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journal homepage: [www.elsevier.com/locate/jjie](http://www.elsevier.com/locate/jjie)Biased monitors: Corporate governance when managerial ability is mis-assessed<sup>☆</sup>

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## ABSTRACT

An important aspect of corporate governance is the assessment of managers. When managers vary in ability, determining who is good and who is not is vital. Moreover, knowing they will be assessed can lead those being assessed to behave in ways that make them appear better. Such signal-jamming behavior can be beneficial (e.g., an executive works harder on behalf of shareholders) or harmful (e.g., the behavior is myopic, boosting short-term performance at the expense of long-term success). In standard models of assessment, it is assumed those doing the assessing behave according to Bayes Theorem. But what if the assessors suffer from one of many well-documented cognitive biases that makes them less-than-perfect Bayesians? This paper begins an exploration of that issue by considering the consequence of one such bias, the base-rate fallacy, for two of the canonical assessment models: career-concerns and optimal monitoring and replacement. Although firms can suffer due to the base-rate fallacy, they can also benefit from this bias.

## 1. Introduction

Since Fama (1980) and Holmstrom (1999) [1982],<sup>1</sup> it has been understood that many key phenomena in corporate governance (agency more generally) derive from the need to assess managerial ability. In particular, such assessment is the source of incentives, both desired (e.g., greater efforts due to career concerns) and perverse (e.g., forgoing profitable investments and other instances of managerial myopia); as well as being key to understanding phenomena around firms' choices of managers (CEOs) and, even, board composition. Much of this literature is surveyed in a forthcoming piece by Hermalin and Weisbach.

As discussed in Hermalin and Weisbach (2017), the models in this literature rely on Bayesian updating (typically, the normal-learning model). A danger in relying on Bayesian updating, as those authors note at the end of their chapter, is that there is a large psychological literature that indicates that most people are, in fact, *not* Bayesian updaters; that is, they revise their beliefs upon receiving new information in ways that are inconsistent with Bayes Law. Hermalin and Weisbach (2017) suggest that reexamining assessment models taking into account known biases in how people update beliefs could be a fruitful avenue for future research. This article is a beginning on that research agenda.

After a brief review of Bayesian learning, in particular the so-called

normal-learning model, the idea of the base-rate fallacy is introduced. This is a well-documented bias in which those making assessments overweight new information and underweight their prior information (the base rates). As is discussed later, this bias is similar to other biases; in particular, the fundamental attribution bias would yield identical results. Additionally, at least for the model in Section 4, the analysis can be recast in terms of wholly rational actors (i.e., perfect Bayesians) in a way that offers insights into trends in corporate governance or helps to explain differences between countries.

In Section 3, the consequences of the base-rate fallacy for Holmstrom's canonical model of career concerns are considered. The principal findings are that the more employers suffer from the base-rate fallacy, the more executives will work in equilibrium. This follows because how hard an executive works is a function of how much weight employers place on his current performance versus their prior assessment of him. Because the base-rate fallacy means more weight on current performance, an executive's incentives to work hard are greater. An employer that suffers less from the base-rate fallacy than a rival will avoid losing money in expectation. The same is not necessarily true of the rival: it can lose money in expectation. On the other hand, there are circumstances in which it too can expect to make money over the course of the game. A further result is that an employer would like to play against a rival that is a worse Bayesian than she (suffers

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<sup>1</sup> Holmstrom's paper was originally published in 1982 as a chapter in a hard-to-find festschrift for Lars Wahlbeck. In 1999, the *Review of Economic Studies* reprinted it.

more from the base-rate fallacy), but if she has to play against one that is a better Bayesian than she, then she does better the more Bayesian her rival is; that is, the worst rival is one that is only slightly more Bayesian than you.

Section 4 takes up the other canonical model of assessment: a firm decides whether to keep or fire its manager based on its assessment of his ability.<sup>2</sup> As in Section 3, the less Bayesian is the firm, the harder its executive will work. This reflects the weighting effect outlined in the previous paragraph, but also the greater monitoring that a less Bayesian firm does. Whether a firm suffers from being non-Bayesian depends on its value for this greater effort and how that compares to (i) over-investing in monitoring; (ii) firing the executive too readily; and (iii) having to pay greater compensation (in the Section 4.3 version only). As it turns out, although a firm *might* do best if wholly Bayesian, this is not always true: in some circumstances, deviations from being a perfect Bayesian maximize the firm’s value.

As indicated, although firms can lose from failing to be Bayesian, they can also benefit. Moreover, because at least in the Section 3 model, the executive tends to undersupply effort from the perspective of welfare, the base-rate fallacy can be welfare improving (even if not always profit improving).

The last section offers a brief conclusion, in which some of the empirical implications of the results are discussed, as well as next steps.

Some technical details, including proofs not given in the text, can be found in the Appendix A.

## 2. Means of updating

### 2.1. Bayesian learning

It is worth briefly reviewing the normal-learning model, which represents rational (Bayesian) updating of beliefs when the relevant parameters are normally distributed. This review will limit itself to settings relevant for this article, for a more extensive review see Hermalin and Weisbach (2017).

Suppose that an employer’s (shareholders’) *expected* payoff is a function of the employee’s (executive’s) ability,  $\alpha \in \mathbb{R}$ . The employer is assumed not to know the employee’s ability, but she does know its relevant statistical properties. Specifically, she knows that  $\alpha$  is drawn according to a normal distribution with mean  $\hat{\alpha}_0$  and variance  $1/\tau_0$ ; that is,  $\alpha \sim N(\hat{\alpha}_0, 1/\tau_0)$ . When the variance is written in the form  $1/\zeta$ ,  $\zeta$  is referred to as the *precision* of the distribution.

Additionally, the employer observes signals that permit her to update her beliefs about the employee’s ability. Specifically, let  $s_t \in \mathbb{R}$  denote the signal she observes at time  $t$  (e.g.,  $s_t$  is the realization of profit at time  $t$  or an indicator of whether the period- $t$  project was successful). The signal in any given period is drawn from a distribution that is conditional on the employee’s true ability. Specifically, assume  $s_t = \alpha + \varepsilon_t$ , where  $\varepsilon_t \sim N(0, 1/\eta)$ . As the signal could always be re-defined as  $\bar{s} = s - \mathbb{E}\{\varepsilon\}$ , there is no loss of generality in assuming  $\mathbb{E}\{\varepsilon\} = 0$ . Assume the  $\varepsilon_t$  are distributed independently of each other. Note that one can express the conditional distribution of  $s_t$  as  $N(\alpha, 1/\eta)$ .

It can be shown (see, e.g., DeGroot, 1970, p. 166), that the *posterior* distribution of ability given a sequences of signals  $s_1, \dots, s_t$  is normal with mean

$$\hat{\alpha}_t = \frac{\tau_0 \hat{\alpha}_0 + \eta \sum_{i=1}^t s_i}{\tau_0 + t\eta} = \frac{\tau_0 \hat{\alpha}_0 + t\eta \bar{s}}{\tau_0 + t\eta} = \frac{\tau_0}{\tau_0 + t\eta} \hat{\alpha}_0 + \frac{t\eta}{\tau_0 + t\eta} \bar{s}, \quad (1)$$

where  $\bar{s}$  is the arithmetic average of the  $t$  signals, and precision

$$\tau_t = \tau_0 + t\eta. \quad (2)$$

Observe, from the last equality in (1), that the posterior belief about

<sup>2</sup> Saying a “firm decides” should be understood as shorthand for certain decision makers, such as the firm’s owners or its board of directors, deciding.

ability is a weighted average of the prior belief and the signals. A generalization of this updating rule is

$$\hat{\alpha}_t = \lambda_t \hat{\alpha}_0 + (1 - \lambda_t) \bar{s}, \quad (3)$$

where  $\lambda_t \in [0, 1]$ . When

$$\lambda_t = \frac{\tau_0}{\tau_0 + t\eta},$$

the updating is consistent with Bayes Law; otherwise it is inconsistent.

### 2.2. Biases in updating

There is a large body of psychological research that convincingly demonstrates that people often hold beliefs or take actions that are inconsistent with their having properly employed Bayes Law to account for new evidence.<sup>3</sup> In particular, the psychology literature documents a number of biases or decision-making fallacies that lead individuals to depart from rationality in their decision-making and, critically, to do so in predictable ways. One such departure is especially relevant here: the *base-rate fallacy*.<sup>4</sup>

The base-rate fallacy is a tendency to *underweight* base rates; that is, when people receive a signal, they revise their beliefs by more than Bayes Law would have them do. In terms of expression (3), the  $\lambda_t$  they use is less than  $\tau_0/(\tau_0 + t\eta)$ ; that is, it violates the normal learning model. Numerous experiments have given test subjects information about the population (the base rate), and then subsequent information that can be used to answer a question. As an example, the experiment might describe a hypothetical diagnostic test for a rare disease: the subjects are told that the prevalence of some disease is, say, one in 10,000 in the population and there is a test for that disease that has only a one-percent false positive rate and a very high (perhaps even perfect) true positive rate. The subjects are then asked how likely is it that a patient who tests positive has the disease. The subjects’ guesses are usually very high, often over 90%.<sup>5</sup> The true answer, however, is less than one percent: if  $p$  is the true positive rate, then, utilizing Bayes Law, the posterior probability of having the disease based on a positive test is

$$\frac{p \times \frac{1}{10,000}}{p \times \frac{1}{10,000} + \frac{1}{100} \times \frac{9999}{10,000}} < \frac{1}{1 + 99.99} \approx 0.0099.$$

In other words, individuals underweight the base rate (the remarkably low prevalence of the disease) and place too much weight on new information (the signal—the test result).

As suggested, the base-rate fallacy translates into the normal learning model as the  $\lambda_t$  in expression (3) underweighting the prior,  $\hat{\alpha}_0$  and overweighting the signal(s). That is,

$$\lambda_t < \frac{\tau_0}{\tau_0 + t\eta}. \quad (4)$$

There are certainly other cognitive biases worth considering (as suggested, e.g., in Hermalin and Weisbach (2017)). Some (e.g., the “hot-hand” fallacy and the fundamental attribution bias) are similar in spirit to the base-rate fallacy, insofar as the predictive value of recent individual achievement is over-estimated. Indeed, it is worth considering the fundamental attribution bias in this context. The fundamental attribution bias is attributing too much to individual actors and too little to their circumstances; for example, attributing too much of the firm’s performance to its executive (the employee) and not enough to random market factors. In terms of the analysis above, the fundamental attribution bias can be interpreted as erroneously believing the

<sup>3</sup> Some good introductions and overviews of this literature are Gilovich (1991), Scott (1993), and Daniel (2011).

<sup>4</sup> See Daniel (2011) for, *inter alia*, an overview of this and other biases.

<sup>5</sup> Having routinely run this experiment in my first-year MBA course, I can attest to such findings.

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