mirrors the theoretical framework I develop in this paper, cautions against overly homogenous organizational arrangements (see, eg. Van den Steen 2010a; Van den Steen 2010b; Krause, Lewis, and Douglas 2006). This scholarship's emphasis on viewpoint diversity lends itself to the view that excessively similar agencies may underperform as result of intra-agency ideological blind spots, poor incentives, or lack of diverse professional expertise. Even these scholars, however, emphasize balance. Few, if any, scholars promote the cultivation of organizations with vastly disparate preferences. This makes the right side of the predicted effect especially surprising, but highly unique in the existing literature.

I rule out the observed effect being a function of a flaw in the design or assessment of PART. Existing literature finds that more conservative agencies received systematically higher PART scores (Gilmour and Lewis 2006). This could, in theory, explain why homogenous

agencies with careerists that widely share the preferences of conservative Bush appointees could receive higher PART scores. However, it fails to explain why heterogenous agencies would also score well. In fact, it would seemingly predict that they would score *worse*. Also, the agency fixed effects control variable should minimize the degree to which any reporting bias in the PART data would influence this papers' results.

Explaining why such a relationship between ideology and performance would exist is difficult, since most all explanations for the efficacy of highly homogenous agencies naturally rule out the efficacy of highly heterogenous ones (and vice versa). It is possible that either side of the curve may be the result of two different phenomena entirely. For instance, the high scoring of agencies with minimal disparity may primarily be the result of the oft cited efficiency gains from substantial preference homogeneity. Highly heterogeneous agencies, conversely, may benefit from the vigorous debate and competition that naturally stems from broad intra-agency disagreement. Agencies with modest preference disparity may fail to sufficiently exploit either of these advantages to substantially improve their performance. This is one of many possible explanations, and it is almost entirely speculative. Untangling the true cause of this unexpected and unintuitive relationship could produce interesting and compelling future research.

As discussed throughout the paper, this research uses inherently imperfect measurement techniques. Thus, it is worth approaching these results with a dose of caution and healthy skepticism. Ideal point estimation is still, relatively speaking, a new phenomenon. Political ideology is complex, dynamic, and highly resistant to generalization and quantification. Indeed, it is hard to imagine a world in which estimating ideology is not, at least to some degree, an inexact science. However, ideal point estimation is a worthwhile endeavor that promises substantial insight into previously uncharted territory for political researchers. As researchers

continue to hone in on more complete and consistent estimation techniques, research projects of this nature will become more feasible and more reliable in their findings.

Estimation of agency performance is similarly difficult to operationalize. PART offers only one of many possible ways for researchers to standardize and compare the quality of policymaking at the agency level. These results beg the question of whether they are unique to this particular way of operationalizing the variables of interest. If future research obtains similar results through different ways of conceiving of ideology and agency performance, the likelihood that these findings are the result of omitted variable bias diminishes. New and creative ways of operationalizing these complicated concepts will open the door to such research.

VIII. CONCLUSION

While it is difficult to make sense of the results of this paper, it certainly provides several new and important insights into the subfield of bureaucratic politics. First, I develop a game theoretical model for agency policymaking that predicts policy quality and ideological location based on the ideological proximity of the actors. Although the predictions of this model are not borne out empirically by these particular data, the model illustrates some of the complex incentives Executive Branch policymakers face as a result of agency structure. It also provides an interesting framework from which to understand and observe Executive Branch policymaking. Given the uncertainty of the empirical findings of this paper, I am unwilling to write off the possibility that this model will be vindicated by future empirical research. This field of research is rife with opportunities for similar theory building, as the incentives for the relevant actors are substantial and complex. Executive Branch policymakers retain an enormous amount of policymaking authority in the United States. Their preferences impact policy outcomes that affect nearly all aspects of American life—from speed limits to banking regulations to the food that we eat. Understanding how the structural incentives of the policymaking process incentivize the behavior of bureaucrats is key to promoting good governance and developing a broader understanding of the origins of the rules that govern us.

Second, this paper finds a unique and intriguing empirical relationship between ideological disparity and the quality of policy output. Though the relationship is inconsistent with my hypotheses and deviates from the lion's share of the existing literature, the results are statistically significant and meaningful. Given the unconventional relationship that the findings detail, I remain somewhat skeptical about their practical validity. The inherent difficulty of properly operationalizing the variables of interest add to this skepticism. More research that uses

a variety of measures for the concepts of interest is to confirm the findings of this paper. At minimum, however, these results encourage researchers to think critically and creatively when seeking to uncover how ideology impacts agency performance.

IX. MATHEMATICAL APPENDIX

1 Derivations of general conditions and inflection points

1.1 *Proof of generalized acceptance condition for principals*

Recalling that $U_p(b, v) = -b^2 + v$ and that principals are incapable of producing policy valence, the principals' utility for setting their own policy is:

$$\begin{aligned} U_p(w, 0) &= \frac{1}{2}(-w^2) - \frac{1}{2}(w^2) \\ &= -w^2 \end{aligned}$$

Thus, the generalized acceptance condition for principals is:

$$U_p(b, v) > -w^2$$

This is where accepting a policy proposal affords more utility than the utility they derive from creating their own policy.

1.2 *Proof of generalized investment condition for careerists*

Recall that: $U_c(b, x) = -(c - b)^2 - x$.

Where $b < w$, careerists have no incentive to invest in valence, since the principals will always accept their proposal *without* valence (see 1.3). Where $b > \sqrt{w^2 + v}$, valence investment is futile,

since no outcome could alter the principal's decision to reject (see 1.4). In both instances, valence investment would constitute costs to careerists that confer no marginal benefit. Thus, I restrict this proof to the range $[w, \sqrt{w^2 + v}]$. In all other ranges, careerists will never choose to invest in valence.

In the range $[w, \sqrt{w^2 + v}]$, where valence investment will always compel the principals to change their choice from reject to accept, careerists' utility outcomes are:

$$\begin{aligned}
 U_c(Invest) &= -(0)^2 - 1 \\
 &= -1 \\
 U_c(\sim Invest) &= -\frac{1}{2}(c - w)^2 - \frac{1}{2}(c + w)^2 \\
 &= -c^2 - w^2
 \end{aligned}$$

Thus, in the range $[w, \sqrt{w^2 + v}]$, careerists will invest in valence where:

$$\begin{aligned}
 -1 &> -c^2 - w^2 \\
 1 &< c^2 + w^2
 \end{aligned}$$

Simply stated, from the perspective of the careerists, the disutility of the principals retaining policymaking power must outweigh the disutility of valence-producing effort.

1.3 Proof of $b = w$

Since careerists will never invest in valence in this range (see 1.4), I remove the v term from the careerist utility function, so, substituting in their utility function, the principal always accepts where:

$$-b^2 > -w^2$$

$$b^2 < w^2$$

$$b < w$$

It follows that $b = w$ is an inflection point where the principals are indifferent to the outcome.

Where $b > w$, principals will reject all policies without valence and set their own policy.

1.4 Proof of $b = \sqrt{w^2 + v}$

Recalling the principals' generalized acceptance condition from 1.1, I reinsert the valence term to calculate the principals' upper bound of acceptable policies that include valence. See 1.2 for proof that careerists will choose to invest in valence in the range $[\sqrt{1 - w^2}, \sqrt{w^2 + v}]$. Including the valence term, the acceptance condition for principals is:

$$-b^2 + v > -w^2$$

$$-b^2 > -w^2 - v$$

$$b^2 < w^2 + v$$

$$b < \sqrt{w^2 + v}$$

This is the upper bound of the model, since any arrangement where $b > \sqrt{w^2 + v}$ would be beyond any acceptable policy the careerists could feasibly propose. Thus, $b = \sqrt{w^2 + v}$ is an inflection point.

1.5 Proof of $b = \sqrt{1 - w^2}$

Recall the careerist investment condition in 1.2. Substituting b for c , since careerists always propose policy at their ideal point, the investment condition becomes:

$$1 < b^2 + w^2$$

$$1 - w^2 < b^2$$

$$\sqrt{1 - w^2} < b$$

Where this condition is true, and inside the range $[w, \sqrt{w^2 + v}]$, careerists will invest in valence.

Where $\sqrt{1 - w^2} > b$, careerists will not invest in valence, and where $\sqrt{1 - w^2} = b$, careerists are indifferent. Since, in the range $[w, \sqrt{w^2 + v}]$, principals' acceptance of the careerist proposal is contingent upon valence investment, principals will reject proposals where $\sqrt{1 - w^2} > b$ and accept proposals where $\sqrt{1 - w^2} < b$. It also follows that the valence investment range for the careerists is $[\sqrt{1 - w^2}, \sqrt{w^2 + v}]$

A full summary of the implications of these proofs is located in Table 1 in the Theory section.

2 Derivation of Constraints and Sequence of Inflection Points

2.1 *w must be less than $\sqrt{\frac{1}{2}}$ and $w < \sqrt{1 - w^2}$, given all constraints*

The model requires that $0 < w < \sqrt{1 - w^2} < \sqrt{w^2 + v}$. In order that $w < \sqrt{1 - w^2}$, it follows that:

$$w < \sqrt{1 - w^2}$$

$$w^2 < 1 - w^2$$

$$2w^2 < 1$$

$$w^2 < \frac{1}{2}$$

$$w < \sqrt{\frac{1}{2}}$$

The practical implication of this condition is consistent with the intuition of the model. As the principals become less precise in their ability to set policy, they eventually collapse the ranges because retaining policymaking authority becomes too costly. Another crucial implication of this proof is that where $w < \sqrt{\frac{1}{2}}$, w is necessarily less than $\sqrt{1 - w^2}$. This confirms a sequential requirement of the model's inflection points.

2.2 v must be positive and greater than or equal to 1 and $\sqrt{1 - w^2} < \sqrt{w^2 + v}$, given all constraints

In order that $\sqrt{1 - w^2} < \sqrt{w^2 + v}$, it follows that:

$$\sqrt{1 - w^2} < \sqrt{w^2 + v}$$

$$1 - w^2 < w^2 + v$$

$$1 - 2w^2 < v$$

Recall that $0 < w < \sqrt{\frac{1}{2}}$. In order that v satisfies the upper bound of w , v must be greater than 0

since:

$$1 - 2 \left(\sqrt{\frac{1}{2}} \right)^2 < v$$

$$1 - 2 \left(\frac{1}{2} \right) < v$$

$$1 - 1 < v$$

$$0 < v$$

. Thus, valence can *never* be negative. This is intuitive (valence is an additive concept) and stipulated by the model. However, as w shrinks to the absolute lowest end of its bound, v must increase to 1, since:

$$\lim_{w \rightarrow 0^-} 1 - 2w^2 = 1$$

Thus, all instances in which $v \geq 1$ satisfy the condition $1 - 2w^2 < v$ in the range of possible w 's.

A separate, but crucial implication of this section is that where $0 < w < \sqrt{\frac{1}{2}}$ and $v \geq 1$, $\sqrt{1 - w^2} <$

$\sqrt{w^2 + v}$ is always true. A simple illustration of this necessity is:

$$\sqrt{1 - w^2} < \sqrt{w^2 + v}$$

$$1 - w^2 < w^2 + v$$

$$1 < 2w^2 + v$$

$$1 - v < 2w^2$$

Given that $v \geq 1$, it follows that $1 - v \leq 0$. Given that $0 < w < \sqrt{\frac{1}{2}}$, it follows that $2w^2$ is always

positive and greater than 0. Thus, $\sqrt{1 - w^2} < \sqrt{w^2 + v}$ is always true.

2.3 $w < \sqrt{w^2 + v}$ is always true, given all constraints

$$w < \sqrt{w^2 + v}$$

$$w^2 < w^2 + v$$

$$0 < v$$

This statement is always true given that $v \geq 1$

X. WORKS CITED

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