

A Theory of Conservatism

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ABSTRACT: A free-rider problem arises when a group choice between two alternatives has to be made based on privately collected evidence, leading to insufficient effort in gathering evidence and ex ante welfare loss for the group. To alleviate the free-rider problem, the group can commit to a “conservative” rule, whereby the decision is made against the alternative favored by the group’s preference or prior when evidence supports it but is not preponderant. Optimal conservatism increases private incentives to gather evidence and improves the quality of the group decision. Our result explains why sometimes groups appear overly cautious toward favored alternatives. It is further shown to be robust to heterogeneity of preferences in groups.

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1. Introduction: Conservatism

Many have criticized the Food and Drug Administration of the United States (FDA) for over-cautiousness in approving new drugs. Some recently approved drugs had waited for a long time after they were proven effective and free of serious adverse side effects. Critics say that FDA's conservatism hinders American drug industry's competitiveness, and more importantly, costs human lives by delaying approval of new drugs.¹ As cited by a survey article of the February 12, 1995 issue of *The New York Times*, an advertisement run by the Washington Legal Foundation declares: "If a murderer kills you, it's homicide. If a drunk driver kills you, it's manslaughter. If the FDA kills you, it's just being cautious." Conservative attitude of the FDA may reflect its great concern for adverse affects of legalizing unproved drugs, but critics often point to scientific results supporting the new drugs as evidence that FDA's cautiousness is not justified. Some people blame bureaucratic failure in the FDA, in particular the divergence of the concerns of bureaucrats from those of the public. We will argue in this paper that a deeper reason lies behind over-cautiousness of the FDA.

Caution or conservatism is not exclusive to drug approval by panels of the FDA. In most democratic countries, constitutional amendments must be approved by an overwhelming majority of congregations of representatives. Jury decisions in civil law suits and criminal trials require strong majority and even unanimity. A recent paper by Fedderson and Pesendorfer (1998) shows that a unanimous conviction rule in jury decisions may lead to higher probability of false conviction as well as false acquittal than a simple majority rule, and the probability of convicting an innocent defendant may increase with the size of the jury. Even if the prior of jury is biased for conviction and the jury cares little about false acquittal, the extreme conservatism of unanimity is difficult to justify.

¹ In his study of the 1962 Kefauver-Harris Amendments to the Food, Drug, and Cosmetics Act, Peltzman (1973) stresses that strengthened regulation by FDA suppresses information about new drugs produced by drug company promotions and by consumer experience from actual usage. The effect of the amendments on consumer surplus depends on whether the suppressed information is mainly exaggerated claims of efficacy by drug companies or beneficial evidence about (potentially) available new drugs. His estimate is that the costs of the amendments to consumers greatly exceed the benefit.

The above examples of group conservatism share a few common characteristics. First, the choice among alternatives affects the welfare of all group members. Second, the decision must be made without fool-proof evidence regarding the superiority of the alternatives. Both type I error of adopting an inferior alternative and type II error of forsaking a superior alternative are possible. Third, the cost of gathering evidence is private. Greater effort by the group as a whole produces more conclusive evidence and helps to reduce both types of error, but individual group members must incur the cost of effort.

A free-rider problem naturally arises because of the public good nature of evidence. Each member in the group disregards the benefits of more conclusive evidence to other members, leading to insufficient individual efforts in collecting evidence. The group suffers from the free-rider problem because the public decision is made without adequate support of evidence, even though the decision can be optimal given evidence. Here, ex post optimality means a standard of proof or threshold of evidence, such that given the group's prior belief about the alternatives and its preference regarding relative importance of the two types of error, which alternative should be chosen depends whether the evidence meets the standard. We show that a deviation from the ex post optimal standard can mitigate the free-rider problem in this situation. Conservatism is a commitment by the group to a decision rule whereby the decision is made against the alternative favored by the group's prior or preference when evidence supports this alternative but is not preponderant. For example, if a hiring committee favors making an offer to a job candidate, either because the committee has high prior that the candidate is qualified or because it is more concerned with wrongful rejection than with wrongful hiring, then under a conservative rule the candidate is hired only if the collected evidence of his qualifications meets a higher standard than the ex post optimal standard. That is, a conservative rule rejects marginal candidates whose qualifications are determined to be barely above the optimal standard. By making it tougher for the committee to make an offer, the extra caution increases the value of more conclusive evidence in reducing wrongful rejection, while decreases the value in reducing wrongful hiring. However, since the committee as a whole favors hiring, the overall effect of a tougher standard is an increase in the value of evidence, and hence an increase in the private incentives in collecting evidence.

We show that a little extra caution or conservatism is always preferred to the ex post optimal decision rule, because it induces greater individual effort in gathering evidence while imposing little cost ex post. Of course, too much conservatism is harmful because the standard deviates too much from the one that minimizes the two types of error given evidence. Optimal degree of conservatism balances the trade-off between ex ante benefit of greater incentives for individuals to gather evidence and ex post cost of being too cautious toward the favored alternative. Larger decision-making groups require a greater degree of conservatism to mitigate a more serious free-rider problem in gathering useful information.

The kind of conservative attitude discussed here should be understood as ex post conservatism. It is over-cautiousness toward the choice favored by the group's prior and preference, in the form of rejecting such choice when new evidence suggests that on balance it would benefit the group. Ex post conservatism contrasts with ex ante conservatism of aversion to testing new ideas (e.g., Dearden, Ickes and Samuelson, 1990). The insight developed here demonstrates that commitment to an ex post conservative decision rule can encourage more effort in experimentation and make the group less conservative ex ante. Conservatism discussed in the present paper should also be distinguished from a collective bias for the status quo. Experimental studies of individual decision-making have recovered a status quo bias: alternatives that receive equal attention from individuals are viewed differently when one of them is selected as the status quo (e.g., Samuelson and Zeckhauser, 1988). Individual bias for the status quo is sometimes used to explain ex post sub-optimal group behavior (e.g., Heiner, 1983). However, the generalization from individual bias to collective bias can be sensitive to assumptions on within-group heterogeneity in information and preferences. In contrast, the present paper focuses on situations where a group is collectively conservative even though no individual member has any status quo bias, and our result is not subject to arbitrary choice of the status quo. Finally, in a literature that stretches from Goldberg's (1974) theory of rights to the status quo to Williamson's (1985) theory of opportunism, conservatism has come to be equated to history-dependence of collective decision-making.² Such history-dependence does not

² See Kuran (1988) for a survey of different approaches in this literature.

necessarily exhibit ex post inefficiency, while conservatism in the present paper is ex post inefficient by definition.

The next section presents the main model in the context of a hiring committee. We explain that a little conservatism helps alleviate the free-rider problem in gathering evidence, and discuss some implications of this result. The main model assumes that the committee members are homogeneous in prior and preference. This assumption is relaxed in Section 3. Section 4 concludes the paper with further discussions on conservatism.

2. Conservatism in a Hiring Committee

Consider a hiring committee in an academic department of $m \geq 2$ members who must decide whether or not to make an offer to a job candidate. Let a number x denote the candidate unobserved qualification. The candidate is either qualified with $x = q > 0$, or unqualified with $x = 0$.³ All members of the committee share the same prior that the candidate is qualified with probability γ . The prior is derived from recommendation letters, reputation of the graduate program that the candidate attends, and teaching and publication record (e.g., standard teaching evaluations and paper counts).

Each member has access to a class of fact-finding technologies, indexed by their precision h . Each technology gives member i a noisy observation $y^i = x + \epsilon^i$, where ϵ^i is normally distributed with zero mean. We imagine that the committee members conduct interviews with the candidate, attend the job seminar, and examine the quality of candidate's research works.⁴ Due to differences in academic perspectives and familiarity with the candidate's work, evidence gathered by committee members is diverse in that ϵ^i 's are conditionally independent. This diversity in turn gives rise to the need for evidence aggregation.⁵ We assume that the observations y^i are publicly observed.

³ The result of this paper extends to the case in which the candidate's qualification takes more than two values and the candidate is qualified if a minimum value is reached.

⁴ We implicitly assume that there is a criterion for summarizing the candidate's record in teaching and research in a single number and that committee members agree on the criterion.

⁵ In a jury setup, Klevorick, Rothschild, and Winship (1984) demonstrate how quality of verdict improves through information aggregation, as opposed to a simple majority vote among jurors.

All committee members are assumed to have the same preference. They are concerned with both the cost of type I error of making an offer to an unqualified candidate (wrongful hiring) and the type II error of turning down a qualified candidate (wrongful rejection). Let $\lambda_1 > 0$ be the weight given by each member to the loss due to wrongful hiring, and $\lambda_2 > 0$ be the weight corresponding to wrongful rejection. These weights depend on factors such as availability of qualified candidates in the market and the budget of the department. Member i 's effort determines the precision h^i of observation y^i : a more careful examination of candidate's record provides more conclusive evidence of the candidate's qualification. However, effort is costly to committee members. We write effort cost e^i as a function $\epsilon(h^i)$, with $\epsilon' > 0$ and $\epsilon'' \geq 0$. Each member i wishes to minimize the sum of the weighted expected loss and the effort cost e^i .

2.1. Ex post optimal hiring standard

Given observations y^1, \dots, y^m , with corresponding precision h^1, \dots, h^m , hiring and rejection can be compared according to the expected loss they result in. A standard result in statistics gives the ex post optimal decision rule (see, e.g., DeGroot, 1970). Since the noise terms in the observations y^1, \dots, y^m are conditionally independent and normally distributed, information aggregation in the committee takes the form of computing a weighted average of the observations and comparing it to a standard or threshold: hire the candidate if the weighted average exceeds the standard; otherwise reject the candidacy. Let y denote the weighted average $\sum_i h^i y^i / H$, where $H = \sum_i h^i$. This is a sufficient statistic for the ex post decision problem. How high the optimal standard is depends on the committee's prior and preferences, as well as the aggregate precision level H .

Figure 1 illustrates of how the ex post optimal hiring standard is chosen. The expected loss t_s to each member as a function of an arbitrary hiring standard s is

$$(1) \quad t_s = \lambda_1(1 - \gamma)(1 - F_0(s)) + \lambda_2\gamma F_q(s),$$

where F_0 and F_q are the distribution functions of the summary statistic y conditional on $x = 0$ and $x = q$ respectively. For any s , $1 - F_0(s)$ gives the probability of wrongful hiring, and $F_q(s)$ gives the probability of wrongful rejection. The curve in Figure 1 traces

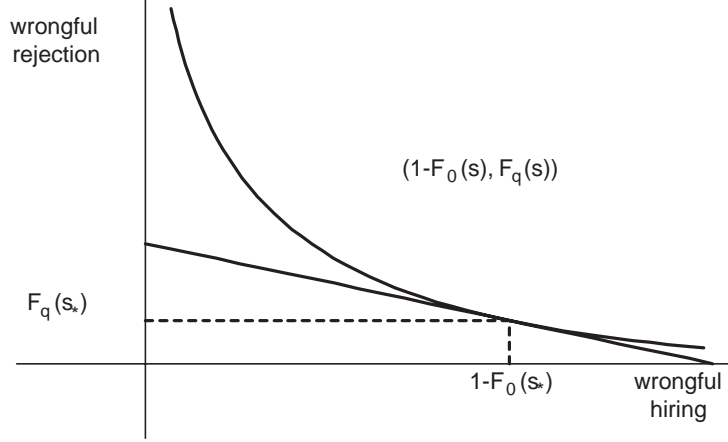


Figure 1. The trade-off between wrongful hiring and wrongful rejection under different standards. Ex post optimal hiring standard is the point where the curve is tangent to an iso-cost line.

out the combinations $(1 - F_0(s), F_q(s))$ under different standards: a lower hiring standard s increases wrongful hiring and decreases wrongful rejection. It is convex to the origin because the negative of its slope is $f_q(s)/f_0(s)$ (the ratio of conditional densities of y), which is monotonically decreasing as s decreases (and $1 - F_0(s)$ increases and $F_q(s)$ decreases.) Figure 1 shows also an iso-cost line. Iso-cost lines have a slope of $-\lambda_1(1 - \gamma)/(\lambda_2\gamma)$, and give the combinations of wrongful hiring and wrongful rejection such that the total weighted expected loss is constant under the committee's prior. The trade-off represented by the curve between wrongful conviction and wrongful rejection under different standards is resolved optimally at the point where the curve is tangent to an iso-cost line. See Figure 1. The ex post optimal standard s_* satisfies the first-order condition in minimizing t_s :

$$(2) \quad \lambda_1(1 - \gamma)f_0(s_*) = \lambda_2\gamma f_q(s_*).$$

Since the sufficient statistic y is normally distributed, with precision H and mean 0 conditional on $x = 0$ and mean q conditional on $x = q$, we can explicitly rewrite (2) as

$$(3) \quad s_* = \frac{q}{2} + \frac{\ln(\lambda_1(1 - \gamma)/(\lambda_2\gamma))}{qH}.$$

The ex post optimal standard s_* includes a bias parameter $\ln(\lambda_1(1 - \gamma)/(\lambda_2\gamma))/(qH)$. Given the committee's prior and preference, a greater precision H of the evidence reduces

this bias parameter and makes the ex post optimal hiring standard closer to $q/2$. Thus, more precise evidence allows the committee to put less weight on the bias due to prior or preference.

The bias parameter can be either positive or negative, and correspondingly s_* can be greater or smaller than $q/2$. In the special case where $\lambda_1(1 - \gamma) = \lambda_2\gamma$, we have $s_* = q/2$, independent of the aggregate precision level H . In this case, iso-cost lines in Figure 1 have a slope of -1 and the tangency occurs at the midpoint on the trade-off curve of wrongful hiring and wrongful rejection. The committee’s concerns for wrongful hiring and wrongful rejection are perfectly balanced with the prior, so that if a decision were made without any evidence, the committee would be indifferent between hiring and rejection. In general, the standard is higher if the committee has a higher prior that the candidate is unqualified, or it is more costly to hire an unqualified candidate relative to rejecting a qualified candidate.⁶ When $\lambda_1(1 - \gamma) < \lambda_2\gamma$, the committee’s preference and prior are such that it is more concerned with wrongful rejection than wrongful hiring. From equation (3), the ex post optimal hiring standard is smaller than $q/2$. If a decision were made without evidence, the committee would optimally choose rejection. In this case, we say that the committee is “biased for hiring.” This is depicted in Figure 1, where iso-cost lines are relatively flat. If instead $\lambda_1(1 - \gamma) > \lambda_2\gamma$, the ex post optimal standard s_* is greater than $q/2$. We say that the committee is “biased for rejection.” The committee is more concerned with wrongful rejection than with wrongful hiring in this case.

2.2. Marginal values of evidence and the free-rider problem

Under the ex post optimal decision rule of making an offer if and only if $y \geq s_*(h)$, the expected loss t_{s_*} to each member is given by equation (1), with s_* replacing s . The “social marginal value of evidence” is reduction of the total expected loss $T_{s_*} = mt_{s_*}$ to all members from an increase in the individual precision level h^i of member i .

⁶ The FDA standard for approving new drugs has often responded to the political costs of false adoption and false rejection. Significant addition to the regulatory power of the FDA was legalized in 1962 after thalidomide produced horrible effects on infants, and the recent quickened release of AIDS drugs is linked to the public awareness that people would die if even very risky drugs were not made available to them. However, changes in relative costs of type I and type II errors cannot explain FDA’s over-cautiousness in approving well-researched drugs.

In general, an increase in h^i changes s_* , but by the Envelope Theorem, the effect on s_* does not show up in the expression of the social marginal value of evidence. More precisely, we take derivatives of T_{s_*} with respect to h^i and use condition (2). Since the committee members are identical, we will consider only the symmetric case of $H = mh$ and drop the subscript i .⁷ We have

$$(4) \quad -T'_{s_*}(h) = \frac{1}{2} \sqrt{\frac{m}{h}} \lambda_1 (1 - \gamma) f_0(s_*) s_* + \frac{1}{2} \sqrt{\frac{m}{h}} \lambda_2 \gamma f_q(s_*) (q - s_*).$$

The first term represents the change in expected loss due to wrongful hiring, and the second term represents the change in expected loss due to wrong rejection. Equation (4) shows that the social marginal value of evidence increases with the committee size. Also, the marginal value of evidence is greater when the committee is less biased. To see this, take derivatives in equation (4) with respect to γ . We find that a decrease in γ has a positive effect on the social marginal value of evidence if and only if $s_*/q < \gamma$. This inequality holds if γ is sufficiently great, because the committee is strongly biased towards making an offer and the ex post optimal hiring standard s_* is low. Conversely, when γ is sufficiently small, a further decrease in γ means that the committee is even more biased for rejection. In this case the hiring standard is high and the inequality is reversed, so that social marginal value evidence decreases as γ decreases.

Throughout the discussion, we assume that the social marginal value of evidence decreases as precision increases, that is, $T_{s_*}(h)$ is a convex function in h . Straightforward algebra reveals that the necessary and sufficient condition for this is

$$(5) \quad \frac{1}{2} m h q^2 > \max\{\ln(\lambda_1(1 - \gamma)/(\lambda_2 \gamma)), \ln(\lambda_2 \gamma/(\lambda_1(1 - \gamma)))\}.$$

Under this condition, equation (3) implies that the ex post optimal hiring standard $s_*(h)$ lies between 0 and q . Moreover, the two terms of $-T'_{s_*}(h)$ in equation (4) are both positive: more precise evidence is valuable because it reduces both the loss due to wrongful hiring and the loss due to wrongful rejection. Condition (5) is always satisfied when the weights on the two types of errors are exactly balanced by the prior γ so that $s_* = q/2$. In general,

⁷ There is no benefit of allocating effort asymmetrically since the cost function e is convex.

it holds so long a qualified candidate is sufficiently distinct from an unqualified candidate (q is great enough), the committee's prior and preference are not too extreme, and the level of precision h is not too low.

Socially optimal individual level of precision h_* minimizes the sum of expected loss $T_{s_*}(h)$ and the cost of effort e . The first-order condition for h_* is

$$(6) \quad -T'_{s_*}(h_*) = e'(h_*).$$

The second-order condition is satisfied because $e'' \geq 0$ and $T''_{s_*}(h) > 0$.

In the absence of a social planner, the precision of collected evidence is determined by a Nash equilibrium. Suppose that the committee adopts the ex post optimal decision rule. In equilibrium each committee member chooses the level of precision to minimize the sum of expected loss due to the two types of errors and his own effort cost. Let $-t'_{s_*}(h)$ be the "private marginal value of evidence," obtained by taking derivatives of the expected loss $t_{s_*}(h)$ with respect to individual level of precision h^i , taking as given h^j for $j \neq i$, and then imposing the symmetry condition that $h^i = h$ for all i . Then,

$$(7) \quad -t'_{s_*}(h) = -T'_{s_*}(h)/m,$$

and the Nash equilibrium individual level of precision \hat{h} satisfies

$$(8) \quad -t'_{s_*}(\hat{h}) = e'(\hat{h}).$$

It follows from (6)-(8) that $\hat{h} < h_*$. Although in the Nash equilibrium the decision is ex post optimal, it is reached with evidence of a lower quality compared with the social optimum. This ex ante inefficiency of the Nash equilibrium is due to the public good nature of evidence and the free-rider problem. Individual committee members do not take into consideration of the beneficial effect on other members when choosing the precision level of their evidence.

The free-rider problem becomes more serious when there are more agents in the committee. Observe from equations (4) and (7) that as m increases, the social value of evidence increases but the private value decreases. A bigger committee as a whole suffers more from insufficient collection of evidence.

2.3. The benefit of conservatism

The free-rider problem in the committee arises because the private benefit of gathering evidence is below its social benefit. Deviations from the ex post optimal decision rule “make an offer if and only if $y \geq s_*(h)$ ” can be a way to increase the private benefit of gathering evidence and mitigate the free-rider problem. Under the ex post optimal decision rule, the private benefit of collecting evidence is given by equations (4) and (7). Now suppose that an arbitrary standard s (fixed for all h) is chosen. The private benefit of collecting evidence becomes:

$$(9) \quad -t'_s(h) = \frac{1}{2\sqrt{mh}}\lambda_1(1-\gamma)f_0(s)s + \frac{1}{2\sqrt{mh}}\lambda_2\gamma f_q(s)(q-s).$$

To see how $-t'_s(h)$ depends on s , take the derivatives in (9) with respect to s for any h :

$$\partial(-t'_s(h))/\partial s = -\frac{1}{2\sqrt{mh}}\lambda_1(1-\gamma)f_0(s)(mhs^2 - 1) + \frac{1}{2\sqrt{mh}}\lambda_2\gamma f_q(s)(mh(q-s)^2 - 1).$$

Using equation (2), we find that $\partial(-t'_s(h))/\partial s$ evaluated at $s_*(h)$ has the same sign as $q/2 - s_*$. If $\lambda_1(1-\gamma) < \lambda_2\gamma$, then $s_*(h) < q/2$ and $\partial(-t'_s(h))/\partial s$ is positive at $s_*(h)$. The opposite occurs when $\lambda_1(1-\gamma) > \lambda_2\gamma$. We have the following result:

PROPOSITION 1. *When the committee is biased for hiring, a higher than the ex post optimal hiring standard can yield greater private marginal value of evidence; when it is biased for rejection, a lower standard can yield greater value of evidence.*

Proposition 1 demonstrates the benefit of being conservative. A little extra caution or conservatism induces a greater private benefit of collecting evidence. Here, “caution” or “conservatism” is defined as deviation from the ex post optimal standard against the alternative favored by the committee’s prior or preference. Under this definition, a higher standard than $s_*(h)$ when $\lambda_1(1-\gamma) < \lambda_2\gamma$ is conservative because the committee favors hiring but the higher standard makes it more difficult. A lower hiring standard (or equivalently, a higher rejection standard) when $\lambda_1(1-\gamma) > \lambda_2\gamma$ is also conservative, because the committee favors rejection but a lower standard makes that more difficult.

The intuition behind Proposition 1 is rather simple. We have seen that the marginal value of evidence tends to be small when the committee is strongly biased either way. The

key to mitigating the free-rider problem in evidence-gathering is to increase the private marginal benefit of evidence. A conservative standard accomplishes this by making it tougher for the committee to choose the favored alternative and thus effectively forcing a reduction in the committee's bias.

An alternative, and more informative, illustration of the intuition behind Proposition 1 uses the following decomposition of the private marginal value of evidence $-t'_s(h)$ (the right-hand-side of equation (9)). Define

$$\begin{aligned} -t'_{1s}(h) &\equiv \frac{1}{2\sqrt{mh}}\lambda_1(1-\gamma)f_0(s)s; \\ -t'_{2s}(h) &\equiv \frac{1}{2\sqrt{mh}}\lambda_2\gamma f_q(s)(q-s). \end{aligned}$$

The term $-t'_{1s}(h)$ represents how hiring standard s affects the private value of evidence in reducing wrongful hiring, and $-t'_{2s}(h)$ represents how s affects the value of evidence in reducing wrongful rejection. We can verify that $-t'_{1s}(h)$ increases with s when $s < 1/\sqrt{mh}$ and decreases with s when $s > 1/\sqrt{mh}$. Similarly, $-t'_{2s}(h)$ increases with s when $s < q - 1/\sqrt{mh}$ and decreases with s when $s > q - 1/\sqrt{mh}$. Figure 2 depicts the two parts of the private marginal value of evidence as functions of s , for the case of $\lambda_1(1-\gamma) < \lambda_2\gamma$.⁸ In this case, $-t'_{1s}(h)$ has a smaller scale than $-t'_{2s}(h)$.

Suppose that the committee is not too biased either way, that is, suppose $1/\sqrt{mh} < s_*(h) < q - 1/\sqrt{mh}$.⁹ Intuitively, a standard higher than the ex post optimal standard $s_*(h)$ decreases $-t'_{1s}(h)$ because it makes wrongful hiring less likely, and increases $-t'_{2s}(h)$ because it increases the chance of wrongful rejection. See Figure 2. Whether a higher or lower standard increases the private benefit of gathering evidence depends on whether the committee is more concerned with wrongful rejection or wrongful hiring. If $\lambda_1(1-\gamma) < \lambda_2\gamma$, the committee is more concerned with wrongful rejection than with wrongful hiring, and the ex post optimal hiring standard $s_*(h) < q/2$. In this case, $-t'_s(h)$ is dominated by $-t'_{2s}(h)$.

⁸ For the purpose of illustration, we assume in Figure 2 that $mq^2h > 4$ so that $1/\sqrt{mh} < q - 1/\sqrt{mh}$. Proposition 1 does not depend on this assumption.

⁹ If the committee is so strongly biased that $s_*(h)$ falls outside the range, then an appropriate deviation from the ex post optimal standard will increase the private marginal value of evidence by increasing both of its two parts. See Figure 2.

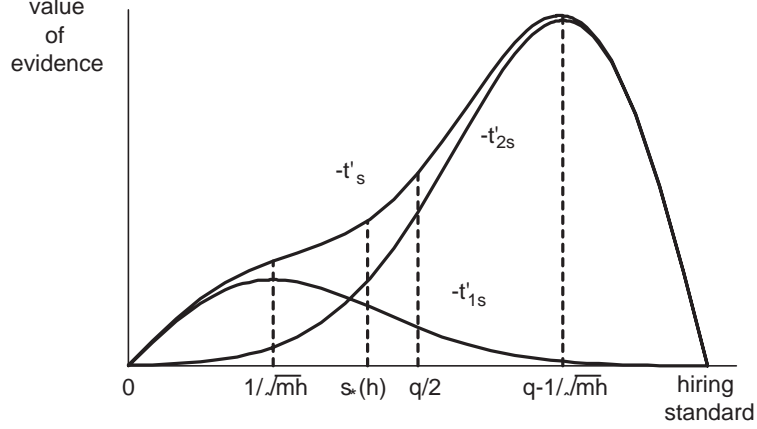


Figure 2. Decomposition of the private value of evidence when the committee is biased for hiring. A higher than the ex post optimal standard makes more conclusive evidence less effective in reducing wrongful hiring and more effective in reducing wrongful rejection, but the overall effect on the private value of evidence is positive.

Since $-t'_{2s}(h)$ increases for any s between $1/\sqrt{mh}$ and $q - 1/\sqrt{mh}$, a higher hiring standard increases the total value of evidence $-t'_s(h)$. In the opposite case of $\lambda_1(1 - \gamma) > \lambda_2\gamma$, the committee is more concerned with wrongful hiring than with wrongful rejection, a lower hiring standard than $s_*(h)$ increases the total value of evidence by increasing $-t'_{1s}(h)$ more than it decreases $-t'_{2s}(h)$.

2.4. Optimal degree of conservatism

Although commitment to deviations from the ex post optimal hiring standard can induce greater participation by the committee members in gathering evidence, it is costly ex post because the standard is suboptimal given the evidence.¹⁰ There exists a trade-off between ex ante incentive for evidence collection and ex post optimality given evidence. To maximize the committee's ex ante welfare, the degree of conservatism must be chosen to balance this trade-off.¹¹

¹⁰ Figure 2 also shows that too great deviation will eventually reduce rather than increase the private marginal value of evidence.

¹¹ The trade-off between ex ante incentive and ex post optimality is related the Prendergast's (1993) theory of yes men, where a manager faces a trade-off between providing ex ante incentives for a worker to gather information by rewarding the worker according to how close the worker's report is to his own

It must be stressed that the trade-off between ex ante incentive for evidence collection and ex post optimality given evidence arises from the free-rider problem. For a single agent, committing to a conservative decision rule will also induce more effort in collecting evidence, but such effort is wasteful because there is no free-rider problem, and ex post sub-optimality of the decision further reduces the ex ante welfare of the agent. The optimal degree of conservatism is zero for a single agent. In contrast, for a committee of multiple agents, optimal degree of conservatism is always positive. Consider increasing the standard s above the optimal level $s_*(\hat{h})$ when the committee is biased for hiring, and decreasing s below $s_*(\hat{h})$ when the committee is biased for rejection. Since $s_*(\hat{h})$ is ex post optimal, such changes do not affect ex post optimality at the margin, but Proposition 1 implies that it will provide greater incentives for evidence-collection.

More precisely, for a given standard s , the Nash equilibrium level of precision \hat{h} satisfies $-t'_s(\hat{h}) = e'(\hat{h})$. This condition determines \hat{h} as a function of s . To maximize the committee's ex ante welfare, the hiring standard s must be chosen to minimize $T_s(h) + e$, taking as given the function $\hat{h}(s)$. Using the Nash equilibrium condition, we can write the first-order condition for the optimal degree of conservatism \hat{s} as

$$(10) \quad \frac{\partial T_{\hat{s}}(\hat{h})}{\partial s} = (-T'_{\hat{s}}(\hat{h}) + t'_{\hat{s}}(\hat{h}))\hat{h}'(\hat{s}),$$

where $\partial T_{\hat{s}}(\hat{h})/\partial s$ denotes the effect of the hiring standard on the expected loss due to wrongful hiring and wrongful rejection, evaluated at the equilibrium \hat{h} and optimal \hat{s} . The term $\partial T_{\hat{s}}(\hat{h})/\partial s$ represents the cost of ex post conservatism: it is zero when s is ex post optimal, positive for any s marginally higher than the ex post optimal standard, and negative for any s marginally lower. By Proposition 1, the term $\hat{h}'(\hat{s})$ represents the positive effect on the equilibrium precision level of a conservative standard: it is positive if $\lambda_1(1 - \gamma) < \lambda_2\gamma$ so that a higher hiring standard than $s_*(\hat{h})$ provides greater incentives to gather information, and negative if $\lambda_1(1 - \gamma) > \lambda_2\gamma$ so that a lower hiring standard provides greater incentives. The term $-T'_{\hat{s}}(\hat{h}) + t'_{\hat{s}}(\hat{h})$ represents the difference between the

observation, and encouraging the worker to be honest about his information ex post. See also Aghion and Tirole's (1997) distinction of formal and real authority. The same trade-off exists in monopoly pricing models, where consumers have to make complementary investments and commitment to rationing increases profits (e.g., Gilbert and Klemperer, 2000).

social marginal value of evidence and the private marginal value of evidence and is positive. Together, the right-hand-side of (10) represents the benefit of conservatism due to greater participation in evidence-collection. Since conservatism has zero cost and positive benefit with a standard of proof just above the ex post optimal level, a little bit of conservatism is always beneficial.

The optimal degree of conservatism depends positively on the size of the committee m . As the committee size increases, social marginal value of evidence $-T'_{s^*}$ increases but private value $-t'_{s^*}$ decreases. A bigger committee as a whole suffers more from the free-rider problem of insufficient collection of evidence. By equation (10), the benefit of a given degree of conservatism increases as the gap between $-T'_{s^*}$ and $-t'_{s^*}$ increases. Everything else equal, this will increase the optimal degree of conservatism. In our model the free-rider problem in evidence-gathering and the conservatism remedy thus generate a scale effect on organization behavior. This scale effect explains the often-made observation that larger organizations tend to have greater organization inertia, such as slowness in discarding old inefficient organization habits.

According to Proposition 1, in a recruitment committee whether conservatism takes the form of a higher hiring standard or a higher rejection standard depends on whether the committee is more concerned with wrongful rejection or with wrongful hiring. For an academic department in a given hiring season, the weights λ_1 and λ_2 on wrongful hiring and wrongful rejection do not vary from candidate to candidate. Then, whether the committee is biased toward hiring or rejecting a candidate depends on its prior belief γ about the candidate. Under the ex post optimal decision, hiring standard decreases as the committee considers candidates deemed to be more likely qualified (see equation (3)). Under the conservatism remedy of Proposition 1, hiring standard does not decrease as fast, because additional incentives to gather information can be provided by raising the standard for promising candidates. Similarly, if we compare the hiring standard applied to candidates of the same prior prospects (same γ) by departments with different weights on wrongful hiring and wrongful rejection, we see that under the ex post optimal decision rule, hiring standard decreases for committees with greater relative weights on wrongful rejection, while it does not decrease as fast under conservative decision rules. In a sense,

conservatism provides greater incentives to gather information by moderating the biases due to prior beliefs or preferences.

For our model to explain FDA's over-cautiousness in adopting well-researched drugs, we need to assume that due to either its prior or preference the FDA is primarily concerned with wrongful denial of availability of new drugs that are safe and effective. It is generally difficult to say how the FDA panels weigh the cost of adopting a new drug with some unknown severe side effects and the cost of forsaking a superior new drug with potential life-saving opportunities. However, for well-researched drugs, the prior of the FDA favors adoption precisely because they are known to have been well-tested. In this case, FDA's bias for quick release of new drugs, coupled with the free-rider problem in producing evidence about their safety and efficacy, calls for a higher than the ex post optimal approval standard.¹² The free-rider problem exists in FDA's panels, either because panelists are jointly responsible for the outcome of the approval process, or because they do not bear all the social cost of making a wrong decision or recoup all the benefit of making a right one. In the latter case, the problem of insufficient effort in gathering evidence is present even if a single individual is responsible for the whole approval process.

Proposition 1 has implications to decision-making in juries. We can interpret the two alternatives in our model as conviction and acquittal, and the two unobserved states as guilty and innocent. Although in the adversarial system evidence is competitively provided by the defendant and the plaintiff, jurors must spend effort in digesting arguments put forth by the lawyers on both sides and following instructions by the trial judge in deliberating the verdict. To the extent that such effort costs individual jurors but benefits the whole jury, a free-rider problem exists in the jury fact-finding process.¹³ If for serious crimes the prior

¹² Although data used by FDA panels come from drug companies, since the 1962 Kefauver-Harris Amendments to the Food, Drug, and Cosmetics Act, the testing procedure employed by a manufacturer to produce the data has been subject to FDA regulation and oversight. According to Peltzman's (1973) study, the 1962 amendments "seek to reduce the cost of new-drug information to the consumer by substituting FDA-produced information for drug-company promotion and information obtained from actual usage" (p.1059). Panelists' effort in monitoring the tests and examining the data is important to the approval process. The next section incorporates incentives for drug companies to produce evidence into the analysis.

¹³ As a jury decision-making model, the model here is a simplification of the real-life situation. See Kaplow (1994) for a broad discussion of the value of accuracy of evidence and Davis (1994) for what determines standard of proof in jury decision-making situations.

of the jury favors conviction, perhaps a reflection of the jury's belief in law enforcement or the high conviction rate in actual juries for such crimes, then Proposition 1 says that a higher conviction standard than what is ex post optimal helps alleviate the free-rider problem in the jury. An implication is that the conviction standard used by juries in criminal cases should be higher than those used by juries in civil lawsuits, because juries in criminal cases are typically larger in size and therefore suffer more from the free-rider problem. This is consistent with the fact that the standard of "guilt beyond reasonable doubt" used in criminal cases is higher than the standard of "preponderance of evidence" in civil lawsuits. Another implication is that the conviction standard used by juries in the adversarial system of Britain and America should be higher than in similar trials in the inquisitorial system of continental Europe where a single judge decides. This is consistent with the observation that while the burden of proof falls squarely on the accusing side in the common law system, in the inquisitorial system the judge often demands evidence from the accused that he is not guilty.¹⁴

3. Conservatism in Heterogeneous Committees

We have motivated this paper with FDA's conservatism, and our result suggests that it can be explained by the bias of the FDA to approve new drugs and the need to provide incentives for the FDA panelists to put in more efforts in the process. But often most of the evidence concerning effectiveness (but perhaps not side effects) of a new drug is provided by its producer, not by the panelists. If we think of a "committee" consisting of the drug producer and the panelists, the committee members clearly have different preferences about the approval decision. We will show in this section that the basic result of this paper, that a little extra caution increases the private incentives to gather evidence and helps mitigate the free-rider problem in the committee, extends to the case of committee members having different preferences. This extension suggests that when drug producers

¹⁴ For a thorough discussion of the legal and political differences of the adversarial system of Britain and America and the inquisitorial system of the continental Europe, see Damaška (1986). Posner (1998) examines the two systems from an economic point of view.

provide most of the new information about the drugs under the FDA consideration, FDA's conservative standards of drug approval may ironically reflect the over-riding influence of the drug industry in the approval process.

To illustrate the point, we consider an extreme case of heterogeneity: suppose that a hiring committee has two members, A and B , with A concerned only with wrongful hiring, and B concerned only with wrongful rejection.¹⁵ Without loss of generality, we assume that the two members' concerns are given equal considerations in the committee. Then, given A 's observation y^A (with precision h^A) and B 's observation y^B (with precision h^B), the ex post optimal decision rule is to make an offer if and only if the summary statistic $y = (h^A y^A + h^B y^B)/(h^A + h^B)$ exceeds s_* , which is given by

$$(11) \quad s_* = \frac{q}{2} + \frac{\ln(\lambda_1^A(1 - \gamma^A)/(\lambda_2^B \gamma^B))}{q(h^A + h^B)}.$$

Note that the ex post optimal standard s_* is a function of the precision level $h^A + h^B$ of the summary statistic y . Further, $s_* > q/2$ if A 's concern for wrongful hiring dominates in the committee ($\lambda_1^A(1 - \gamma^A) > \lambda_2^B \gamma^B$), and $s_* < q/2$ if B 's concern for wrongful rejection dominates ($\lambda_1^A(1 - \gamma^A) < \lambda_2^B \gamma^B$). We establish an extension of Proposition 1.

PROPOSITION 2. *Suppose that $e''' \leq 0$. When the committee is dominated by concerns for wrongful rejection, a higher than the ex post optimal hiring standard can yield greater total incentives in gathering evidence; when it is dominated by concerns for wrongful hiring, a lower standard can yield greater total incentives.*

The socially optimal levels of precision h_*^A and h_*^B satisfy:

$$(12) \quad \begin{aligned} -\partial T_{s_*} / \partial h^A &= e'(h_*^A); \\ -\partial T_{s_*} / \partial h^B &= e'(h_*^B) \end{aligned}$$

where $T_{s_*} = \lambda_1^A(1 - \gamma^A)(1 - F_0(s_*)) + \lambda_2^B \gamma^B F_q(s_*)$ is the total expected loss to A and B . In contrast, under the ex post optimal standard s_* , the Nash equilibrium levels of precision \hat{h}^A and \hat{h}^B are determined by

$$(13) \quad \begin{aligned} -\partial t_{s_*}^A / \partial h^A &= e'(\hat{h}^A); \\ -\partial t_{s_*}^B / \partial h^B &= e'(\hat{h}^B), \end{aligned}$$

¹⁵ The result derived below holds for committees with less extreme heterogeneity.

where $t_{s_*}^A = \lambda_1^A(1 - \gamma^A)(1 - F_0(s_*))$ and $t_{s_*}^B = \lambda_2^B \gamma^B F_q(s_*)$ are expected loss to A and B respectively. Comparing equations (12) and (13), we find that $\hat{h}^A < h_*^A$ and $\hat{h}^B < h_*^B$. The free-rider problem in evidence-gathering exists in a heterogeneous committee for the same reason as in a homogeneous committee: each member does not take into consideration of the benefits to the other member when choosing the level of precision.

Depending on whether A 's concern for wrongful hiring or B 's concern for wrongful rejection dominates in the committee, a lower or a higher hiring standard will increase the aggregate precision level and alleviate the free-rider problem. Suppose $\lambda_1^A(1 - \gamma^A) < \lambda_2^B \gamma^B$ so that B 's concern dominates. In this case, $s_* < q/2$ from equation (11). Under the ex post optimal standard s_* , we can verify that $-\partial t_{s_*}^A / \partial h^A < -\partial t_{s_*}^B / \partial h^B$, so that A spends less effort than B ($\hat{h}^A < \hat{h}^B$). As in Section 2, if a hiring standard s higher than s_* is chosen, then the value of evidence in reducing wrongful hiring, $-\partial t_s^A / \partial h^A$, decreases, while the value of evidence in reducing wrongful hiring, $-\partial t_s^B / \partial h^B$, increases. As a result, \hat{h}^A falls and \hat{h}^B rises. But since B 's concern for wrongful rejection dominates, as long as the second derivatives of the effort function are decreasing or do not increase too fast (for example, when the effort function is linear or quadratic), the overall effect is a greater $\hat{h}^A + \hat{h}^B$. More precisely, one can verify that the necessary and sufficient condition for $d(\hat{h}^A + \hat{h}^B)/ds > 0$ at $s = s_*$ is

$$D^A e''(\hat{h}^B) + D^B e''(\hat{h}^A) > 0,$$

where D^A and D^B denote the effect of changes in s on $-\partial t_s^A / \partial h^A$ and $-\partial t_s^B / \partial h^B$ respectively. We know that $D^A < 0$ and $D^B > 0$, but $D^A + D^B > 0$ because $s_* < q/2$. Thus, $d(\hat{h}^A + \hat{h}^B)/ds > 0$ if $e''' \leq 0$ or if e'' does not increase too fast.

4. Further Discussions of Conservatism

In this paper, caution or conservatism is defined as deviation from the ex post optimal standard that makes it more difficult for the group to adopt an alternative favored by prior or preference. For the example of recruitment committees, conservatism takes the form of either a high hiring standard or a high rejection standard, depending on the prior and

preference. But often conservatism is seen as a status quo bias. Such bias can be explained in the context of the present model by noting that many organization decision-making situations are characterized by a sequential screening process. For example, proposals for constitutional amendments often need to garner enough grass root support before they can be voted by a decision-making committee. Major legislative actions first have to pass muster in subcommittees of the parliament. In such situations, the status quo decision is naturally rejection of the alternative being considered for approval. In later stages of the screening process, the fact that the proposal has passed earlier stages implies that the prior of the final decision-making committee favors approval. Conservatism therefore takes the form of a bias in favor of maintaining the status quo.

Conservatism in this paper is a commitment by a group to induce more effort in gathering information in the presence of the free-rider problem and in the absence of centralized effort in gathering evidence. The informational requirement for this commitment is not stringent, because implementation of a conservative rule requires neither observation of the precision level of the summary evidence nor any information about the individual levels of precision or effort. If the group could commit to decision rules that depend on aggregate level or even individual levels of precision and effort, then the social optimum may be achieved through a threat. Consider that the following decision rule: if the individual level of precision is at least h_* , the socially optimal individual level of precision, then choose the decision according to the ex post optimal standard; otherwise, choose the decision that maximizes the expected loss given the evidence. With this threat of punishment, there is an equilibrium where each agent spends the socially optimal amount of effort in acquiring information. However, such schemes are seldom observed in situations involving collective decisions. The reason may be that their implementation requires the group to monitor the precision level or the effort level, and this is too strong to be realistic.

In this paper we have assumed that evidence is public information. Under this assumption, information aggregation in the committee takes the simple form of computing a weighted sum of the observations, and the decision is made by comparing the sum to a threshold. The free-rider problem in evidence-gathering still exists when evidence is private to the committee member who gathers it, because a member cannot recoup all

the benefits from a better committee decision that comes with his efforts.¹⁶ However, when evidence is private and committee members have different prior and preferences, the problem of free-riding in evidence-gathering is compounded with the problem of evidence-manipulation. Li, Rosen, Suen (1998) show that incentives to manipulate evidence by committee members to their own advantage make efficient sharing of evidence impossible. Instead, under any committee decision rule such as the threshold rule in Section 2, the support of each member's evidence is partitioned into intervals, and only the rank ordered information of which interval the observation lies in matters to the committee decision. Thus, private and manipulable evidence imposes restrictions on the way information is aggregated in the committee. Any remedy to the free-rider problem should respect these restrictions. Analysis of the free-rider problem in evidence-gathering in the presence of information manipulation is worth pursuing in future research.

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¹⁶ Persico (1998) compares different decision rules in a private-information model that combines information aggregation and information acquisition. In his model, each agent must incur a fixed cost to learn a binary signal, and a mechanism designer can choose a subgroup to make the decision. He shows that decision rules close to veto power of individual members in the subgroup are optimal only if the signals are sufficiently accurate.

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