Left, Right, and Center: Strategic Information Acquisition and Diversity in Judicial Panels*

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Abstract

In the last fifteen years, numerous empirical studies of multi-member courts have documented a phenomenon popularly known as "panel effects." Two provocative findings from this literature are: (1) the inclusion of (non-pivotal) members from outside the dominant ideology on the panel predicts higher reversal rates of administrative agencies that are "like minded" with the panel's median voter; and (2) when mixed panels do not reverse, they frequently issue unanimous decisions. The apparently moderating effects of mixed panels both pose a challenge to conventional median voter theories and call into question the predictability and legitimacy of judicial review. Accordingly, many scholars have offered their own explanation for panel effects (including collegiality, deliberation effects, whistle-blowing, and others). In this paper, we propose a general model that (among other things) predicts panel effects as a byproduct of strategic information acquisition. The kernel of our argument is that non-pivotal members of diverse deliberative panels have incentives to engage in costly searches for information in cases where pivotal members would rationally choose not to do so. As a result, the inclusion of ideologically diverse members may catalyze more information production in a way that increases the likelihood that a mixed panel will overturn ideologically allied agency actors. Our informational account – if correct – has normative implications for the composition of judicial panels in particular and for deliberative groups more generally.

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1 Introduction

Within the growing empirical literature on judicial review of administrative agencies, three notable findings stand out. First, *politics matters:* Democrat appointed judges tend to uphold liberal agency decisions and reverse conservative ones more often than their reviewing Republican counterparts.[1] Second, *party matters:* while qualitatively similar in behavior, Democrat and Republican judges are not exactly the mirror images of one another in quantitative dimensions (*e.g.,* Democrats appear empirically more likely to "cross the party line" on occasion than Republicans). And third, *diversity matters:* mixed three-judge panels (*i.e.,* two Democrats and one Republican or two Republicans and one Democrat) tend to make decisions that are more moderate than do homogenous panels dominated by a single party (Democrat or Republican).[2]

This paper focuses on the third feature – the apparent moderating effects of heterogeneity – and in the process says something about the others. Our contribution is principally theoretical: we develop and analyze a model connecting (a) hierarchical auditing of lower-tier actors (*e.g.,* administrative agencies or trial courts), (b) group deliberation within the auditing entity (*e.g.,* an appellate judicial panel); and (c) strategic decisions by group members to make costly investments in information acquisition relevant to the deliberation (*e.g.,* about the case or underlying policy choice). An immediate implication of our model is that it generates an equilibrium prediction of behavior quite analogous to moderation effects. Specifically, we show that heterogeneous judicial panel compositions are more likely to incentivize broad information production than would other configurations with more homogenous composition. A lone Republican (or Democrat) on a 3 judge panel may be willing to provide an informational public good to her counterparts even if they were not willing to provide it themselves. To the extent that our hypothesis is correct, moreover, it holds implications as to whether mixed judge panels are desirable, or even should be required. (Miles & Sunstein 2008, Tiller & Cross 1999; cf. Schanzenbach & Tiller 2008).[3]

[1] See Revesz (1997), Cross and Tiller (1998), and Miles & Sunstein (2006, 2008), Sunstein, Schkade and Ellman (2004), as well as earlier work in political science, cited in note __, for empirical confirmation. The explanation for this phenomenon is fairly widely accepted: ideological disposition. (Segal & Spaeth, 2002). See Stephenson 2009, at 46 ("Republican appointees are more likely, all else equal, to uphold conservative agency decisions and reject liberal agency decisions, while Democratic appointees are more likely to uphold liberal decisions and reject conservative decisions, and these effects are typically substantively as well as statistically significant."). See generally Stephenson (2009).

[2] See also Peresie (2005), finding similar effects for male and female judges.

[3] As Stephenson (2009, pg. 47) points out, there are two effects from mixed judicial panels. One is the tendency of the minority judge to vote with the majority. The second, and in our opinion likely the more important effect, is the tendency of the majority judges to creep ever so subtly in the direction of the minority. This latter effect is more important because it changes the outcome of the case. In contrast, when the minority voter moderates his vote to join the majority, the outcome is likely left unchanged. As it happens, in our model, described below, both effects can occur simultaneously. In other words, and in certain circumstances, both Republican and Democratic judges are likely to vote a bit more like each other. Both effects stem from the increased willingness of minority judges to do costly research in situations where

The framework developed here builds most directly on our prior work, *Judicial Auditing,*[4] but departs from it in a few crucial ways. First, we attempt here to generalize the model to yield a deeper understanding of appellate court dynamics (and hierarchical auditing more broadly). Rather than treat the appelate court as a unitary actor (as both we and Cameron, Segal & Songer 2000 did), we explicitly consider it as a multimember body. This generalization is, in fact, critical since it is the strategic interaction among the panelists that generates the core intuitions we suggest here. Second, we endeavor to tailor our framework to correspond roughly to some key institutional attributes surrounding agency appeals. When agency decisions are appealed, the court must hear such appeals. Yet, for matters on appeal, judges might or might not expend appreciable effort to investigate further the basis for the agency's decision. Regardless, the court may overturn the agency regardless of whether or not any judge on the panel has invested in acquiring greater information about the case.

Political scientists have, by turn, suggested a number of theories for explaining the moderating effect of including a minority judge on a three judge panel. A first set of explanations hinges on social *cohesion and collegiality* (*e.g.,* Songer 1982, pg. 226), asserting that various social pressures may lead non-pivotal minority judges to go along with the majority, as a mechanism for enhancing (or preserving) inter-panelist harmony. Even if such tastes for collegiality are relatively weak, they may be enough to deter the minority panelist from taking the time and energy to author a dissent.[5] In a related vein, some have posited that additional pressures from "group polarization" may play a more extreme role in homogenous panels, which can in turn lead to apparent moderation of mixed panels (*e.g.,* Sunstein, Schkade and Ellman, 2004, pg. 308). That is, individuals may become more extreme when interacting with homogeneously like minded counterparts (Myers 1975; Asch 1951). Applied to judges, polarization effects predict that homogenous panels "reinforce" each other's prior commitments, thereby leading to more ideologically extreme decision making (and apparently more moderation in mixed panels).

A second explanation, sometimes known as *whistleblowing* is perhaps the

majority judges would not bother to do so.

[4] Spitzer and Talley (2000). We are also implicitly building on Cameron, Segal, and Songer, which was published contemporaneously with ours and which uses a model very similar in spirit. One of the few important differences is that in Cameron, Segal and Songer the Higher court can learn the facts with certainty once it pays the cost of an audit, whereas in Spitzer and Talley the Higher court has a better estimate of the true state of the world than does the Lower court, but is still somewhat uncertain.

[5] Within this literature, both social and workload-related costs/benefits can play a role. Atkins, ("social pressure"); Atkins & Green (empirical support for workload and dissents inversely related); Goldman (norm of consensus); Green (workload reduces dissents).
See also Posner (2002, pg. 32) ("[m]ost judges do not like to dissent....Not only is it a bother and frays collegiality, and usually has no effect on the law, but it also tends to magnify the significance of the majority opinion."); Landes & Posner (2009) (discussing "dissent aversion").

Relatedly, in a contemporaneous piece to this one, Fischman (2009) studies an attitudinal model, augmented by a cost to writing a dissent. The higher the cost of the dissent, the more likely it is that a minority judge will choose to join the majority opinion. His model does not, however, predict that the majority judges will ever moderate their position and join the minority.

leading explanation among positive political theory ("PPT") scholars to explain panel effects. First developed by Cross and Tiller (1998), this account conjectures that a minority party panelist can effectively threaten to "tattle" on the majority (e.g., through a dissent) if those majority actors ignore established precedent or doctrine. The minority member, they argue, can expose a majority's manipulation or disregard of legal doctrine, and thus her credible threat to blow the whistle deters such manipulation in the first instance, producing more moderation. (Cross and Tiller 1998, p. 2156).

Significantly, the whistleblower account harbors a distinct role for formal legal doctrine as a constraint on judicial review. That is, the whistleblower account gets its traction from the existence of an independent, commonly subscribed legal canon, whose violation can be detected and communicated to an outside community. Our approach, in contrast, neither requires nor precludes the possibility that legal doctrine might also do some work and, in fact, allows for doctrine to be vague, contested, over- or under-determined, or simply unintelligible. In order to highlight the role of endogenous information production, we will focus only on ideology, information, choice and outcomes.[6]

A final explanation, perhaps the leading one among legal academics, was proposed by Revesz (1997, pg. 1732), and is sometimes identified as the *deliberation* hypothesis. In essence, by being on a panel with judges of the opposite political party and deliberating with them, one is naturally led to moderate one's position. The informational explanation that we propose here is perhaps closest in spirit to Revesz' suggestion, but we attempt to develop it within a more formal PPT framework, which may generate more precise predictions about the mechanics of panel effects. Within our model, it is the rational willingness of judges with diverse ideologies from the median to engage in costly research, embedded within a deliberative setting, that produces deliberative effects. Consequently, the panel's decisions not only embody median voter's preferences (the standard insight from PPT) but also indirectly reflect preferences of extreme members on the panel (who have the greatest incentive to engage in search).

Before proceeding, one caveat deserves specific mention. Although our analysis aims to understand and explain judicial panel effects, it has obvious ties to other literatures in political science, psychology, economics and elsewhere on group effects within deliberative fora. These include papers on (so called) persuasion games,[7] inquisitorial versus advocacy systems,[8] political lobbying,[9]

[6] We hasten to add that the role of doctrine may certainly be important (and we have published on the role and characterization of doctrine before. (Spitzer & Tiller; Cohen & Spitzer; Talley 1999)). The strategic formulation of doctrine by the Supreme Court, and its effects on lower courts, takes up a significant fraction of research in this field. See Cross & Tiller 2006, Jacobi 2009, Jacobi & Tiller 2007, Lax 2007, 2008, Lax & Landa 2009, McNollGast 1995, Strauss 1987, Tiller 1998, Shavell 2009.

It is important to note that the process of "information acquisition" we model here could, in pricinple, also pertain to conventional legal research on existing precedents, and as such whistleblowing would represent a special case of our framework.

[7] Milgrom & Roberts (1986).

[8] Dewatripoint & Tirole 1999.

[9] Cameron & DeFigeueiredo (2009).

media reporting and bias,[10] and the value of ideological diversity more generally within deliberative fora.[11] We do not attempt to develop these links fully here, though our general approach may both inform such inquiries and is, in some respects, informed by them.

Our analysis proceeds as follows. The following section describes at greater length the literature relating to panel effects, along with the prevailing theories that have been posited to explain them. Section 3 presents our theoretical model and characterizes its equilibria. Section 4 uses simulation methods to calibrate our model to real-world data, and develops some preliminary thoughts about testing our model against alternatives. Section 5 discusses extensions of our model. Section 6 considers implications, and Section 7 concludes.[12]

2 Empirical Panel Effects

Before beginning with our analytic enterprise, it is perhaps useful to situate our claims within the empirical literature on panel effects. As noted in the introduction, during the last decade empirical academic literature on panel effects has proliferated rapidly. Although we cannot canvass all of them here, a few of the central pieces in this literature are worth recounting. Revesz (1997) is often credited with being the first legal academic to notice and document the phenomenon. He collected challenges to decisions of the Environmental Protection Agency that were brought in the DC Circuit between 1970 and 1994. Revesz divided the time into periods in which the membership of the DC Circuit was unchanged and utilized the random assignment of judges to test hypotheses about the effect of panel composition on votes and outcomes.[13] Employing a qualitative response analysis of industry challenges to EPA regulations, Revesz found that panel behavior differed by time period, and that Democrats and Republicans did not always act as the mirror images of one another. For the 1970s he found:

> First, a Republican judge was significantly more likely to reverse when there was at least one other Republican on the panel. Second, for a Democratic judge, the probability of reversal was not significantly affected by the composition of the panel. Third, Democrats, but not Republicans, were significantly more likely to reverse in in-

[10] Gentzkow and Shapiro (2006).

[11] For example, this paper ties into a substantial literature, reviewed in Farhang and Wawro (2004), on racial minority and female judges. Both Farhang and Wawro (2004), and Peresie (2005) emphasize the intersection between including minority judges on panels and deliberation. We believe that their initial steps are correct; to the extent that minority judges have preferences that are different from those of other judges, our information-based model should apply.

[12] A technical Appendix includes a number of technical derivations and proofs that are suppressed in the text.

[13] Revesz also tested hypotheses unconnected to panel composition, and found voting patterns that are consistent with an ideological component to judicial voting.

> dustry challenges raising a procedural claim than in industry challenges not raising such a claim.[14]

For the latter time periods of his study, he reached a slightly different conclusion:

> The following conclusions can be drawn from the significance of these variables for industry challenges during [the latter] period[s]. First, a Republican judge was significantly more likely to reverse when there was at least one other Republican on the panel. Second, a Democratic judge was significantly less likely to reverse when there was at least one other Democrat on the panel.[15]

We regard these results as empirical support for panel effects, though they are ambiguous as to which particular pattern of effects is supported by the data. In the 1970s the findings appear to be flat out asymmetric, but in the subsequent periods they appear more symmetrically distributed.

Shortly after Revesz's study, Cross and Tiller (1998) conducted an empirical test on 170 cases in which the DC Circuit reviewed Agency interpretations of regulatory statutes. They found that unified panels (RRR or DDD in our lexicon) were 17% less likely to defer to Agencies than were split panels (RRD or DDR). It is difficult to interpret their findings in our framework; we are looking for moderation on a political dimension, not a tendency to defer. However, they produced one statistic that appears to support moderation by split panels. They calculated that unified panels deferred to Agencies only 33% of the time when the panel's politics would not support the Agency's position, but deferred to the Agency 62% of the time when the panel was split (significant at.05). (Cross and Tiller, 1998, pg. 2172). This is evidence for moderation, we believe.

Sunstein, Schkade and Ellman (2004) investigated the votes of federal appeals judges in thirteen categories. They found that although the typical pattern of panel effects existed in most of the subject areas (e.g. campaign finance, affirmative action, EPA regulation) in one it was muted (Title VII discrimination cases) and in three areas (federalism, criminal law, takings clause) the pattern was missing entirely. In some of the areas the effects were symmetric, while in other areas not. In two areas (abortion and capital punishment) they found pure ideological voting, but no panel effects, at all.

Miles and Sunstein (2006, 2008) also present evidence supporting panel effects[16] and exhibiting some asymmetries. They investigate all Circuit Court review of EPA and NLRB decisions between 1996 and 2006 for insufficient factual basis or for being arbitrary or capricious, which together they call "arbitrariness" review. Next, they compute "validation rate," which is the rate at which the court upholds administrative action against challenge. Then they code administrative action by looking at who challenged Agency action; if industry challenged the Agency action then the Agency action is liberal, whereas

[14] Revesz at 1759

[15] Revesz at 1760.

[16] In a similar vein, see Cox and Miles (2007).

if a union or an environmental group challenged an Agency action, then the Agency action was conservative. Last, Miles and Sunstein coded each judge's political party as equal to the party of the appointing president for that judge.

Miles and Sunstein found the same basic ideological component of voting that others have found. Judges appointed by Democratic Presidents were more likely to vote to validate liberal administrative agency actions than they were to validate conservative ones. Judges appointed by Republican Presidents had the reverse tendency. In addition, judges appointed by Republican Presidents were more likely to vote to validate conservative Administrative Agency actions when they were sitting with two other Republican Judges than when they were sitting with a Democrat. Judges appointed by Democratic Presidents seemed to behave in more complicated ways.

Unfortunately, Miles and Sunstein constructed their measures by pooling all mixed panels, rather than separating, for example, DRR and DDR panels. So, we cannot observe the change in tendencies between a minority member of a panel and the same judge as part of a two-judge majority. Using their approach, Miles and Sunstein measure the change in willingness of a Democratic judge to uphold agency decisions when he is moved from a unified Democratic panel to a mixed panel. Miles and Sunstein find that Democratic judges are significantly less likely to uphold liberal Agency decisions when they are moved to mixed panels, and (perhaps) significantly more likely to uphold conservative Agency decisions when on mixed panels. A similar approach measures the change in the willingness of Republican judges to uphold Agency decisions. Miles and Sunstein find that a Republican judge on a mixed panel is significantly more likely to uphold a liberal Agency action than is a Republican judge on a unified panel. And a Republican judge is (insignificantly) less likely to uphold a conservative Agency decision when part of a mixed panel than when part of a unified panel. We regard these results as evidence in favor of panel effects; that is, inclusion on a mixed panel tends to moderate voting patterns. It is less clear whether the Miles & Sunstein results should be taken as evidence of an asymmetry, however. We tentatively conclude the evidence is probably consistent with either symmetry or asymmetry.[17]

[17] Cf Schanzenbach and Tiller (2008), which reviewed the treatment of sentencing guidelines after the Supreme Court's Apprendi v. New Jersey and United States v. Booker decisions. Apprendi and Booker rendered the guidelines "advisory." Using an informal PPT model of strategic sentencing by District Court judges under the guidelines, they make empirical predictions:

The empirical implications, thus, are as follows: (1) policy preferences matter in sentencing-liberal (Democratic-appointed) judges give different (generally lower) sentences than conservative (Republican-appointed) judges for certain categories of crime; (2) the length of the sentence given by sentencing judges depends on the amount of political-ideological alignment between the sentencing judge and the circuit court; and (3) sentencing judges selectively use adjustments and departures to enhance or reduce sentences, and the use of departures is influenced by the degree of political alignment between the sentencing judge and the overseeing circuit court, while the use of adjustments is not so influenced.

Adjustments, which are very difficult to review by the appellate court, allow some (almost) unreviewable sentencing discretion to the sentencing judge, while departures, which are much more likely to be reviewed, give the sentencing judge much more discretion to adjust the

Some recent pieces have injected some skepticism (or at least noise) in the enterprise of empirical estimation of judicial preferences. Edwards and Livermore (2009, pg. 1916), for example, strongly criticize this literature, partly on the ground that it is based on an attitudinal model that does not take into account deliberation. Our model is the first that we know of to attempt to characterize an aspect of deliberation – exchange of information. For reasons that are not clear, several commentators seem to regard collegial deliberation as inconsistent with ideological explanations. (Edwards and Livermore (2009, pg. 1917); Tacha (1995, pg. 586); Wald (1999, pg. 255). As our model shows, the two concepts can work together. Landes and Posner (2008) "correct" and clean the most commonly used data bases, and then present a large number of analyses. They claim that they could not code lower Federal Court votes as majority or dissent, and hence do not say little about panel effects per se. They did find, however, that judges appointed by Democratic Presidents were more likely to cast liberal votes than were judges appointed by Republican Presidents, and also that mixed panels appeared to create some "moderation" in views, at least among Federal Circuit panels (but not on the Supreme Court).

In sum, the empirical literature provides significant support for ideological differences between Democrat and Republican judges in ways that "matter" for outcomes. It also provides evidence supporting the moderating effect of sitting on mixed panels instead of unified panels. This literature, moreover, provides some evidence of the tendency of minority and majority judges on mixed panels to move towards each other when voting. Finally, there is some intermittent evidence that even as they respond in a qualitatively symmetric pattern, Republican and Democrat judges do not always behave as complete mirror images of each other quantitatively.

3 Model

In this section, we develop and analyze a formal model of strategic information acquisition among individual judges in multi-judge panels. Using this model, we show how ideological diversity, even if insufficient to change median voter preferences, may still generate voting patterns that appear to look very much like moderating panel effects. The driving force behind our result is in the endogenous nature with which judges produce information that is informative to all panel members. Our model builds on the basic framework set out in Spitzer & Talley (2000), but it adds a few modifications and simplifications to focus on

sentence if (and only if) he is politically aligned with the Court of Appeal in his circuit.

Their data on effect of alignment are weakly supportive of their hypothesis. For Democratic judges who are sitting in a Democratic Circuit, the coefficients on length of sentence (shorter) , probability of departing from the Guidelines (higher), and the size of downward departure from Guidelines (larger) are all consistent with their hypothesis, but only the coefficient on probability of departure is significant. We regard this as weak evidence in favor of the whistleblower theory, and weak evidence of some asymmetry in judicial review of lower courts.

the effects of multi-member upper courts. In order to expose our key intuitions, we will start with a simple information structure. In later sections, we will discuss how our result carries over to more complex informational environments.

3.1 Framework

Consider a two-level hierarchy, consisting of a unitary initial actor, A, representing an administrative agency or a district court, and a reviewing/appellate panel J that may review the A's decision. We assume that the decision at issue concerns a regulatory / policy outcome denoted as Y, normalized so that $Y \in \{-1, 1\}$. Intuitively, we will think of this decision as tantamount to a choice between a "liberal" policy ($y = -1$) and a "conservative" policy ($y = 1$). For example, if the first-level actor is an administrative agency, it might be considering maintaining a de-regulatory status quo ante or adopting a more restrictive regulation.[18] In contrast, if the first-level actor is a lower court, it might be considering whether to interpret a statute in a way that favors consumers or businesses.

Although we allow actors to be motivated by political commitments, we also suppose that they care about the fit between their policy choice and objective states of the world – what we will call "facts." Specifically, we presume that some random variable $X \in \mathbb{R}$ represents the "true" facts, and that X is commonly known *ex ante* to be normally distributed with mean μ and precision τ.[19] (Our framework also admits the limiting degenerate case when $\tau \to 0$, so that priors are essentially uninformative).

3.1.1 Judicial & Agency Actions and Preferences

Information about the true realization of facts, x, is important to all decision makers because it affects their assessment of which policy y is the best fit between the facts and policy commitments. In particular, we assume that each regulatory / judicial actor i realizes quadratic payoffs over policy outcomes of the form $-(x + \theta_i - y)^2$, where x and y are as described above, and $\theta_i \in \mathbb{R}$ denotes the *ideological leaning* of the actor in question. Each actor's ideology is drawn from a distribution $H(\theta)$. We place little structure (at this stage) on the distribution of ideological leanings across the population of the various actors (indeed, it could be composed of say, two mass points at $\theta_i \in \{\theta_D, \theta_R\}$, corresponding to "Democrats" $(\theta_i = \theta_D)$, and "Republicans" $(\theta = \theta_R > \theta_D)$). Regardless, each actor possesses an ideal point in policy space, $y^*_{\theta_i} = x + \theta_i$, and utility falls in the squared distance from that point. Note that while actors' preferences are fixed, the location of their ideal points – which reflect their

[18] It would, in principle, be possible to allow for the policy space to involve more than two outcomes, but in many circumstances this is a reasonable assumption and it exposes our intuitions most cleanly.

[19] Because normal distributions make our analysis significantly more tractable, we will utilize them throught the analysis below. It will, however, become clear below that our general arguments to do not turn crucially on this distributional form.

ideologies – also dependent on the realization of facts x. This is by design, as our framework allows for (and indeed presumes) actors who may lean left or right, but are not "ideologues." In principle, the underlying facts (x) could be strong enough to overcome political leanings (θ_i), and thus cause a left-leaning judge/agency to favor a relatively conservative policy (and vice versa).

Figure 1 below illustrates the ideal point mapping, in the specific case where the $x = \frac{1}{2}$, comparing the ideal point of two decision makers: a "Democrat" (with $\theta_i = \theta_D \equiv -1$); and a "Republican" (with $\theta_i = \theta_R \equiv 1$). In the figure, the Republican judge leans toward conservative policies on a priori grounds; when she observes a set of facts $\left(x = \frac{1}{2}\right)$ that also pushes in that direction, her ideal point becomes $y_R^* = 1.5$. If constrained to choose some $y \in \{-1, 1\}$, she will prefer $y = 1$. The Democrat, in contrast, leans liberal; observing facts that mildly support a conservative outcome pushes her mildly right, but only enough to move her ideal point to $y_D^* = -0.5$. Thus, the Democrat judge would favor $y = -1$. Had the facts (i.e., the realization x) taken on a larger value ($x > 1$), it would be enough to sway the Democrat to support the conservative outcome. (And symmetrically with the Republican for $x < -1$).

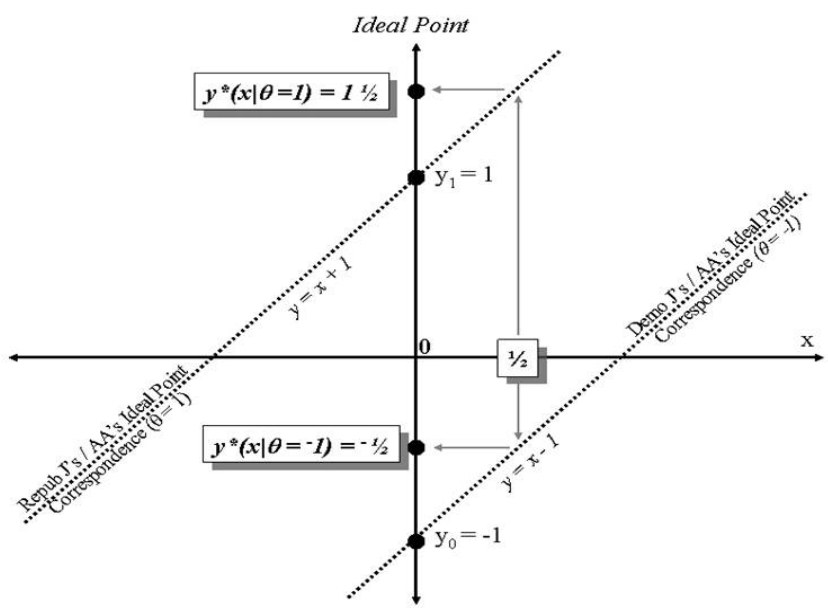

Figure 1: Ideal point as a function of facts (x) & ideology (θ)

Our model injects a significant complication into the story illustrated by Figure 1. Specifically, decision makers are assumed to act without complete information about the realization of x. Rather, they endeavor to maximize $-E_{x|\omega}\left\{(x + \theta_i - y)^2 |\omega\right\}$, where ω denotes the decision maker's available infor-

mation (described in greater detail below).

The judicial review process in our posited game consists of two stages. In the first stage, the lower level actor (Player "A") possessing ideology θ_A makes a decision about legal/regulatory policy. In reaching its decision, Player A and is privy to a signal $Z \in \mathbb{R}$, which conveys noisy information about x. We assume that Z is itself normally distributed, with mean x and precision γ, so that $Z \tilde{} N\left(x, \frac{1}{\gamma}\right)$. (We also assume that this signal is either automatically generated or is collected at no incremental cost to the decision maker). After observing the signal, player A acts announces a regulatory rule, $y = -1$ or $y = 1$.

After player A makes a decision, the second stage begins. In this stage, player A's policy ruling may be appealed to an appeals court with exogenous probability $\pi \in (0, 1)$. The appellate court, denoted collectively by J, is in turn composed of an odd number of $(2M - 1)$ judges, where $M \in \{1, 2, 3, ...\}$, chosen at random – and only after A has acted – from the judiciary pool.[20] For a given panel, then, the set of judicial ideologies is given by $\Theta \equiv \{\theta_1, ..., \theta_{2M-1}\}$. Without loss of generality, one can re-index the individual panelists in terms of ascending ideological "order statistics", $\left\{\theta_{(1)}, ..., \theta_{(M)}, ..., \theta_{(2M-1)}\right\}$, so that $\theta_{(1)}$ corresponds to the ideology of the *most liberal* judge on the panel, $\theta_{(2M-1)}$ corresponds to the ideology of the *most conservative* judge on the panel, and $\theta_{(M)}$ corresponds to the ideology of the *median* judge on the panel. As it turns out, we will be particularly interested in a 3-tuple of order statistics consisting of $\hat{\Theta} \equiv \left\{\theta_{(1)}, \theta_{(M)}, \theta_{(2M-1)}\right\}$, which corresponds to the extreme left, extreme right and median ideologies of the panel (the "Left, Right and Center" if you will).

Should the appellate panel hear the case, we assume it costlessly observes the realization of Z – that is, the factual signal / record upon which the agency relied.[21] In addition, however, any of the judges on the panel may, at a cost, invest in an "auditing" technology that reveals an additional signal – denoted V – where $V \tilde{} N\left(x, \frac{1}{\sigma}\right)$. Significantly, auditing is costly, imposing a fixed effort cost $c > 0$ on the auditing judge, entering additively into her payoff. The value of c reflects the opportunity cost of judicial time (which may be a function of docket pressures, etc).[22] Nevertheless, each panelist acts independently in deciding whether to audit. We further assume that signal constitutes a common value across panelists: that is, if any of the judges purchase V, she can credibly share

[20] A three-judge panel, therefore, would correspond to $M = 2$; the U.S. Supreme court would correspond to $M = 5$. The assumption here is meant to track actual practice. Three-judge appeals panels are drawn randomly from the court of appeal judges in the circuit in which review takes place. Thus, the Agency can only form a probabilistic estimate of who might be on the panel. Further, if more than one suit is filed in timely fashion in different Circuits against the Agency action, a lottery determines which Circuit will hear the appeal (28 U.S.C. § 2112(a)). This vastly complicates the computational load on the Agency.

[21] Note that this assumption is different from Spitzer & Talley (2000), where the appellate judge was assumed only to observe the lower level actor's decision, and observed the lower court's signal only if investing in additional verification. In a later sectoin we disextend our analysis to the case where player A's signal is not observable without an additional investment.

[22] All our results carry over to the case where the realized value of c is stochastic, and drawn from a distribution function $G(c)$ defined on $c \in (0, \infty)$.

her observation with other members of the committee.[23] Moreover, if a judge if more than one judge purchases a signal, the second purchase provides no additional information. Once the judges (if any) have purchased and shared the signal, the panel makes a decision by majority vote.[24] Should the panel overturn A's decision, we suppose that A suffers a reputational cost equal to $\varepsilon \geq 0$. We will require that all players' policy votes and auditing decisions are consistent with the solution concept of Bayesian perfection.

3.1.2 Motivating J's "Extra" Signal

Before proceeding, it seems sensible to pause at this juncture to motivate and animate our assumption about an additional "signal" available to individual panelists on J through auditing. What would it mean, in institutional terms, for an appellate court panelist to spend significant resources to "take another draw" on the facts? One obvious meaning could be a closer examination of the materials in the docket. But since they are usually the same materials that the trial judge confronted, the draw should have the same content. On the other hand, since the judge (and his clerks) have different backgrounds and abilities than the Agency administrator, and since they are acting at a different time, the nature of their inference may be substantially different. The Court of Appeals is supposed to review the entire record as part of its duty in an appeal. But a "review" can be done with more or less attention paid to the contents. A careful, costly review would plausibly fit with our characterization of "another draw."

As an alternative, one could regard the docket materials that the Agency used as the "first" draw, with the appellate court's subsequent draw coming from new materials about the same problem. Where would the new materials come from? A few possibilities suggest themselves. First, amicus briefs often contain or refer to studies that were not before the Agency. Second, Agencies often receive studies and written testimony after the closing date for the submission of evidence. Sometimes these studies were being created, but were not yet complete, at the time the Agency closed the docket. In other circumstances studies are done in response to the Agency's "concise statement of basis and purpose" published in the Federal Register.[25] On appeal, the reviewing court must decide whether to consider the new materials, and how much attention to give to them.

As a third (related) alternative motivation, new information may be submit-

[23] At this stage we are not allowing panelists to hide or distort their monitoring activities on either the extensive or intensive margin.While such extensions are fairly straightforward, they add distracting complications. In a later section we discuss how such alternative environments would operate within our framework.

[24] There is a parallel literature, originally due to Kornhauser (1992a, 1992b), which conceptualizes "law" (and which he calls an "extended rule") as a mapping of all possible sets of facts into outcomes. Our structure unpacks the way in which judges come to know the facts. However, in our structure, the translation into final outcomes is probabilistic for any true set of facts. This is because the judges cannot learn the facts with certainty.

[25] Administrative Procedure Act § 553.

ted by the parties themselves. Consider, for example, the famous case *Scenic Hudson Preservation Conference v. Federal Power Commission.*[26] In *Scenic Hudson,* the court reviewed the FPC's decision to grant permission to Consolidated Edison to build a pumped storage hydroelectric power plant on the Hudson River. The plaintiffs, who were residents and environmentalists, objected (perhaps strategically) that the plant would be very hard on fish, would look ugly, and would interfere with other uses of the Hudson River valley. After the closing of the docket, plaintiffs petitioned the FPC to allow additional evidence on the feasibility of gas turbines, rather than using hydroelectric power[27] and the relocation of the plant so as to avoid fish.[28] The court could have just dismissed these claims as untimely, and noted the wide discretion given to Agencies (sometimes) as to when to close their dockets. Instead, the court clearly took a serious (and, we might surmise, costly) look at the materials that parties had attempted to submit. According to the court's opinion, it was the serious look at these materials that persuaded it to remand the proceeding to the FPC. Within our framework, a decision to "take another draw" may reflect a decision to consider materials submitted after the Agency's docket closed.

3.2 Panelists' Optimal Strategy

The first (and most painstaking) task for characterizing the equilibrium of this game is to analyze the incentives of the members of a representative judicial panel that is hearing an appeal, assuming that A has already rendered a decision. Ultimately, the members of that panel must decide both whether to collect additional information (become informed) and how to vote. To make predictions about their individual payoffs (and thus their behavior in a group), we need to compare the likely actions and expected payoffs of informed and uninformed judge, respectively. To do so, let us first consider the preferences of each panelist in isolation.

3.2.1 Uninformed Preferences and Decisions

Let us begin with a representative uninformed judicial/administrative actor, who has ideology θ_i and observes only the lower level actor's signal, z, and define such an actor's preferred choice here to be y_i^U. By definition of the judge's payoff function, it is easy to confirm that $y_i^U = 1$ (i.e., panelist i favors the conservative

[26] 354 F.2d 608 (2nd Cir. 1965), cert. den. ___ U.S. ___ (196_).
[27] *Id.* At 618.
[28] *Id.* at 624.

outcome) if and only if[29]:

$$\begin{aligned} E\left(-\left(x+\theta_i-1\right)^2+\left(x+\theta_i+1\right)^2|z\right) &\geq 0 \\ E\left(x|z\right) &\geq -\theta_i \\ \frac{\tau\mu+\gamma z}{\tau+\gamma} &\geq -\theta_i \\ z &\geq z_i^U \equiv -\frac{\theta_i\left(\tau+\gamma\right)+\tau\mu}{\gamma} \end{aligned} \tag{1}$$

It is easily confirmed that z_i^U is strictly decreasing in θ_i, and thus for any two decision makers j and k with $\theta_j < \theta_k$, $z_j^U > z_k^U$. Intuitively, this means that more liberal players are a "harder sell" on the conservative outcome: they require a higher public signal z than do relatively conservative players in order to induce a preference for the conservative outcome. By the same reasoning, conservative actors are a harder sell on the liberal outcome. Note that since the administrative agency is a unitary actor with ideology θ_A if it were to act sincerely (more on this below) it would issue a policy decision that corresponds precisely with the above criterion.

Should the judicial panel hear the case, in contrast, its actions depend more on the median voter's ideology. Assuming the panel never becomes informed, the panel's decision will track the median voter's preferred outcome, y_M^I, yielding the conservative outcome over the liberal one if and only if:

$$z \geq z_M^U \equiv -\frac{\left(\theta_{(M)}\cdot\left(\tau+\gamma\right)+\tau\mu\right)}{\gamma} \tag{2}$$

Given this behavior, the representative panelist with ideology θ_i sitting on a panel that has remained uninformed will realize an expected payoff of[30]:

$$\begin{aligned} \pi_U\left(\theta_i|z,\theta_{(M)}\right) &= -E_{x|z}\left\{\left(\left(x+\theta_i\right)-y\right)^2|z\right\} \\ &= -\left(\frac{1}{\tau+\gamma}+\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}+\left(\theta_i+1\right)\right)^2\right)+\begin{cases} 0 & \text{if } z\leq z_M^U \\ 4\left(\theta_i+\frac{\tau\mu+\gamma z}{\tau+\gamma}\right) & \text{else} \end{cases} \end{aligned} \tag{3}$$

An example of expected payoffs for uninformed panelists is pictured in Figures 2A 2B and 2C below for the parametric restriction where $\mu = 0$, $\tau = 0.5$, and $\gamma = 1$. The figure envisions a 3-judge panel consisting of a "liberal" $\left(\theta_{(1)} = -1\right)$ a "centrist" $\left(\theta_{(2)} = 0\right)$ and a "conservative" $\left(\theta_{(3)} = 1\right)$, and depicts for each judge the expected payoffs associated with both the liberal policy choice

[29] The last line in the derivation comes from invoking Bayes theorem to show that $(X|Z)$ is normally distributed with mean $\frac{\tau\mu+\gamma z}{\tau+\gamma}$, and variance $\frac{1}{\tau+\gamma}$. A number of the other derivations below also depend on manipulated distributional parameters of the normal distribution. See appendix for details.

[30] See the Appendix for details of this derivation.

(black curve) and the conservative one (gray curve). In addition, each curve distinguishes between equilibrium payoffs (solid lines) and out-of-equilibrium payoffs (dashed lines). In Figure 2B, depicting the centrist panelist, note that the judge's equilibrium payoff tracks her maximal expected payoff, reflecting the power of the median voter to dictate outcomes. So long as the court remains uninformed about v, the panel's decision will track the median judge's preferences as illustrated in Figure 2B. Note also that a local minimum of her expected payoff occurs at $z_0^U = 0$, where the judge is indifferent (or perhaps more accurately, ambivalent) between the conservative and liberal policy. In Figure 2A, the liberal panelist is far more pre-disposed towards the liberal outcome than the conservative one. In fact, it takes a relatively strong factual case ($z > 1.5$) to sway her to favor the conservative policy. Nevertheless, her equilibrium payoff experiences a downward discontinuity at $z = 0$, corresponding to the fact that at this point the median panelist would swing in favor the conservative outcome. Figure 2C illustrates the opposite case, for a judicial actor whose ideology is $\theta_i = 1$. For this judge, the indifference point between outcomes occurs at $z_{-1}^U = -1.5$, reflecting the fact that it takes an analogously strong case ($z < -1.5$) to sway the conservative actor to the liberal policy. Similar to the liberal panelist, the conservative judge's payoff also realizes a discontinuity (this one upward) at $z = 0$, reflecting the point where the median swings from liberal to conservative. It will turn out the location of the median judge's indifference point – and any payoff discontinuities for the non-median judges at that point – relate directly to auditing incentives within the panel.

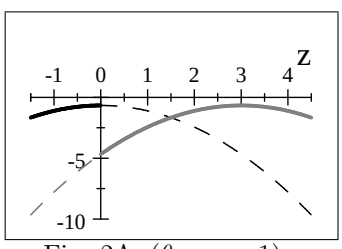

Fig. 2A: ($\theta_{(1)} = -1$)

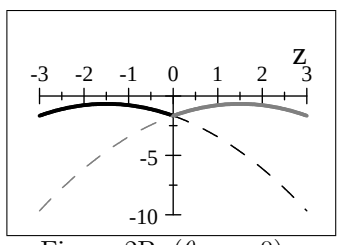

Figure 2B: ($\theta_{(2)} = 0$)

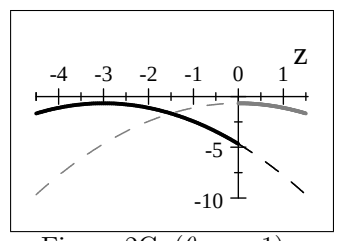

Figure 2C: ($\theta_{(3)} = 1$)

3.2.2 Informed Preferences and Decisions

Now let us consider strategies and payoffs assuming the panel becomes informed, so that the representative judge i with ideology θ_i will develop an ideal point that depends on both z and v; as above, define such an informed actor's preferred choice here to be y_i^I. By definition of the judge's payoff function, it is easy to confirm that $y_i^I = 1$ (i.e., panelist i favors the conservative outcome) if and only

iff:

$$
\begin{aligned}
E\left(-\left(\theta_i+x-1\right)^2+\left(\theta_i+x+1\right)^2|z,v\right) &\leq 0 \\
E\left(x|z,v\right) &\geq -\theta \\
\frac{\tau\mu+\gamma z+\sigma v}{\tau+\gamma+\sigma} &\geq -\theta_i \\
v &\geq v_i^I \equiv -\left(\frac{\theta_i\cdot(\sigma+\tau+\gamma)+z\gamma+\tau\mu}{\sigma}\right)
\end{aligned} \tag{4}
$$

This in turn implies that for a given z, an informed panel will issue a holding coinciding with the informed median judge's preferred outcome, or y_M^I. In other words, the panel will issue the conservative outcome iff:

$$
v \geq v_M^I \equiv -\left(\frac{\theta_{(M)}\cdot(\sigma+\tau+\gamma)+z\gamma+\tau\mu}{\sigma}\right) \tag{5}
$$

Thus, for a judge with ideology θ_i on an informed panel with ideological profile Θ, her expected payoff conditional on being informed is given by[31]:

$$
\begin{aligned}
\pi_I\left(\theta_i|z,\theta_{(M)}\right) &= -E_{v|z}\left\{E_{x|z,v}\left(x+\theta_i-y^*\right)^2|z,v\right\} \\
&= -\left(\frac{1}{\tau+\gamma}+\left(\frac{z\gamma+\tau\mu}{\tau+\gamma}+(\theta_i+1)\right)^2\right) \\
&\quad +4\cdot\left(\theta_i+\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)\left(1-\Phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right)\right) \\
&\quad +4\cdot\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}\cdot\phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right)
\end{aligned} \tag{6}
$$

3.2.3 The Value of Information

Having characterized the expected payoffs associated with both uninformed panels and informed panels, we are now in a position to consider the expected difference – denoted as $\Delta\left(\theta_i|z,\theta_{(M)}\right)$ – between the judge's expected payoff in the informed state and its counterpart payoff in the uninformed state. Implicitly, then, $\Delta\left(\theta_i|z,\theta_{(M)}\right)$ corresponds to the expected value (in equilibrium) each judge places on additional information (in the form of signal v). It is therefore a function of not only the judge's own ideology, but also of the known facts in the uninformed state (z) and the ideology of the median judge $\theta_{(M)}$, who provides

[31] See the Appendix for details of this derivation.

the pivotal vote on the panel. Differencing (3) from (6) yields the following:

$$\begin{aligned}\Delta\left(\theta_i|z,\theta_{(M)}\right) &= \pi_I\left(\theta_i|z,\theta_{(M)}\right)-\pi_U\left(\theta_i|z,\theta_{(M)}\right) \\ &= 4\cdot\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}\cdot\phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) \\ &\quad +4\left(\theta_i+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)\cdot\begin{cases}\left(1-\Phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right)\right) & \text{if } z\le z_M^U \\ -\Phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) & \text{if } z> z_M^U\end{cases}\end{aligned} \tag{7}$$

where $\phi(.)$ and $\Phi(.)$ represent the standard normal probability density and cumulative distribution functions, respectively.

This expression embodies a core intuition from this paper. Note that for each judge i, the value of information hinges on both the judge's own ideology (θ_i) and that of the median panelist $\left(\theta_{(M)}\right)$. This makes sense, since the judge's own policy commitments should factor into whether she finds more information helpful, but so should the pragmatic realization that additional information can affect the panel's ultimate decision only if it sways the median panelist. An additional signal, therefore, may not only help the judge refine her own assessment of the preferred policy, but in addition it may help to win over a median judge who was leaning in the opposite direction. Or alternatively, more information could cause the judge to lose the support of the median judge who had been allied with her. Consequently, the judge will tend to audit strategically and systematically only when more information is likely to help and not hurt. As a judge's ideology grows further distant from that of the median judge, the magnitude of these latter effects (winning over or losing the support of a wavering median judge) grows, and eventually predominates.

We express these observations in a series of lemmas as follows:

Lemma 1: *For the median judge, $\Delta\left(\theta_{(M)}|z,\theta_{(M)}\right)$ is maximal at $z=z_M^U$, and falls symmetrically in both directions as z diverges from z_M^U. Consequently, when panel ideologies are homogenous, the auditing range also will constitute a symmetric interval around z_M^U.*

Lemma 2: *If judge i is more conservative than the median judge $\left(\theta_i>\theta_{(M)}\right)$:*

- *Judge i values information more than the median judge when $z\le z_M^U$ and less than the median judge when $z>z_M^U$.*
- *The extent to which the more conservative judge's valuation exceeds / falls short of the median judge's increases strictly in θ_i.*

If judge i is more liberal than the median judge $\left(\theta_i<\theta_{(M)}\right)$:

- *Judge i values information more than the median judge when $z\ge z_M^U$ and less than the median judge when $z<z_M^U$.*

- *The extent to which the more liberal judge's valuation exceeds / falls short of the median judge's decreases strictly in θ_i.*

Figure 3 below illustrates Lemmas 1 and 2 in graphical form. The Figure returns to the same calibration as in Figure 2, involving a 3-judge panel composed of a liberal judge, a centrist median judge, and a conservative judge, in which $\hat{\Theta} = \{-1, 0, 1\}$. The figure also continues to assume that $\mu = 0$, $\tau = 0.5$, and $\gamma = 1$, and in addition that $\sigma = 1$. Each respective panel represents the value that the liberal, moderate and conservative judge attaches – in equilibrium – to the additional signal, as a function of the agency's signal z. The median judge (Figure 2B) always places positive value on the extra signal, since she will dictate the final outcome, and such information can only help her with this choice. In fact, an additional signal is *most* valuable when $z = 0$ – the point where median panelist is indifferent (or more aptly, maximally ambivalent) about whether to opt for the liberal or conservative policy option. As z moves away from this point of indifference, her preferred policy choice becomes more clear cut, and in turn the value she places on additional information falls off (symmetrically, as noted in Lemma 1).

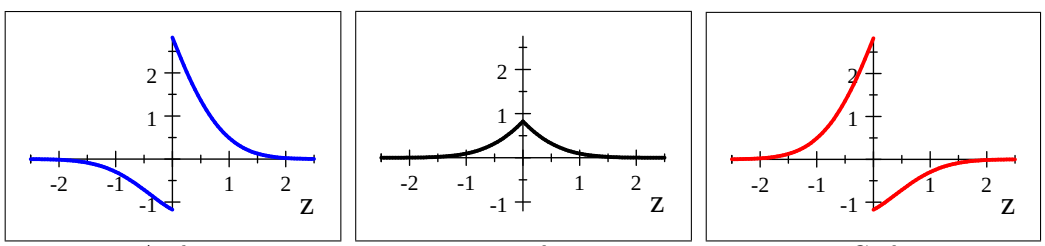

Figure 3A: $\theta_{(1)} = -1$ Figure 3B: $\theta_{(2)} = 0$ Figure 3C: $\theta_{(3)} = 1$

In contrast, the liberal and conservative judges (Figures 3A and 3C respectively) attach more complicated equilibrium valuations to additional information (as described in Lemma 2). The liberal judge, for example, values additional information only when the agency's signal $z \geq z_M^U = 0$. Moreover, in this region, the liberal judge places a much higher value on learning the new signal than either of the other panelists. When $z < 0$, in contrast, the liberal judge in this example actually places *negative* value on additional information, and certainly would not expend any effort to collect it. The intuition here is as follows: when $z \geq 0$, the liberal judge knows that the median panelist leans towards the conservative policy outcome. If she is able to convince the moderate judge to switch sides, the liberal judge expects to receive a discontinuous upward shock to her payoff. But she cannot win over the median judge without some informational ammunition; by auditing, she may discover information that will bring the median voter on board, and in the process generate a significant welfare payoff. In contrast, when $z < 0$, the median panelist is already leaning her support towards the liberal policy; additional information, while nice in the

abstract, runs an appreciable risk pushing the median panelist to the other side of the political aisle. In the example pictured in Figure 3, this latter threat is so significant that it swamps any plausible value from auditing when $z < 0$ for the liberal panelist. Exactly the opposite logic follows for the conservative judge: she places significant value on auditing when $z \leq z_M^U = 0$, so that the median judge is leaning towards the liberal outcome. In contrast, the conservative judge places no value (and even negative value) on more information when $z > 0$.

Put together, then, in this example *either* the liberal *or* the conservative judge (but generally not both) has a greater incentive than the median judge to collect additional information. As it turns out, this logic carries over more generally to panels of arbitrary size and ideology, an insight that we convey using Lemmas 3 and 4:

Lemma 3: *When $z < z_M^U$ the most conservative judge (with ideology $\theta_{(2M-1)}$) has the maximal incentive of all panelists to audit. Similarly, when $z > z_M^U$, the most liberal judge (with ideology $\theta_{(1)}$) has the maximal incentive to audit. If $z = z_M^U$, the most conservative (most liberal) panelist has the greatest incentive to audit when $\left(\theta_{(2M-1)} - \theta_{(M)}\right)$ is larger (smaller) than $\left(\theta_{(M)} - \theta_{(1)}\right)$.*

Lemma 4: *If $c \leq c(\hat{\Theta}, z)$, the panel will audit (and thus learn v) where*

$$\begin{aligned} c(\hat{\Theta}, z) \quad = \quad & 4\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}} \cdot \phi\left(-\frac{\theta_{(M)} + \frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) \\ & + \begin{cases} 4\left(\theta_{(2M-1)} + \frac{\tau\mu+\gamma z}{\tau+\gamma}\right) \cdot \left(1 - \Phi\left(-\frac{\theta_{(M)} + \frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right)\right) & \text{if } z \leq z_M^U \\ -4\left(\theta_{(1)} + \frac{\tau\mu+\gamma z}{\tau+\gamma}\right) \cdot \Phi\left(-\frac{\theta_{(M)} + \frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) & \text{if } z > z_M^U \end{cases} \end{aligned} \tag{8}$$

This criterion implicitly defines strictly positive (but possibly asymmetric) auditing interval $\left[\underline{z}(\hat{\Theta}), \overline{z}(\hat{\Theta})\right]$ around z_M^U. When the panel audits, the additional signal is collected by the most conservative (liberal) member whenever $z \in [\underline{z}(\hat{\Theta}), z_M^U)$ (whenever $z \in (z_M^U, \overline{z}(\hat{\Theta})]$).

Note from Lemma 4 that the auditing interval is characterized by the ideologies of the median judge and the two ideologically most extreme judges. Interestingly, no other judge's ideology enters into the expression from Lemma 4 (at least with this characterization of the model[32]). In general, as the extreme members of the panel become increasingly extreme, the auditing range grows (and with it grows the prospect of agency reversal).

[32] Generalizations of the model might make other judges' ideolgies important in the analog of Proposition 1. For example, if the judges faced differential costs in auditing, a low-cost moderate judge may place a higher net benefit on auditing than an extreme judge who faces a high cost of auditing. Similarly, if a moderate judge can collect a more accurate signal than an extreme judge, that moderate judge may determine the extreme end of the interval.

A number of corollaries immediately follow from inspection and/or differentiation of the expression in Lemma 4. They are as follows:

Corollary 4.1: *All else constant, the auditing range expands as the panel becomes more ideologically diverse (i.e., the left and/or right wing grow further from the median ideology).*

Corollary 4.2: *The effect noted in Corollary 4.1 is potentially asymmetric. That is, as the conservative (liberal) wing of the party grows more extreme, the panel is increasingly likely to reject liberal (conservative) policies that the uninformed median voter would have favored; but it is no more or less likely to reject conservative (liberal) policies that the uninformed median voter would have favored.*

Corollary 4.3: *The auditing range is invariant to all median- and extrema-preserving transformations; e.g., if one holds constant the ideology of the median, most liberal and most conservative judges, then the auditing ranges produced by, say, a 3 judge panel and a 99 judge panel are the same.*[33]

Corollary 4.4: *The auditing interval is strictly increasing in the precision of the auditing technology* (σ), *and strictly decreasing in both the precision of A's signal* (γ) *and the realized cost of auditing* (c).

3.3 Agency's Optimal Strategy

Having characterized the equilibrium strategy of the judicial panel J should an appeal occur, we now move backwards in sequence to analyze the strategy of the agency (A), who in equilibrium anticipates the continuation strategy described above. Recall that A is motivated both by a desire to implement her preferred outcome (*i.e.,* the one closest to her fact-contingent ideal point) and a desire to avoid being overturned by J. Moreover, recall that with probability $(1-\pi)$, player A's decision will never be appealed, in which case the best she could do is to implement her sincere policy choice given z. On the other hand, if A's decision is appealed (with probability π), her payoff becomes more complicated. Most directly, A suffers a cost ε should her decision be overturned by J. But there may also be a silver lining to reversal, if the reviewing court also augments A's information through auditing, they will issue a more informed policy choice, which will also affect – and may even increase – A's welfare. Combining these factors, A's expected payoff given z is:

[33] This may not be true, by the way, when panelists are capacity constrained as to how many simultaneous audits they can do across different cases.

$$(1-\pi)\cdot E_x\left(-\left(x+\theta_A-y_A\right)^2|z\right) \tag{9}$$
$$+\pi\cdot\left(\begin{array}{l} E_{\hat{\Theta},x}\left[\left(1-q_{\hat{\Theta},z}\right)\times\left(-\left(x+\theta_A-y_M^U\right)^2-\left\{\begin{array}{lll}0 & if & y_M^U=y_A\\ \varepsilon & else & \end{array}\right.\Big|z;c>c\left(\Theta,z\right)\right)\right] \\ +E_{\hat{\Theta},x,v}\left[q_{\hat{\Theta},z}\times\left(-\left(x+\theta_A-y_M^I\right)^2-\left\{\begin{array}{lll}0 & if & y_M^I=y_A\\ \varepsilon & else & \end{array}\right.\Big|z,v,c\leq c\left(\Theta,z\right)\right)\right]\end{array}\right)$$

where $q_{\hat{\Theta},z}$ is an indicator function taking on a value of 1 if, for an ideology configuration of $\hat{\Theta}$, the agency's signal z lies within the panel's auditing interval.[34] Remember that because panelists are not selected until *after* player A has reached a decision, she may not know for sure whether the facts of the case before her will fall within J's auditing interval, and she must therefore take expectations over the probability density for the 3-tuple $\hat{\Theta}=\left\{\theta_{(1)},\theta_{(M)},\theta_{(2M-1)}\right\}$, which we denote as $f(\hat{\Theta})$.[35]

Inspection of its structure allows some simplification of its analysis. First, note that A's decision, y_A only enters into this expression in two ways: (1) It directly affects A's payoff in the event that no appeal is heard, and (2) it affects the potential costs that A may suffer if she is overturned by J. Numerous other terms of this expression, including $q_{\hat{\Theta},z}$, $\left(x+\theta_A-y_M^U\right)$ and $\left(x+\theta_A-y_M^I\right)$, are invariant to A's ultimate choice, and can effectively be held constant. These observations, in turn, yield Lemma 5:

Lemma 5: *Given the equilibrium behavior of a panel with configuration $\hat{\Theta}$, A will make the conservative decision if and only if:*

$$\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}+\theta_A\right)\geq\frac{\pi\varepsilon}{4\left(1-\pi\right)}\cdot\left(\begin{array}{c}\iiint\limits_{\hat{\Theta}|z<\underline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta}-\iiint\limits_{\hat{\Theta}|z>\overline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} \\ +\iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]}\left(2\Phi\left(-\left(\theta\tau+\theta\gamma+z\gamma+\tau\mu\right)\right)-1\right)f(\hat{\Theta})d\hat{\Theta}\end{array}\right) \tag{10}$$

To best understand the expression in Lemma 5, it helps to think about the limiting cases for the probability of appeal (π) and the cost to being reversed (ε). Consider first how the agency would decide a case if its cost of being overturned were zero or negligible, so that $\varepsilon\approx 0$. This assumption may be plausible in many situations. One could imagine, for example, that agency appointees are not sufficiently long lived to worry much about a subsequent court's actions; or that public attention tends to wane over time so that even if the agency head remains, later reversals barely register on the political radar screen *de jure*;

[34] In terms of Lemma 4, above,
$$q_{\hat{\Theta},z}=\left\{\begin{array}{lll}1 & if & z\in\left[z_{\min}(\hat{\Theta}),z_{\max}(\hat{\Theta})\right]\\ 0 & else & \end{array}\right. .$$

[35] The functional form of $f(\hat{\Theta})$ is provided in the Appendix.

or that agencies derive considerable utility from expressing their policy stance (rather than from its actual implementation). In such environments, the right hand side of (10) effectively disappears, and A's choice boils down to selecting the conservative outcome if and only if the left hand side of this expression is nonnegative, which occurs when $z \geq z_A^U$. Not surprisingly, this limiting case is identical to having the agency announce its sincere policy preference.

In a similar fashion, suppose cost of being overturned were non-trivial, but that the probability of appeal were negligible, so that $\pi \approx 0$. Here once again, the agency would focus on the left hand side of the expression above, and it would generate a sincere policy decision.

In contrast, suppose that both the costs of reversal were non-trivial and that the probability of appeal were close to unity. Here, the agency knows that its initial policy choice is almost certainly going to be revisited, and now it is the left hand side of the above expression that becomes close to zero. Now, A will tend to focus solely on the right hand side of (10), and will issue a conservative opinion iff:

$$\underbrace{\iiint\limits_{\hat{\Theta}|z<\underline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} + \iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]} \Phi\left(-\left(\theta\left(\tau+\gamma\right)+z\gamma+\tau\mu\right)\right) f(\hat{\Theta})d\hat{\Theta}}_{E(\Pr\{J \text{ reverses a conservative decision } |z\})} \quad (11)$$

$$\leq \underbrace{\iiint\limits_{\hat{\Theta}|z>\overline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} + \iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]} \left(1-\Phi\left(-\left(\theta\left(\tau+\gamma\right)+z\gamma+\tau\mu\right)\right)\right) f(\hat{\Theta})d\hat{\Theta}}_{E(\Pr\{J \text{ reverses a liberal decision } |z\})}$$

Although this expression looks complicated, its interpretation is simple – in this case, the agency's strategy devolves into one of minimizing the expected probability of reversal. Effectively, the agency will endeavor to mimic the most likely decision of the future reviewing panel.

Finally, consider intermediate cases, where the combination of ε and π is sufficiently large to "matter" but not so large to dominate. Here, the agency will care both about its sincere policy commitments and its desire to avoid being overturned. In this parametric case, the agency's behavior will turn on the relative stakes from each concern. For example, if the facts the agency observes in a case z are very close to A's indifference point, z_A^U, then the agency will be ambivalent about which policy outcome it most desires. Here, its desire to avoid being overturned will tend to predominate. On the other hand, suppose the distribution of ideologies within the judiciary – and from which the panel is drawn – is highly dispersed, then it may be difficult for the agency to make strong predictions about whether the panel is ultimately more likely to overturn a liberal decision or a conservative one. Here, the agency may rationally throw up its hands at the prospect of gaming its decision against later reversals, and will instead concentrate on issuing a sincere policy decision.

3.4 Equilibrium

Having characterized the equilibrium payoffs of both A and all panelists in J, we can characterize an equilibrium for the game. Before doing so, however, it is necessary to dispose of a technical issue relating to equilibrium selection, particularly for the panelists on J. As should be clear from the above discussion, there can often be cases where more than one judge on a panel places positive value on auditing. Because auditing provides a public informational good to all, however, auditing by more than one panelist is not a pure strategy equilibrium, and any mixed strategy equilibria that support such outcomes are easily dominated by numerous coordinated pure strategy equilibria.[36] Thus, it is sensible to assume that the panelists will find some mechanism for coordinating their investments. One such mechanism, which we presume hereafter, is as follows:

Assumption A: *(1) If multiple judges on the same panel value additional information enough to justify auditing, then the judge who places the greatest value on the additional signal is presumed to invest and provide information to the panel. (2) If two or more judges on the same panel share the same greatest value of an additional signal, they utilize a commonly-observable randomization device that selects one of them to audit.*

Although Assumption A seems reasonable (at least to us), there are many alternatives that would generate outcome-equivalent equilibria.[37] Applying this selection assumption to the Lemmas above, the following result immediately emerges:

Proposition 1: *If Assumption A holds, the following is the unique equilibrium of the auditing game:*

- *The agency issues a conservative opinion iff the condition in (10) is satisfied;*
- *If an appeal occurs, and if* $z \in \left[\underline{z}(\hat{\Theta}), z_M^U\right)$, *panelist* $\theta_{(2M-1)}$ *audits (revealing* v*), and the panel issues a conservative decision iff* $v \geq v_M^I$;
- *If an appeal occurs, and if* $z \in \left(z_M^U, \overline{z}(\hat{\Theta})\right]$, *panelist* $\theta_{(1)}$ *audits (revealing* v*), and the panel issues a conservative decision iff* $v \geq v_M^I$;
- *If an appeal occurs, and if* $z = z_M^U$, *panelists* $\theta_{(1)}$ *and* $\theta_{(2M-1)}$ *randomize over who audits (revealing* v*), and the panel issues a conservative decision iff* $v \geq v_M^I$;

[36] One potential variation of our framework would involve each judge having access to a separate signal that is not common to others. We discuss this more below.

[37] For example, an alternative assumption (that is outcome equivalent) posits that judge i audits a case with initial signal z if (1) she places a positive net value on auditing, and (2) the next judge closer to the median judge (if she exists) does not place a positive net value on auditing.

- *If an appeal occurs, and if* $z \notin \left[\underline{z}(\hat{\Theta}), \overline{z}(\hat{\Theta})\right]$, *the panel remains uninformed about* v, *and it issues a conservative policy (overturning Player A if necessary) iff* $z \geq z_M^U$.

Note that just as in Lemma 4, in Proposition 1 the auditing decisions and policy choice of the panel are fully characterized by the ideology of the median judge and the two judges on either extreme of the distribution. Interestingly, no other judge's ideology enters into the expression from Proposition 1 (at least with this characterization of the model[38]). In general, as the extreme members of the panel become more and more extreme, the auditing range expands (as do the prospects for agency reversal). Notwithstanding the dominance of the median voter model in positive political theory, then, the results above suggest ways in which judicial panels (and other deliberative bodies) respond to their extreme wings rather than the middle. As such, it joins a growing literature in documenting how non-median members can affect outcomes, by lobbying, influencing, shaming, or (in our case) injecting different types of useful information. Given this effect, it is perhaps not surprising that there was so much concern about whether the moderately liberal Justice Souter's replacement on the US Supreme Court – Sonya Sotomayor – was only mildly liberal or extremely liberal. Although her appointment did not have an effect on the median voter of the court, it might have changed the extreme in a way that could have influenced the median (and consternated the extreme right wing). A similar explanation may apply prospectively when Justice Stevens – largely regarded as the most liberal member of the current court – leaves the bench.[39]

4 Examples, Simulations, and Empirical Implications

Although the framework developed above contains insights about how ideology, information, and deliberation interact within a very general framework, an immediate implication of the model pertains to so-called judicial panel effects along discrete party lines. As noted above, the empirical literature provides significant support for ideological differences between Democrat and Republican judges in ways that "matter" for outcomes. It also provides evidence supporting the moderating effect of sitting on mixed panels instead of unified panels, documenting a tendency of minority and majority judges on mixed panels to move towards each other when voting. Finally, there is some intermittent evidence

[38] Generalizations of the model might make other judges' ideolgies important in the analog of Proposition 1. For example, if the judges faced differential costs in auditing, a low-cost moderate judge may place a higher net benefit on auditing than an extreme judge who faces a high cost of auditing. Similarly, if a moderate judge can collect a more accurate signal than an extreme judge, that moderate judge may determine the extreme end of the interval.

[39] Indeed, Justice Stevens recent anemic hiring of clerks has been flagged as a sign of his impending retirement. See Kate Phillips, "Supreme Court Watch on Justice Stevens" New York Times (2 Sept. 2009) (http://thecaucus.blogs.nytimes.com/2009/09/02/supreme-court-watch-on-justice-stevens/).

that even as they respond in a qualitatively symmetric pattern, Republican and Democrat judges do not always behave as complete mirror images of each other quantitatively. Below we demonstrate how these predictions can play out in our model, first in the form of a numerical example, and then in a simulation calibrated against real-world data. Finally, we develop some preliminary thoughts about how our model might be tested against alternatives in the literature.

4.1 Numerical Example

First, consider a numerical example of our model involving a three judge panel. To fix ideas (and to concentrate on panel effects), suppose that the agency is a Democrat ($\theta_A = 1$), that the cost of reversal (ε) and/or probability of appeal (π) is negligible, and that that – as in the calibration exercise above – $\tau = 0.5$, $\mu = 0$, and $\gamma = \sigma = 1$. With these parameter values, it is easily confirmed that the ex ante chances of a liberal policy pronouncement by the agency are 80.6 49%, and the ex ante chances of a conservative pronouncement are 19.2 97%.

4.1.1 Homogenous DDD Panel

Consider first a judicial panel composed entirely of share judges with left-of-center ideology identical to the agency, so that $\theta_{(1)} = \theta_{(M)} = \theta_{(3)} = \theta_A = -1$. We define this set of panelists as being a homogeneously democratic panel, or "DDD." The solid line in Figure 4 below represents – for a given prior signal z – the expected value (to each panelist) of collecting an additional signal v. Notice that the value of information is symmetric around a maximum at $z = 1.5$, which is exactly the margin where the D-agency and D-judges are maximally ambivalent between the two policy outcomes. This makes great intuitive sense, as precisely at this margin of ambivalence where additional information is likely to be the most useful. In contrast, when $z < -0.5$ or $z > 3.5$, the ex ante case provided by the first signal (z) is so strong that an additional signal (v) is effectively 0 for the $D-$panelists. That is, more information is overwhelmingly unlikely to change their decision, and thus the expected value of auditing is therefore quite modest.

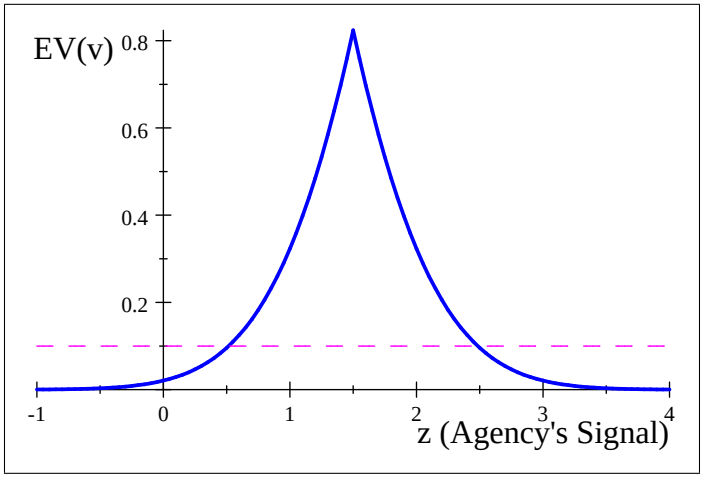

Figure 4: Auditing Range of DDD Panel

Continuing with the above diagram, suppose further that the distribution of costs of collecting the signal for a D-judge is given by a mass point $c = \frac{1}{10}$ (represented by the dashed horizontal line). If the court consisted solely of a unitary D-judge, then she would audit any administrative opinion where the signal $z \in [0.5155, 2.4845]$ (approximately). In the discussion that follows, we will refer to this interval as the *"majority auditing interval"*. Inside it, they audit and base their decision on (z, v). Outside it, they do not audit and base their decision solely on z. Note that this interval is symmetric around $z = 1.5$ (the point of indifference for both the court and agency), and in this sense the D-court would engage in "two-sided" auditing of A. Thus, within this example, the equilibrium has the following characteristics:

- The D-aligned agency A issues the liberal (conservative) ruling whenever $z < (\geq)\ 1.5$.
- The DDD judiciary panel's approximate auditing interval is given by $z \in [0.5155, 2.4845]$, which is symmetric around $z = 1.5$.
- The DDD panel upholds the agency without an additional audit whenever $z \notin [0.5155, 2.4845]$
- If the DDR panel audits, it will favor the conservative (overturning A if necessary) outcome whenever $v + z > \frac{5}{2}$. Otherwise it will favor the liberal outcome (overturning A if necessary).
- Viewed ex ante, the DDD court will (unanimously) overturn liberal policy positions by the D-agency at a rate of approximately[40] 6.227%. In ad-

[40] That is,

$$\int_{-\infty}^{\infty} \left(\int_{0.5155}^{1.5} \left(\int_{\frac{5}{2}-z}^{\infty} f(v|z,x)\, dv \right) f(z|x)\, dz + \int_{1.5}^{2.4845} \left(\int_{-\infty}^{\frac{5}{2}-z} f(v|z,x)\, dv \right) f(z|x)\, dz \right) f(x)\, dx$$

dition, the DDD panel will (unanimously) overturn a conservative policy decision by the agency at a rate of 18.0 97%. The unconditional rate of reversal of the agency by the DDD panel in this case is 8.514 2%.

4.1.2 Heterogeneous DDR Panel

Now consider what happens if one replaces a Democrat panelist with a Republican — a "DDR" panel. According to conventional median voter logic, the injection of a single R panelist should not affect outcomes, since she is not a pivotal voter, and thus the panel's decision rule (i.e., how they translate either z or (z, v) into policy space y) cannot change from the DDD case, *so long as one holds available information constant.* However, available information may change with the addition of an R panelist, who faces different incentives to become informed of the additional signal (v). In particular, the lone R may wish to audit cases that the majority would not – so long as his inquiry might plausibly sway their opinion. As predicted by Proposition 1, the R judge will tend to pick cases to audit which lie just to the "left" (in z space) of the D majority's indifference points. These are the very issues about which the majority is potentially persuadable, but about which they are somewhat less actuated than is the R panelist.

The dark solid line in Figure 5 below depicts the maximal valuation that any of the panelists place on auditing (as a function of z). Note that when $z > 1.5$, the diagram is identical to Figure 4. In this region, only the two Democrat judges place a positive value on auditing. The Republican panelist actively eschews auditing within this range, since the Democrat panelists are already leaning his way, and he fears that with more information he may lose them. In contrast, when $z < 1.5$, the diagram is identical to Figure 3c. Here, the Republican is strongly motivated to audit, as reflected by the upward shift of the valuation curve (relative to Figure 4) over that interval.

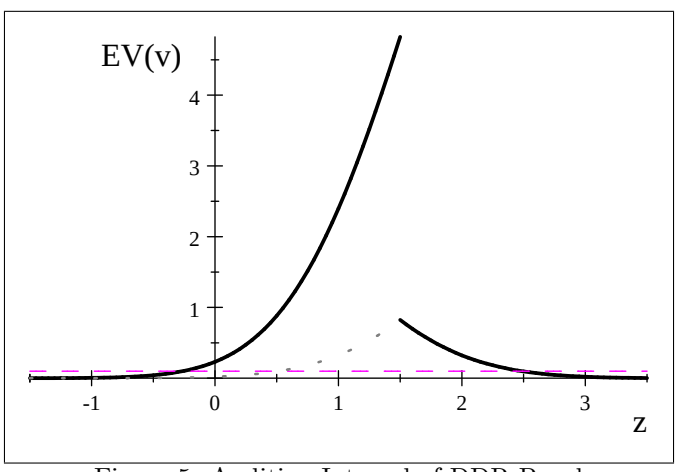

Figure 5: Auditing Interval of DDR Panel

Recall that in the DDD panel, if only the D judges could audit, they would

choose to audit cases where $z \in [0.5155, 2.4845]$ (approximately). Here, because of the added motivation of the R for $z < 1.5$, that interval increases to $z \in [-0.261\,5, 2.484\,5]$ (approximately). Thus, within the DDR panel, the equilibrium is characterized as follows:

- D-Agency issues the liberal (conservative) ruling whenever z is less than (greater than) 1.5 .
- The DDR judiciary panel's approximate auditing interval is given by $z \in [-0.261\,5, 2.484\,5]$, which expands the DDD's auditing interval asymmetric to the left of $z = 1.5$.
- The DDR panel upholds the agency without an additional audit whenever $z \notin [-0.261\,5, 2.484\,5]$
- If the DDR panel audits, it will favor the conservative (overturning A if necessary) outcome whenever $v + z > \frac{5}{2}$. Otherwise it will favor the liberal outcome (overturning A if necessary).
- Viewed ex ante, the DDR panel will (unanimously) overturn a liberal holding by the D-agency at a rate of approximately 7.1 94% (which exceeds the conditional reversal rate of the DDD panel (6.227%)). The DDR panel will overturn a conservative policy decision by the agency (sometimes unanimously and sometimes on a party line vote) at a rate of 18.0 97% (which is identical to the DDD panel[41]). Finally, the unconditional rate of reversal of the agency by the DDR panel in this case is 9.294 1% (which is higher than the unconditional rate for the DDD panel of 8.514 2%).

The key effect laid out above is an example of our core intuition regarding deliberative panel effects. In this example, expected reversal rates increase when one adds *even a single, non-pivotal minority member*, with the effect being driven solely by an enhanced expected frequency with which a *unanimous* panel reversals of liberal agency rules. To an outsider, this might look like the inclusion of the R on the panel has made the Ds more collegial, or the R has threatened to blow the whistle on the Ds. But the effect is distinct. Rather, simple self-interest in a noncooperative setting can drive an outcome where more information is being produced. In other words, the pivotal D voter isn't becoming "nicer"; she's just marshaling more information.

4.2 Calibrated Simulation

As another means for understanding our framework, we attempted to calibrate the parameters of our model to observed data, and in particular that of Miles

[41] To see why there is no change on this reversal rate, note that the upper bound of the auditing interval for the DDD and DDR panels is the same. This is because it is up to the most extreme *Democrat* to audit the agency's conservative policies. Republicans – quite happy with the conservative outcome – do not lift a finger to help, so the auditing and reversal probabilities are identical between the cases.

and Sunstein (2008). Of particular interest is their Table 2 (Miles and Sunstein 2008, p. 786), which reports rates at which individual judges vote to validate an agency's decision, contingent on the other judges on the panel. The first column of the table below lists each possible panel composition; the second lists the type of judge within the panel; and the third lists Miles & Sunstein's (2008) reported empirical validation rate.[42] Note that the simulations below also estimate a single agency political ideology (which is slightly liberal), even though the actual data likely come from several different agency types (in terms of ideology).[43] The results, in our opinion, seem impressive. With a not unreasonable set of parameters we can come very close to the affirmance rates observed by Miles and Sunstein; the simulation averaged an error of 1.84% across all six conditions. The parameters used for this simulation mean that the true state of the world is almost neutral ($\mu = -.0227$) in expectation, but has a significant amount of variance ($\tau = .3677$). In addition, the agency's signal about the true state of the world appears noisy ($\gamma = .0837$) when compared to the reviewing court's signal ($\sigma = 1.3397$). We do not claim that our exercise proves that the parameter values represent the "true" characteristics of the courts and agencies. Rather, our exercise shows that *if* the characteristics embedded within the parameter values used in the simulation happened to be true, then we would observe affirmance rates very similar to those observed by Miles and Sunstein.

Panel Composition	Panelist Type	Empirical Validation Rate (M&S 2008)	Simulated Val. Rate	Abs. Difference Sim. v. Empirical
(D, D, D)	D	0.746	0.7539	0.0079
(D, D, R)	D	0.697	0.6822	0.0148
(D, D, R)	R	0.667	0.6295	0.0375
(D, R, R)	D	0.678	0.6933	0.0153
(D, R, R)	R	0.604	0.6109	0.0069
(R, R, R)	R	0.551	0.5792	0.0282

Table 1: Simulated Affirmance Rates

Having satisfied ourselves that we could replicate their central summary results, we obtained the actual decision-level data from Miles and Sunstein (2008).[44] Again, the object was to see how well we could simulate their measured outcomes, but here we hoped to pull apart the Miles and Sunstein data into more granular categories, and then produce a simulation that came close.

[42] The table reflects simulated affirmance rates using parametric values that best fit the actual outcomes under a least squares criterion. This generates parametric values of $\tau = 0.3677$, $\mu = -0.0227$, $\gamma = 0.0837, \sigma = 1.3397$, $c = 0.7458; \theta_A = -0.157$. Other empirical fit criteria generate similar results.

[43] We also continue to assume in this simulation (as above) that the costs of reversal and/or the probability of appeal are modest, so that the agency issues sincere opinions the the distribution of panel types need not be factored into our analysis. This distributional information was not available in the Miles/Sunstein data. Including it would increase our degrees of freedom, so it would only cause our simulated results to improve.

[44] We express sincere thanks to Tom Miles and Cass Sunstein for sharing their data with us.

In particular, we went through the data and accounted for whether the *administrative agency* was under a Democrat or Republican administration, and then controlled for panel composition. In addition, for this exercise we simulated the probability of a panel (i.e. the median voter) voting to overturn the agency. This exercise produced following chart:[45]

Agency Type	Panel Composition	Empirical Reversal Rate	Simulated Reversal Rate	Absolute Difference
D	(D, D, D)	0	.1325	.1325
D	(D, D, R)	.4375	.2642	.1733
D	(D, R, R)	.3913	.4573	.0660
D	(R, R, R)	.5	.4969	.0031
R	(D, D, D)	.4	.4445	.0445
R	(D, D, R)	.3928	.3636	.0292
R	(D, R, R)	.4528	.3622	.0906
R	(R, R, R)	.25	.3121	.0621

Table 2. Simulations Using Agency Data

Note that this simulation – while still relatively solid – does not "fit" as well as the prior one. There are likely multiple reasons for this. First, there are two places where the data are nonmonotonic. With a Democratic agency, theory predicts that as we move from a DDR to a DRR judicial panel, the reversal rate should not fall. Yet, in the Miles / Sunstein data, the reversal rate between these two permutations falls from .4375 to .3913. Similarly, with a Republican agency, our theory predicts that when we move from a DDR to a DRR panel, the reversal rate should not rise. Again, the Miles/Sunstein granular data contradict this prediction. This effect could be mere chance; the number of cases in some of the cells is fairly small; or relatedly it might pertain to unobserved characteristics (issue level or judge level) that neither we nor Miles/Sunstein account for. In any event, when we fit the parameters in our simulation, our model does not allow the reversal rate to fall and rise in such non-monotonic ways in the way that it does in the data. Second, we are trying to fit the data on more dimensions in this simulation that in the prior one, which will tend to produce a looser fit. Third, in these simulations we are assigning ideology scores to the Democratic agency ($\theta = -1$) and the Republican one ($\theta = 1$). In Table 1, in contrast, we instead estimated a one that we applied across all cases (effectively giving us more degrees of freedom to calibrate). Nevertheless, even with these restrictions our model does reasonably

[45] For this simulation we minimized the sum of the squares of the values in the last column, and the minimizing parameter values are μ = -0.7841, $\tau = 0.05$, $\gamma = 0.0029$, $\sigma = 0.6395$, and $c = 4.786$. We also fit the model using other maximands.

In addition we played around with different lag definitons of when an agency "becomes" associated with the president in charge, given that upon a change in administration, the incumbent agency may have to continue to defend its actions under the previous administration. As far as we could tell, such adjustments do not affect these results significantly (though we are still experimenting).

well. The only large divergences take place in the first two rows of the chart, and perhaps in the R-DRR case. The other cases fit quite well.

At least as an initial matter, we find these simulations are suggestive. They illustrate that there are parameter values for our model that make it perform, more or less, like empirical observations of judges. If our model had failed such a test – if we could not find parameters that made the model "look like" the data – then we would regard the model with some skepticism. However, since it passed this initial test at least from an eyeballing perspective, it will be a serious candidate for testing in future work. Although we do not concentrate on it here, another artifact of our model may be consistent with other empirical stylized facts in the panel effects literature. Although the sole R-panelist in the DDR panel is uncovering information instrumentally, for the purposes of swaying his D counterparts, it is possible that his additional digging will generate a signal that has the opposite effect: That is, it convinces the R-panelist that the liberal policy outcome is optimal even from his perspective. This effect is a small one, but under some circumstances the additional digging undertaken by the minority panel member can also cause him to switch allegiances.

4.3 Empirical Implications

We recognize that for a theory to be useful, it should also be testable against other candidates. And so it is with our theory. To test it we must find situations in which our information-based theory produces different predictions than the other theories, such as whistle-blowing or social collegiality. And constructing such tests must be done with care. (Epstein, et al, 2004; Fischman 2009). We are currently endeavoring to develop a suitable set of cases for just such a comparison; the results of this project will likely be contained in another paper. At the same time, however, we reiterate that in many respects this paper *is* already empirically driven – for our very enterprise here is to explain a stylized fact that a significant existing literature (See Section 2) has already uncovered.

Nevertheless, there are a number of potential tests of our model empirically. For example, Landes and Posner (2009) find strong evidence of mixed-ideology moderation on 3-judge panels, but fail to find it on the Supreme Court. Their failure to detect a moderation trend at the US Supreme Court level may – if our model is correct – be attributable to the fact that they were regressing conservative votes on the overall political breakdown of the Court (e.g., percent Republican-appointed) rather than considering ideological variation at the extremes. In appeals court panels, in contrast, there are only three judges, and therefore fractional Republican composition is more highly reflective *both* the median and the extreme judges.

In a related vein, our model may shed light on how ideological scores of various judges have evidently "drifted" over time (e.g., Martin & Quinn 2002; Epstein et al 2007). The identifying model in this literature is an attitudinal, complete-information, sincere-voting framework. But our model suggests that even a median and other moderate voters with dynamically consistent ideologies might appear drift over time when the extreme tails of the court are subject

to variation. If our model is valid, then, it would suggest that phenomena of apparent drift are (a) not really ideological drift, but rather are information effects; and (b) such episodes should be the largest during periods where the political extremes of the panel are subject to shocks.

In addition, we may be able to get some empirical traction from the fact that the effect we derive here stems from environments that are both information poor and relatively politicized. That is, the poor quality of information provides the opportunity for judges to become more informed, and politics provide them (or at least some of them) with the motivation. Our framework therefore suggests that we are more likely to see panel effects in fields that share these joint characteristics (such as in environmental law, securities regulation or antitrust) than in fields that are largely political (such as abortion or gun control) or technocratic.

Finally, our account may shed light on the role of "merit" in Senate confirmation of nominees to the Supreme Court. Epstein and Segal measure merit by coding newspaper editorial evaluations of a nominee. They report that, other things being equal, the higher the merit of the candidate, the more likely a Senator is to vote for the candidate. Perhaps surprisingly, this effect is strong enough to overcome all or most political considerations. Thus, Scalia was confirmed unanimously, and Ginsburg was confirmed with only three dissenting votes. How can this be?[46] Our model provides at least a partial explanation if "merit" can be interpreted as a credible ability to enhance "accuracy." In our model all judges have the same accuracy; yet minority judges have an incentive to work hard (at least in some situations) to provide more information to the panel. To be sure, the minority judge's efforts work to his favor; but perhaps less obvious is the fact that *majority judges may also be better off* by the inclusion of the minority judge, due to the public informational good he provides, which increases accuracy. The increased accuracy will allow better estimation of the state of the world, and better partitioning of the cases in which each judge wants to vote to uphold or reject the Agency. In this sense, ideological outliers can be good for everyone; a possibility that even politicians might respond to as well.

5 Extensions

There are a number of potential extensions of our analytical framework – both technical and topical – that we do not endeavor to develop in full detail here. Nevertheless, we discuss some of them more briefly below, along with noting their likely effects on our predictions.

An obvious set of extensions would be to alter the fundamental information structure of the model. For instance, we might map it more directly into the framework of Spitzer & Talley (2000) and Cameron et al (2000), so that the judicial panel is unable to observe the factual input (z) providing the basis for

[46] We exclude the obvious and extremely appealing hypothesis that former law professors are irresistable. Robert Bork, a former Yale Law Professor was rejected by the Senate.

the agency's decision, and instead can observe only the agency's decision itself ($y = -1$ or 1). The appropriateness of such an assumption would likely be context specific, and would require a more lengthy appraisal of the circumstances in administrative law and regulation where an agency's information is reliably encapsulated in its record. Although we do not work through details of this extension here, our core arguments likely carry over (with some caveats) to an environment in which the agency's signal is unobservable. In fact, if the median panelist and the agency share similar ideologies, our results would become even *stronger*. For example, suppose a Democrat agency is reviewed by a DDR panel. Here, by virtue of its political similarity, the agency's decision reveals considerable information to the median panelist about how she should vote if uninformed. Consequently, the agency's action also reveals information to the minority Republican panelist about whether he should audit the agency's holding; he will do so only for the liberal agency announcements. Of course, when the realized value of z is unobservable, neither the Democrats nor the Republican can engage in "targeted" hard looks (i.e., an auditing rule that turns on z). Rather, they each must make a categorical decision about whether to audit. In many cases, however, this will mean that the *only* auditing that occurs is conducted by the Republican panelist following a liberal agency policy announcement.[47]

Another set of information structure extensions focuses on the information revealed by auditing, and would allow the auditing panelist to garble or misrepresent her information. For example, a judge may be able to cover up (at a cost) the *extensive* margin of her efforts, effectively hiding whether in fact she has learned additional information through auditing. Imposing this variation on our framework would change little due to an effective "unraveling" effect (Milgrom & Roberts 1986). That is, the silence of a judge whose ideology gives her a clear incentive to audit justifies an inference that the judge audited and discovered information that works against her; consequently, the silence of the ideologically distinct judge tends to harden the median judge's opposite leanings even further.

Judges might also attempt to misrepresent signals on the *intensive* margin. In other words, instead of attempting to cover up whether she audited, a panelist might attempt to falsify what she learned (again at some cost). This extension is somewhat more involved, but would involve a similar effect, in which the median panelist, aware that such falsification is possible, may discount any messages that the auditing judge offers which coincides with the latter's *a priori* politics. In fact, the magnitude of the median judge's skepticism increases the more politically distant the auditing judge is. One implication that comes out of this extension is that extreme "ideologues" may simply become untrustworthy generators of information in equilibrium. (And, knowing this, ideologues will not find it worthwhile to audit). Consequently, we conjecture that this extension (if fully developed) would suggest that there are potential limits to the

[47] Of course, the categorical nature of auditing here also implies that there are some cases when *both* Democrats and Republicans audit, or when *neither* do. Factoring these possibilities in, our panel effects result is likely to persist, even if in weak form.

information-generating benefits of panel diversity: that is, within some threshold diversity can be valuable tool to catalyze information production, but outside that threshold added diversity loses its information generating capacity.

A related extension might allow each member of a panel to draw an independent signal from her other panelists – either simultaneously or sequentially. Under these assumptions, there may be instances where *multiple judges* choose to draw a signal that may swing the median voter. We have already experimented with this extension, and it appears to support equilibria where extreme members of the panel may engage in a type of "arms race" of auditing – actuating a type of persuasion tug-of-war, of sorts. We intend to pursue this extension in future work.

We might also endeavor to expand the permissible policy space to allow more than two policy outcomes. For example, we might add a "centrist" policy option ($y = 0$) in addition to the liberal and conservative ones. This extension turns out to be a relatively straightforward within our model, and has the effect of dampening auditing by all judges. For the median judge, a richer set of policy choices affords her the opportunity to "fine tune" the policy choice to her ideal point given available information. Consequently, it becomes more attractive simply to remain uninformed and adopt the centrist position than to invest in additional auditing. The more ideological judges will also value additional information less, but they will still have incentives that are qualitatively similar to the analysis above. The only difference is that with multiple outcomes, there may now be multiple auditing interval ranges "around" each indifference point for the median judge.[48]

Another obvious – and possibly difficult – extension is to endogenize the Agency's decision to do research. In our model the Agency always takes a draw; there is no decision to be made. A literature, going all the way back to Gilligan and Krehbiel,[49] investigates within a formal model the incentives of an agency[50] to gather information and expertise as a consequence of delegated authority. This literature has been extended to consider judicial oversight (Stephenson, 2007, 2008) and its effects on an Agency's decision to gather expertise. A sophisticated court, Stephenson argues, will consider the feedback effects of its decision rule on the Agency's decision, and will incorporate these effects into its rule of review. We could follow this path with our model.

We could also focus our general model on the literature on surrounding Supreme Court nominees and the location of the median justice. (Krehbiel 2007; Moraski & Shipan 1999; Rohde & Shepsle 2007). This literature uses spatial models that assume that policy choices of the Supreme Court will always coincide with the ideal point of the median justice. The President and the

[48] Moving to a continuous policy spaces makes things harder. Weconjecture, however, that doing so tends to dilute the additional incentives that extreme judges have over median judges to invest in more information.

[49] More recently, see Bueno de Mesquitavand Stephenson (2007)

[50] Gilligan and Krehbiel called the Agency a Committee in their work, but the basic ideas were identical. Subsequent work by Bawn and others extended the ideas in the legislature. Recent work (Callander) has extended the model to circumstances where social outcomes are a product of both policies chosen and Brownian motion.

Senate then strategically tussle over new appointments to the bench with an eye on affecting the median. Our approach suggests that finding the policy outcome on the Supreme Court may be more complicated and subtle than the existing literature assumes. In particular, our model suggests that while the median justice's ideology is undoubtedly important, the ideologies of the extreme wings on the court may be every bit as critical. For it is those justices who stake out the boundary of the auditing intervals that later provide the fodder for potential reversals. Within the judicial appointments context, our framework suggests that, for example, strategic Senators or Presidents may care substantially about appointments that do not plausibly affect the location of the median justice, but would instead change the location of the politically extreme members of the court (see our earlier discussion above).

Finally, we might attempt to embed our model within a multiple level auditing game. (See generally George 1999; George & Solomine 2001). If we were to include the Full Circuit (for en banc review) and the Supreme Court, we would have four levels. Work is starting to be done with three levels, focusing on the Full Circuit's decision to review.[51] Indeed, Clark (2009) provides an elaborate empirical test of granting en banc review within a three level principal agent framework, but does not provide a formal model. The equilibria of these models can be complex – a fact that may explain why some recent work (e.g., Landes & Posner 2009) fail to find panel effects at the Supreme Court level even though finding evidence at the Circuit Court level). Because our model provides a general framework for analyzing endogenous information production in arbitrarily sized panels, it may lend itself to such an extension.

6 Implications

In our framework, mixed panels induce more information production, which in turn can catalyze more informed decisions. At the same time, of course, it need not follow that more informed decision making is always optimal, for at least two reasons: First, information in this model is only produced at a cost; even if majority panelists are eventually "brought around" with new information, it does not imply that the added information was justified by its cost. Second, the additional information is generated instrumentally, and is therefore skewed towards the interests of parties and party interests. If those parties do not themselves accurately represent the interests of the citizenry, it is not obvious that more information is a real public good. These concerns aside, however, our analysis might lend *some* theoretical support to suggestions that we require mixed panels within the federal judiciary (Schanzenbach and Tiller 2008).

Our framework does not directly allow us to say anything about doctrine, because doctrine is not included within the model. Thus, we cannot say whether unified or mixed panels are more or less likely to follow doctrine. Other models

[51] Revesz (1997) at page 1747, investigates a "hierarchical constraint" hypothesis that stems from the possibility of Supreme Court review.

will be needed to analyze that issue. Similarly, the model can say little about writing opinions, because that feature is not in our model.

Our model may also have implications for the burgeoning theoretical and empirical literature on Supreme Court appointments. In this literature, the Senate and President observe the departure of a member of the Supreme Court, and then they bargain in some structural setting (resembling a "setter" game, perhaps) over the new appointee. E.g. Krehbiel (2007). Both the Senate and the President evaluate the new appointee by referring to the new appointee's expected votes. These expectations are determined solely by the nature of each potential nominee. Our model (and the empirical literature that prompted us to do the model) suggests that the votes of the new appointee may depend on who is sitting with him/her. This will make the theoretical work much more situation-specific and also change the equilibria.

From a topical perspective, there may be a number of applications of our approach. For example, many of the endogenous information production arguments offered above could be applied to other multi-member political decision makers, such as committees or agencies themselves.[52] In addition, our approach may dovetail with and contribute to the literature about the endogenous formation of peer groups through "homophily" (i.e., connection and information sharing among philosophically allied individuals[53]). Within organizational theory, our analysis may shed light on the extent to which heterogeneity of world views among board members may better inform corporate decisions. For example, the now well-documented disagreements between Patricia Dunn (a "governance"-oriented director) and Tom Perkins and Jay Keyworth (two "strategy"-oriented directors) on the Hewlett Packard Board may have some benefits even while it potentially foments internal conflict.[54]

7 Conclusion

In this paper, we have presented a simple information-based model of panel effects at the circuit court level. Proposition 1 captures two central insights from the empirical literature. We have illustrated how mixed panels may induce equilibrium behavior resembling "moderation" among majority (and even minority) panelists. The type of moderation we predict is not an artifact of colleagiality or whistleblowing per se, but rather an artifact of better information, developed and provided by panelists who have distinct ideological commitments. In at least some respects, our argument is consistent with the claim that mixed panels produce not only different results, but also better results than their homogenous counterparts. At this point, our information-based theory joins a group

[52] Cites.

[53] See, e.g., Currarini,, Jackson & Pin (2008).

[54] See, e.g., Wall St. Journal (10/9/06) "Boardroom Duel Behind H-P Chairman's Fall, Clash With a Powerful Director The Cautious Patricia Dunn And Flashy Tom Perkins Were a Combustible Pair" at A__. Although their clashing styles ultimatetly led to distrust (and a publcly embarrassing episode about illegal pretexting, during that same time period HP gained an unprecedented degree of market dominance.

of theories attempting to explain the phenomena of both majority and minority judges as a function of panel composition, and empirical tests will be needed to sort out which theory has greatest explanatory power in practice. We leave those empirical studies, however, for another day.

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9 Appendix

This appendix includes some basic mathematical derivations that enter into the analysis, as well as proof of core propositions.

9.1 Distributional Identities

Analyzing the model in the text requires some manipulation of the normal distribution. For the reader's reference, some of the key identities (for use later) are below.

- Recall that the "true" state of the world, X, is distributed $N\left(\mu, \frac{1}{\tau}\right)$.
- Player A's signal about X is $Z : (Z|X)$ is distributed $N\left(x, \frac{1}{\gamma}\right)$
- Player J's additional signal about X is $V : (V|X)$ is distributed $N\left(x, \frac{1}{\sigma}\right)$
- Applying Bayes theorem, the conditional random variable $(X|Z, V)$is distributed as follows:

$$(X|Z, V) \tilde{} N\left(\frac{\tau\mu + \gamma z + \sigma v}{\tau + \gamma + \sigma}, \frac{1}{\tau + \gamma + \sigma}\right) \tag{12}$$

- If we observe only the realization z, then posterior $(X|Z)$ is distributed:

$$(X|Z) \tilde{} N\left(\frac{\tau\mu + \gamma z}{\tau + \gamma}, \frac{1}{\tau + \gamma}\right) \tag{13}$$

- If we observe only the realization v, then posterior $(X|V)$ is distributed:

$$(X|V) \tilde{} N\left(\frac{\tau\mu + \sigma v}{\tau + \sigma}, \frac{1}{\tau + \sigma}\right) \tag{14}$$

- We will also be interested in the distribution of $(V|Z)$. Using the identities immediately preceding, one can piece together the PDF of $(V|Z)$ as follows.

$$\begin{aligned}
f(v|z) &= \int_{-\infty}^{\infty} \underbrace{f(v|x, z)}_{N\left(x, \frac{1}{\sigma}\right)} \cdot \underbrace{f(x|z)}_{N\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}, \frac{1}{\tau+\gamma}\right)} \quad dx \\
&= \int_{-\infty}^{\infty} \left(\frac{\sqrt{\sigma}}{\sqrt{2\pi}} e^{-\frac{(v-x)^2\sigma}{2}}\right) \cdot \left(\frac{\sqrt{(\tau+\gamma)}}{\sqrt{2\pi}} e^{-\frac{\left(x - \frac{\tau\mu+\gamma z}{\tau+\gamma}\right)^2(\tau+\gamma)}{2}}\right) \cdot dx \\
&= \int_{-\infty}^{\infty} \frac{\sqrt{\sigma}\sqrt{(\tau+\gamma)}}{\sqrt{2\pi}\sqrt{2\pi}} \times \\
&\quad \exp\left(-\frac{\left(v - \left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)^2 \left(\frac{(\tau+\gamma)\sigma}{\tau+\gamma+\sigma}\right) + \left(x - \left(\frac{(\tau\mu+\gamma z+v\sigma)}{(\tau+\gamma+\sigma)}\right)\right)^2 (\sigma+\tau+\gamma)}{2}\right) dx \qquad (15) \\
&= \frac{\sqrt{\frac{\sigma(\tau+\gamma)}{\tau+\gamma+\sigma}}}{\sqrt{2\pi}} \exp\left(-\frac{\left(v - \left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)^2 \left(\frac{(\tau+\gamma)\sigma}{\tau+\gamma+\sigma}\right)}{2}\right)
\end{aligned}$$

and thus, $(V|Z)$ is distributed:

$$(V|Z)\ \tilde{}\ N\left(\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right),\left(\frac{(\tau+\gamma)\,\sigma}{\tau+\gamma+\sigma}\right)^{-1}\right) \tag{16}$$

- Similarly, the distribution of $(Z|V)$ is:

$$(Z|V)\ \tilde{}\ N\left(\left(\frac{\tau\mu+\sigma v}{\tau+\sigma}\right),\left(\frac{(\tau+\sigma)\,\gamma}{\tau+\gamma+\sigma}\right)^{-1}\right) \tag{17}$$

- Finally, for a variable X that is distributed $N\left(\alpha,\frac{1}{\beta}\right)$, the expectation of X conditional on x exceeding a specified threshold $\hat{x}$ is given by:

$$E\left(X|x\geq\hat{x}\right)=\alpha+\frac{1}{\sqrt{\beta}}\cdot\left(\frac{\phi\left(\left(\hat{x}-\alpha\right)\sqrt{\beta}\right)}{1-\Phi\left(\left(\hat{x}-\alpha\right)\sqrt{\beta}\right)}\right) \tag{18}$$

  where $\phi\left(.\right)$ and $\Phi\left(.\right)$ represent the standard normal probability density and cumulative distribution functions, respectively. (See Landsman & Valdez, 2005).

9.2 Derivation of PDF for Order Statistics Comprising $\hat{\Theta}$

Consider a set of random variable realizations $\Theta\equiv\left\{\theta_1,\theta_2,...,\theta_{2M-1}\right\}$, drawn independently from an identical distribution $H\left(\theta\right)$ with associated density $h\left(\theta\right)$. Without loss of generality, we can reorder Θ in terms of order statistics $\left\{\theta_{(1)},...,\theta_{(M)},...,\theta_{(2M-1)}\right\}$. Define $\hat{\Theta}\subset\Theta$ as the 3-tuple $\left\{\theta_{(1)},\theta_{(M)},\theta_{(2M-1)}\right\}$, representing the minimal, median and maximal realizations within Θ.

The k-th order statistic, or $\theta_{(k)}$, has a pdf of:

$$h_{(k)}\left(\theta_{(k)}\right)=\frac{(2M-1)!}{(k-1)!\,(2M-1-k)!}\left(H\left(\theta_{(k)}\right)\right)^{k-1}\left(1-H\left(\theta_{(k)}\right)\right)^{(2M-1-k)}h\left(x\right) \tag{19}$$

Applying this expression iteratively, the joint pdf of $\hat{\Theta}$, in terms of $H\left(\theta\right)$ and $h\left(\theta\right)$, is as follows:

$$\begin{aligned} f(\hat{\Theta}) &= \frac{(2M-1)!}{(M-2)!^2}\cdot h\left(\theta_{(1)}\right)\cdot h\left(\theta_{(M)}\right)\cdot h\left(\theta_{(2M-1)}\right) \\ &\quad\times\left(H\left(\theta_{(M)}\right)-H\left(\theta_{(1)}\right)\right)^{(M-2)}\left(H\left(\theta_{(2M-1)}\right)-H\left(\theta_{(M)}\right)\right)^{(M-2)} \end{aligned} \tag{20}$$

9.3 Derivation of Expected Payoff for Uninformed Judge

Consider a judge with ideology θ_i sitting on an uninformed panel with ideological profile Θ. Judge i's expected payoff if informed (conditional on z) is given by:

$$
\begin{aligned}
\pi_U\left(\theta|z,\theta_{(M)}\right) &= -E_{x|z}\left\{\left((x+\theta_i)-y\right)^2|z\right\} \\
&= \begin{cases} -E_{x|z}\left\{(x+\theta_i+1)^2|z\right\} & \text{if } z \leq z_M^U \\ -E_{x|z}\left\{(x+\theta_i-1)^2|z\right\} & \text{else} \end{cases} \\
&= -E_{x|z}\left(x^2+1+\theta_i^2\right)+2\begin{cases} -E_{x|z}\left\{(x\theta+x+\theta_i)|z\right\} & \text{if } z \leq z_M^U \\ -E_{x|z}\left\{(x\theta-x-\theta_i)|z\right\} & \text{else} \end{cases} \\
&= -E_{x|z}\left(x^2+2x\left(\theta_i+1\right)+\left(\theta_i+1\right)^2\right)+4\begin{cases} 0 & \text{if } z \leq z_M^U \\ E_{x|z}\left\{(\theta_i+x)|z\right\} & \text{else} \end{cases} \\
&= \left(\frac{1}{\tau+\gamma}+\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}+(\theta_i+1)\right)^2\right)+\begin{cases} 0 & \text{if } z \leq z_M^U \\ 4\left(\theta_i+\frac{\tau\mu+\gamma z}{\tau+\gamma}\right) & \text{else} \end{cases},
\end{aligned}
$$

which is the expression given in (**??**) in the text.

9.4 Derivation of Expected Payoff for Informed Judge

$$
\begin{aligned}
\pi_I\left(\theta_i|z,\theta_{(M)}\right) &= -E_{v|z}\left\{E_{x|z,v}\left(x+\theta_i-y^*\right)^2|z,v\right\} \\
&= E_{v|z}\left[\left.\begin{cases} -E_{x|v,z}\left\{(x+\theta_i+1)^2|z,v\right\} & \text{if } v\le v_M^I \\ -E_{x|v,z}\left\{(x+\theta_i-1)^2|z,v\right\} & \text{if } v> v_M^I \end{cases}\right| z,v\right] \\
&= E_{v|z}\left[-E_{x|z,v}\left(x^2+2\left(\theta_i+1\right)x+\left(\theta_i+1\right)^2\right)+\begin{cases} 0 & \text{if } v\le v_M^I \\ 4E_{x|z,v}\left\{\left(x+\theta_i\right)|z,v\right\} & \text{if } v> v_M^I \end{cases}\right] \\
&= -\left(\frac{1}{\tau+\gamma}+\left(\frac{z\gamma+\tau\mu}{\tau+\gamma}+\left(\theta_i+1\right)\right)^2\right)+E_{v|z}\begin{cases} 0 & \text{if } v\le v_M^I \\ 4\left(\frac{\tau\mu+\gamma z+\sigma v}{\tau+\gamma+\sigma}+\theta_i\right) & \text{if } v> v_M^I \end{cases} \\
&= -\left(\frac{1}{\tau+\gamma}+\left(\frac{z\gamma+\tau\mu}{\tau+\gamma}+\left(\theta_i+1\right)\right)^2\right) \\
&\quad +\Pr\left\{v>v_M^I\right\}\cdot 4E_{v|z}\left(\theta_i+\frac{\tau\mu+\gamma z}{\tau+\gamma+\sigma}+\frac{\sigma}{\tau+\gamma+\sigma}v\middle| v>v_M^I\right) \\
&= -\left(\frac{1}{\tau+\gamma}+\left(\frac{z\gamma+\tau\mu}{\tau+\gamma}+\left(\theta_i+1\right)\right)^2\right) \\
&\quad +4\left(\theta_i+\frac{\tau\mu+\gamma z}{\tau+\gamma+\sigma}\right)\left(1-\Phi\left(\left(v_M^I-\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)\sqrt{\frac{\left(\tau+\gamma\right)\sigma}{\tau+\gamma+\sigma}}\right)\right) \\
&\quad +4\left(1-\Phi\left(\left(v_M^I-\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)\sqrt{\frac{\left(\tau+\gamma\right)\sigma}{\tau+\gamma+\sigma}}\right)\right)\left(\frac{\sigma}{\tau+\gamma+\sigma}\right) \\
&\quad \times\left(\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)+\sqrt{\frac{\tau+\gamma+\sigma}{\left(\tau+\gamma\right)\sigma}}\cdot\left(\frac{\phi\left(\left(v_M^I-\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)\sqrt{\frac{(\tau+\gamma)\sigma}{\tau+\gamma+\sigma}}\right)}{1-\Phi\left(\left(v_M^I-\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)\sqrt{\frac{(\tau+\gamma)\sigma}{\tau+\gamma+\sigma}}\right)}\right)\right) \\
&= -\left(\frac{1}{\tau+\gamma}+\left(\frac{z\gamma+\tau\mu}{\tau+\gamma}+\left(\theta_i+1\right)\right)^2\right) \\
&\quad +4\cdot\left(\theta_i+\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}\right)\right)\left(1-\Phi\left(-\frac{\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\sigma+\tau+\gamma)(\tau+\gamma)}}}\right)\right) \\
&\quad +4\cdot\sqrt{\frac{\sigma}{\left(\tau+\gamma+\sigma\right)\left(\tau+\gamma\right)}}\cdot\phi\left(-\frac{\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\sigma+\tau+\gamma)(\tau+\gamma)}}}\right)
\end{aligned}
$$

9.5 Proof of Lemmas 1-5

Lemma 1: *For the median judge, $\Delta\left(\theta_{(M)}|z,\theta_{(M)}\right)$ is maximal at $z=z_M^U$, and falls symmetrically in both directions as z moves away from z_M^U. Conse-*

quently, when panel ideologis are homogenous, the auditing range also will constitute a symmetric interval around z_M^U.

Proof: First, note that $\left(\theta_i + \frac{z\gamma+\tau\mu}{\tau+\gamma}\right)\Big|_{z=z_M^U} = 0$. Therefore, $\Delta\left(\theta_{(M)}|z,\theta_{(M)}\right)$ simplifies to:

$$\begin{aligned}\Delta\left(\theta_{(M)}|z,\theta_{(M)}\right) &= 4\cdot\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}\cdot\phi(0) \qquad (21)\\ &= 4\cdot\phi(0)\cdot\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}\\ &= \sqrt{\frac{8}{\pi}\cdot\left(\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}\right)}\end{aligned}$$

Note further that the standard normal density $\phi(x)$ is maximized at $x = 0$, and thus term α is maximized when $z = z_M^U$. As to term β, it is easily verified that term β is negative for all values of $z \neq z_M^U$. Thus, since both α and β are individually maximized at z_M^U, so must their sum. They symmetry of $\Delta\left(\theta_{(M)}|z,\theta_{(M)}\right)$ around $z = z_M^U$ follows immediately from the symmetry of the standard normal distribution around 0. *QED*

Lemma 2: *If judge i more conservative than the median judge, so that $\theta_i > \theta_{(M)}$:*

- – *Judge i values information more than the median judge when $z \leq z_M^U$ and less than the median judge when $z > z_M^U$.*
  - – *The extent to which the more conservative judge's valuation exceeds / falls short of the median judge's increases strictly in θ_i.*

If judge i more liberal than the median judge, so that $\theta_i < \theta_{(M)}$:

- – *Judge i values information more than the median judge when $z \geq z_M^U$ and less than the median judge when $z < z_M^U$.*
  - – *The extent to which the more liberal judge's valuation exceeds / falls short of the median judge's decreases strictly in θ_i.*

Proof: An equivalent way to express the value of information for the non-median judge is to consider the degree to which judge i's valuation of auditing exceeds that of the median judge. Denoting this valuation gap as $\xi\left(\theta_i,\theta_{(M)},z\right)$, the following expression emerges:

$$\begin{aligned}\xi\left(\theta_i,\theta_{(M)},z\right) &= \Delta\left(\theta_i|z,\theta_{(M)}\right) - \Delta\left(\theta_{(M)}|z,\theta_{(M)}\right) \qquad (22)\\ &= 4\cdot\left(\theta_i-\theta_{(M)}\right)\cdot\begin{cases} 1-\Phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) & \text{if } z\leq z_M^U\\ -\Phi\left(-\frac{\left(\theta_{(M)}+\frac{z\gamma+\tau\mu}{\tau+\gamma}\right)}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) & \text{if } z> z_M^U\end{cases}\end{aligned}$$

The statements in the Lemma come directly from inspection and/or differentiation of $\xi\left(\theta_i, \theta_{(M)}, z\right)$.*QED*

Lemma 3: *When $z < z_M^U$ the most conservative judge (with ideology $\theta_{(2M-1)}$) has the maximial incentive of all panelist to audit. Similarly, when $z > z_M^U$, the most liberal judge (with ideology $\theta_{(1)}$) has the maximial incentive to audit. If $z = z_M^U$, the most conservative (most liberal) panelist has the greatest incentive to audit when $\left(\theta_{(2M-1)} - \theta_{(M)}\right)$ is larger (smaller) than $\left(\theta_{(M)} - \theta_{(1)}\right)$.*

Proof: Direct implication of Lemma 2.

Lemma 4: *If $c \leq c(\hat{\Theta}, z)$, the panel will audit (and thus learn v) where*

$$c(\hat{\Theta}, z) = 4\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}} \cdot \phi\left(-\frac{\theta_{(M)} + \frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) \tag{23}$$
$$+ \begin{cases} 4\left(\theta_{(2M-1)} + \frac{\tau\mu+\gamma z}{\tau+\gamma}\right) \cdot \left(1 - \Phi\left(-\frac{\theta_{(M)} + \frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right)\right) & \text{if } z \leq z_M^U \\ -4\left(\theta_{(1)} + \frac{\tau\mu+\gamma z}{\tau+\gamma}\right) \cdot \Phi\left(-\frac{\theta_{(M)} + \frac{z\gamma+\tau\mu}{\tau+\gamma}}{\sqrt{\frac{\sigma}{(\tau+\gamma+\sigma)(\tau+\gamma)}}}\right) & \text{if } z > z_M^U \end{cases}$$

This criterion implicitly defines strictly positive (but possibly asymmetric) auditing interval $\left[\underline{z}(\hat{\Theta}), \overline{z}(\hat{\Theta})\right]$ around z_M^U. When the panel audits, the additional signal is collected by the most conservative (liberal) member whenever $z \in [\underline{z}(\hat{\Theta}), z_M^U)$ (whenever $z \in (z_M^U, \overline{z}(\hat{\Theta})]$).

Proof: Direct implication of Lemmas 2-3.

Lemma 5: *Given the equilibrium behavior of a panel with configuration $\hat{\Theta}$, A will make the conservative decision if and only if:*

$$4(1-\pi)\left(\frac{\tau\mu+\gamma z}{\tau+\gamma} + \theta_A\right)$$
$$\geq \pi\varepsilon \cdot \left(\iiint\limits_{\hat{\Theta}|z<\underline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} - \iiint\limits_{\hat{\Theta}|z>\overline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} + \iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]} \left(2\Phi\left(-\left(\theta(\tau+\gamma) + z\gamma + \tau\mu\right)\right) - 1\right) f(\hat{\Theta})d\hat{\Theta} \right)$$

Proof: Conditional on knowing z, if A issues the conservative decision ($y_A = 1$), her expected payoff will be:

$$-(1-\pi) \cdot E\left((x + \theta_A - 1)^2 | z\right) \tag{24}$$
$$-\pi\varepsilon \cdot \left(\iiint\limits_{\hat{\Theta}|z<\underline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} + \iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]} \Phi\left(-\left(\theta(\tau+\gamma) + z\gamma + \tau\mu\right)\right) f(\hat{\Theta})d\hat{\Theta} \right)$$

If A makes the liberal decision $(y_A = -1)$, in contrast, her expected payoff will be:

$$-(1-\pi)\cdot E\left((x+\theta_A+1)^2|z\right) \tag{25}$$
$$-\pi\varepsilon\cdot\left(\iiint\limits_{\hat{\Theta}|z>\overline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} + \iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]} \left(1-\Phi\left(-\left(\theta\left(\tau+\gamma\right)+z\gamma+\tau\mu\right)\right)\right) f(\hat{\Theta})d\hat{\Theta}\right)$$

Consequently, A will make the conservative decision if and only if the difference between these two expressions is positive, or:

$$4\left(1-\pi\right)\left(\frac{\tau\mu+\gamma z}{\tau+\gamma}+\theta_A\right)+\pi\varepsilon\cdot\left(\begin{array}{c}\iiint\limits_{\hat{\Theta}|z>\overline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} - \iiint\limits_{\hat{\Theta}|z<\underline{z}(\hat{\Theta})} f(\hat{\Theta})d\hat{\Theta} \\ + \iiint\limits_{\hat{\Theta}|z\in\left[\underline{z}(\hat{\Theta}),\overline{z}(\hat{\Theta})\right]} \left(1-2\Phi\left(-\left(\theta\left(\tau+\gamma\right)+z\gamma+\tau\mu\right)\right)\right) f(\hat{\Theta})d\hat{\Theta}\end{array}\right)\geq 0 \tag{26}$$

Rearranging yields the expression in the Lemma.