The Man(ager) Who Knew Too Much

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November 18, 2019

Preliminary and Incomplete

Abstract

There is widespread evidence that better informed individuals exhibit the "curse of knowledge." We study how this bias affects communication choices and investment decisions within a firm. A principal chooses the optimal level of investment in a risky project, conditional on the information she receives from a better informed, but "cursed," manager. The curse of knowledge leads the manager to overestimate the informativeness of his communication. This misperception amplifies the information loss from strategic communication when the manager and principal's incentives are misaligned. However, this same distortion in the manager's perception leads him to over-invest in acquiring private information. We characterize the overall impact on firm value and on the choice of whether to delegate the investment decision to the manager.

JEL Classification: D8, D9, G3, G4

Keywords: curse of knowledge, cheap talk, disclosure, delegation, belief formation.

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1 Introduction

Firms continually make decisions under uncertainty. While managers and employees "on the ground" are likely to be better informed about product demand, operational constraints, and new technologies, "top level" managers are usually responsible for deciding in which projects to invest and how much capital should be invested. As a result, the communication of dispersed information within the organization is a critical determinant of performance. A large literature has focused on how misaligned incentives, contractual incompleteness and organizational frictions can limit the effectiveness of communication within firms. And yet, the economics literature has largely overlooked a robust and pervasive regularity exhibited by informed individuals: the "curse of knowledge."

Coined by Camerer, Loewenstein, and Weber (1989), the "curse of knowledge" refers to a cognitive bias whereby better informed individuals fail to ignore their private information when predicting the beliefs of others. As a result, these individuals tend to overestimate the extent to which others' beliefs are aligned with their own. This bias is a robust and widespread phenomenon (e.g., see the survey by Ghrear, Birch, and Bernstein (2016)). For instance, an older sibling, cursed by the knowledge of his parents' actions on Christmas Eve, does not understand why his younger sister continues to believe in Santa Claus.[1] A business school professor underestimates the explanation required to teach "simple concepts" such as net present value or sunk costs to her first-year MBA students. And a division manager, cursed by the knowledge of his own ability, overestimates how favorable the CEO will be towards his next project.

We study how the curse of knowledge affects communication and investment decisions within a firm. In our model, a principal chooses how much to invest in a risky project after communicating with her manager, who is privately informed about the project's productivity. The manager is subject to the curse of knowledge: his perception of the principal's beliefs about the project is tilted towards his own expectation. As a result, he believes that he communicates more effectively. The existing literature (e.g., Camerer et al. (1989)) suggests that this misperception can help alleviate the inefficiencies generated by asymmetric information.[2] In contrast, we show that these mistaken beliefs actually leads the manager to further distort his strategic communication, thereby making it less informative in equilibrium. Thus, when the manager is endowed with private information, the curse of knowledge decreases both investment efficiency and firm value. This highlights the importance of disen-

[1] We borrow this example from Ghrear, Birch, and Bernstein (2016).

[2] In particular, Camerer et al. (1989) argues that curse of knowledge on the part of the privately informed seller can reduce the likelihood of market breakdown due to adverse selection because it leads her to set the price of a lemon (peach) lower (higher, respectively) than is strategically optimal.

tangling biases in preferences from those in beliefs when trying to understand communication and informational frictions within firms.

With endogenous information acquisition, however, the curse of knowledge leads the manager to acquire more private information because he underestimates how much is lost through communication. We demonstrate that, in some settings this latter channel can be impactful enough that firm value increases with the severity of the curse of knowledge. Finally, we characterize the conditions under which the principal prefers to delegate the investment decision to the manager, and show that the principal may prefer to delegate to a sufficiently "cursed" manager while retaining control with an unbiased one. Thus, understanding the source of the manager's inefficient communication (bias in preferences or a bias in beliefs) is essential to ensure the efficient allocation of control rights within the firm.

Section 2 introduces the model. We study communication and investment in a firm with a principal (she) and a manager (he). The principal faces uncertainty about the productivity of a risky project and must choose the optimal level of (costly) investment. The manager observes a noisy, private signal about the return on the project and can send a costless message to the principal before she makes the investment decision. The utility for both the principal and the manager increases in their expectation of firm value which is increasing in the informativeness of the manager's message. The manager, however, also derives a non-pecuniary, private benefit which increases with the size of the investment. This private benefit introduces a wedge between the principal's and the manager's preferred level of investment.

Importantly, we assume that the manager suffers from the curse of knowledge. As a result of his informational advantage, he therefore believes that the principal's expected return on investment, conditional on his message, is closer to his conditional expectation than it actually is. We consider both non-verifiable and (partially) verifiable communication, and in each case, allow the manager to choose the precision of his signal by exerting costly effort.

In section 3, we analyze the setting in which the manager's communication is not verifiable, i.e., where he can engage in "cheap talk". We show that the resulting communication equilibria are analogous to those in Crawford and Sobel (1982). Specifically, if the manager's private benefit from investment is sufficiently small, there is a standard, partition equilibrium in which he sends the same message for all signals in a given interval. If his bias towards over-investment is too large, however, an informative equilibrium does not exist.

When the precision of his private information is fixed, we show that the curse of knowledge reduces the manager's ability to communicate along two dimensions. First, as the degree to which the manager exhibits the curse of knowledge increases, the maximum bias for which informative cheap talk is feasible decreases, i.e., informative cheap talk is less likely to be sustained. Second, in an informative, cheap talk equilibrium, an increase in the curse of knowledge decreases the maximal number of partitions i.e., less information can be conveyed via informative, cheap talk. As a result, holding fixed the precision of the manager's information, the curse of knowledge reduces the expected value of the firm.

Intuitively, the manager's communication strategy trades off his desire to inflate investment (due to the private benefit he receives) against the incentive to credibly convey information (to maximize firm value). However, since he suffers from the curse of knowledge, the manager perceives that the principal's beliefs (conditional on his message) are closer to his than they actually are, i.e., his communication is more informative than it is. This tilts the tradeoff faced by the manager and pushes him to further distort his message in an effort to increase investment. In fact, we show that an increase in the degree of the manager's curse of knowledge has the same effect on communication as increasing his private benefit, and consequently, the curse of knowledge increases his "effective bias." All else equal, this leads to less informative communication.

Surprisingly, however, when the manager can optimally chooses the precision of his private signal, the expected value of the firm can be *increasing* in the severity of the curse of knowledge. Because the manager perceives his communication to be more informative than it actually is, his perceived marginal utility of increasingly precise information increases in the extent to which he exhibits the curse of knowledge. The net effect of the curse of knowledge on the firm's expected value depends, therefore, on (i) the precision chosen by the manager, and (ii) how much of this private information is lost through communication with the principal. We show that, in some cases, the first effect can dominate the second: the endogenous increase in precision can be sufficiently large to increase the informativeness of the manager's message, despite the distortion created by the curse of knowledge. As a result, expected firm value can increase.

Section 4 considers a setting with strategic disclosure in which the manager can verifiably disclose her signal, but cannot verifiably disclose that he is uninformed. We consider the canonical setting (e.g., see Dye (1985)) in which, with some positive probability, the manager does not observe any information. If he chooses not to disclose, the principal forms her expectation knowing that (i) the manager may not have any information to disclose or (ii) the manager may be strategically choosing not to disclose his signal.

As before, the manager's optimal disclosure strategy trades off his incentive to increase investment against his desire to convey accurate information about productivity. When the bias towards over-investment is sufficiently large, the former channel dominates, which leads the manager to withhold his private information when it is sufficiently negative. The resulting equilibrium features one-sided, "disclosure on top," i.e., the manager only discloses his signal if it is higher than a certain threshold. When the bias is sufficiently small, there can also arise a two-sided disclosure equilibrium in which the manager also discloses all signals below a threshold. This is because the non-pecuniary benefit the manager receives is outweighed by the loss in firm value due to over-investment for sufficiently low signals. We show that as the manager's bias falls, he discloses his signal over a larger interval, which increases the informativeness of his communication and expected firm value.

As in the case with cheap talk, when the manager's signal precision is fixed, the curse of knowledge makes communication less informative and, consequently, decreases firm value. However, with endogenous precision choice, an increase in the manager's curse of knowledge can lead him to acquire more precise information and, in some cases, this can lead to higher firm value. The intuition for this result mirrors the earlier one. Even when the manager does not disclose his signal, the curse of knowledge distorts his beliefs about the principal's expectation of productivity: he incorrectly believes her conditional expectation will be tilted towards his own beliefs, and so closer to the truth. This lowers the perceived cost of non-disclosure (driven by less efficient investment) which, in turn, leads to non-disclosure for a larger range of signal realizations. As the curse of knowledge grows, the region in which the manager chooses not to disclose expands, lowering expected firm value. Moreover, if the curse of knowledge is sufficiently large, the two-sided equilibrium is no longer sustainable and the shift to one-sided disclosure lowers the expected value of the firm further. When the manager can choose the precision of his signal, a higher curse of knowledge leads him to acquire more precise information because he mistakenly believes that he is communicating more effectively with the principal. As a result, we show that in some cases the curse of knowledge can lead to higher firm value in expectation..

In Section 5, we analyze whether the principal prefers to delegate the investment decision to the manager. If the principal delegates, she allows the manager to utilize his more precise information to make the investment decision. The tradeoff, however, is that the principal expects the manager to investment more than she would consider optimal. With cheap talk communication, the principal follows a threshold strategy: she delegates if the bias is sufficiently small, and otherwise retains control. Interestingly, this threshold does not depend upon the curse of knowledge. The principal only wants to retain control when the manager's communication is uninformative and so the curse of knowledge has no impact on the principal's information set.[3] With verifiable disclosure, the principal's decision to delegate depends upon whether the equilibrium features one-sided or two-sided disclosure.

[3]This mirrors the result from Dessein (2002), who considers the decision of delegation versus communication in the absence of the curse of knowledge.

In the former case, the manager's disclosure threshold does not depend on the curse of knowledge, and so neither does the decision to delegate: if the true bias is sufficiently small, the principal delegates. With the two-sided disclosure, however, the decision to delegate depends upon the effective bias. In this setting, the manger's message is distorted by his misperception of the principal's beliefs while his preferred investment level is not. As a result, if the curse of knowledge is the primary driver of the manager's effective bias, the principal prefers to delegate.

Related Literature

Our paper is motivated by the literature in psychology on the curse of knowledge, which has been documented to be a robust, and widespread cognitive friction. As discussed in the survey by Ghrear et al. (2016) and the papers within, the bias has been documented in many information structures, across different cultures, and in a variety of settings. Camerer et al. (1989) is the first paper to explore the implications of the curse of knowledge in economic decision-making. Using an experimental design, the authors document that the bias is a robust feature of individual forecasts and is not eliminated by incentives or feedback. Based on their analysis , the authors conclude that the curse of knowledge can help "alleviate the inefficiencies that result from information asymmetries." For example, because better informed agents do not exploit their informational advantage fully, the seller of a lemon (peach) sets the price lower (higher, respectively) than they otherwise would. As a result, the likelihood of market failure highlighted by Akerlof (1970) is alleviated by the curse of knowledge. Moreover, they conclude that better informed agents may suffer larger losses, and so "more information can actually hurt."

Our analysis of communication in the presence of the curse of knowledge leads to somewhat different conclusions. In our setting, the same distortion in beliefs exacerbates the effects of asymmetric information: because the manager perceives a smaller information asymmetry, his strategic communication becomes less informative in the presence of the curse of knowledge and investment decisions can be less informationally efficient. However, because he believes his messages to be more informative than they actually are, a cursed manager does prefers to acquire more precise information, and this can increase utility and firm value.

Our paper is also related to the broader literature on communication within a firm, and the resulting efficiency of investment choices. To our knowledge, we are the first paper to study the impact of the curse of knowledge on standard variants of communication studied in the literature: cheap talk (e.g., Crawford and Sobel (1982)) and and voluntary disclosure (e.g., Dye (1985)). We also complement the analysis in Dessein (2002), by characterizing how the curse of knowledge affects the tradeoff between delegation and communication. While much of this literature considers rational behavior on the part of both the principal and manager, there is a growing list of papers that introduces behavioral biases (e.g., see Malmendier (2018) for a recent survey) The managerial biases considered include overconfidence (e.g., Gervais, Heaton, and Odean (2011)) , reference-dependence (see Baker, Pan, and Wurgler (2012)), experience effects (see Malmendier, Tate, and Yan (2011)) and confirmation bias (see Martel and Schneemeier (2019)). Like us, Campbell, Gallmeyer, Johnson, Rutherford, and Stanley (2011) argue that some level of overconfidence can lead to value-maximizing policies. In the context of cheap talk models, Kawamura (2015) argues that overconfidence can lead to more information transmission and welfare improvement.

2 Model Setup

We begin with a description of the general model.

Payoffs and Technology. There are two dates $t \in \{0, 1\}$ and a single firm. The terminal value of the firm is given by $V \equiv V(R, k)$ where R measures the return on investment, or productivity, of the project available and k represents the scale of investment in the project. For analytical tractability, we assume

$$V(R, k) = Rk - \tfrac{1}{2}k^2, \tag{1}$$

$$R = \mu + \theta, \tag{2}$$

with μ is the expected productivity, while $\theta \sim U\left[-\frac{\sigma}{2}, \frac{\sigma}{2}\right]$ is the learnable shock to the return on investment.

Beliefs. The firm consists of a principal p (she) and a manager m (he). The manager observes a noisy, private signal, x, about productivity and can send a message d to the principal. Specifically, the manager observes θ with probability $p \geq \frac{1}{2}$ and an independent shock η with probability $1 - p$, i.e.,

$$x = \begin{cases} \theta & \text{with probability } p \\ \eta & \text{with probability } 1-p \end{cases}, \tag{3}$$

where $\eta \sim U\left[-\frac{\sigma}{2}, \frac{\sigma}{2}\right]$ and is independent of θ. The probability p denotes the **precision** of the manager's private signal x.

Let $\mathcal{I}_m$ and $\mathcal{I}_p$ denote the information sets of the manager and principal, respectively and note that $\mathcal{I}_m$ is finer than $\mathcal{I}_p$. We assume that both agents have common priors about the joint distribution of fundamentals and signals, and that these priors are consistent with the objective joint distribution. However, we assume that the manager exhibits the **curse of knowledge**. In particular, when (1) the manager forecasts the principal's conditional expectation of a random variable X and (2) the principal's information set is coarser, the manager's conditional expectation is given by

$$\mathbb{E}_m\left[\mathbb{E}\left[X|\mathcal{I}_p\right]\middle|\mathcal{I}_m\right] = (1-\omega)\,\mathbb{E}\left[X|\mathcal{I}_p\right] + \omega\mathbb{E}\left[X|\mathcal{I}_m\right] \text{ for all } \mathcal{I}_p \subseteq \mathcal{I}_m. \tag{4}$$

We distinguish between the expectations operator $\mathbb{E}_m[\cdot]$, which reflects the "cursed" (biased) expectation of the manager, and the expectations operator $\mathbb{E}\left[\cdot\right]$ without the subscript, which corresponds to the expectation under objective beliefs. The parameter $\omega \in [0,1]$ measures the degree to which agent i exhibits the curse of knowledge. When $\omega = 0$, the manager correctly applies the law of iterated expectations; however, as ω increases, the manager's forecast is biased toward his conditional expectation (given his private information). The specification in (4) matches the one utilized by Camerer, Loewenstein, and Weber (1989).

Preferences. The principal prefers an investment level which maximizes the expected value of the firm, given her information set, $\mathcal{I}_p$. Specifically, her desired level of investment, given her information set $\mathcal{I}_p$ is

$$k^p \equiv \arg\max_k \mathbb{E}\left[Rk - \tfrac{1}{2}k^2\middle|\mathcal{I}_p\right] = \arg\max_k \mathbb{E}\left[\tfrac{1}{2}R^2 - \tfrac{1}{2}\left(R-k\right)^2\middle|\mathcal{I}_p\right] \tag{5}$$

$$= \mathbb{E}\left[R|\mathcal{I}_p\right] = \mu + \mathbb{E}\left[\theta|\mathcal{I}_p\right] \tag{6}$$

The principal would like the level of investment, k, to be as close as possible to the firm's productivity, R, (i.e., she wants to decrease $(R-k)^2$) since this maximizes the value of the firm.

The manager, however, also derives a non-pecuniary, private benefit from investment. As a result, his desired level of investment given his beliefs ($\mathcal{I}_m$) is

$$k^m \equiv \arg\max_k \mathbb{E}\left[Rk - \tfrac{1}{2}k^2 + bk\middle|\mathcal{I}_m\right] = \arg\max_k \mathbb{E}\left[\tfrac{1}{2}R^2 - \tfrac{1}{2}\left(R-k\right)^2 + bk\middle|\mathcal{I}_m\right], \tag{7}$$

where $b \geq 0$ reflects the manager's private benefit from investment. Intuitively, all else equal, he prefers that the principal invest (weakly) more than optimal since he receives private benefits from managing a larger project. The manager's desired level of investment reflects a tradeoff between his preference for higher investment (the bk term) and more efficient investment (the $(R-k)^2$) term.

In the following sections, we consider the impact of the bias in the manager's preferences,

b, and in his beliefs, ω, on communication. Specifically, we assume that the principal chooses her preferred level of investment, k^p; however, since she does not directly observe the signal about fundamentals, x, her decision relies on the manager's message, d, i.e., $k^p = k^p(d)$. As a result, and given his preferences, the manager's optimal message is

$$d(x) \equiv \arg\max_{d} \mathbb{E}_m \left[(R+b)\, k^p(d) - \tfrac{1}{2} \left(k^p(d)\right)^2 \middle| x, d \right]. \tag{8}$$

To measure the impact of the curse of knowledge on the quality of the manager's communication, we utilize a standard measure of informativeness: the expected reduction in the receiver's uncertainty after observing the message.

Definition 1. The message function $d(x)$ is **more informative** than $\hat{d}(x)$ if $\mathbb{E}[\text{var}(\theta|d)] < \mathbb{E}\left[\text{var}\left(\theta|\hat{d}\right)\right]$.

In the following sections we show how the curse of knowledge affects the principal's investment (and therefore, firm value) through the distortions it creates in both communication and information acquisition. We focus on settings in which the message is costless to send, but consider both non-verifiable communication (Section 3) and verifiable disclosure (Section 4). Finally, in Section 5, we consider whether the investment distortions that arise due to biased communication can be alleviated via delegation. Specifically, we analyze under what conditions the principal would delegate the investment decision to the manager, i.e., allow the manager to choose his desired level of investment, k^m, given his beliefs.

3 Non-verifiable communication (Cheap talk)

We begin by studying how curse of knowledge affects strategic communication in a setting where the manager can engage in "cheap talk": costless and non-verifiable communication. Suppose that, after observing his signal x, the manager can send a costless but non-verifiable message, $d = d(x)$, to the principal. As is standard in the class of "cheap talk" models introduced by Crawford and Sobel (1982), we begin by conjecturing that if an informative communication equilibrium exists, it follows a partition structure. Specifically, conjecture that there exists a partition characterized by cutoffs $-\frac{\sigma}{2} = s(0) < s(1) < s(2) ... s(N) = \frac{\sigma}{2}$, such that for all $x \in [s(n-1), s(n)]$, the manager sends the same message $d(n)$. In such an equilibrium, a message $d(n)$ induces the principal to optimally set

$$k^p(d(n)) = \mathbb{E}[\theta | x \in [s(n-1), s(n)]] + \mu \tag{9}$$

$$= p\frac{s(n-1) + s(n)}{2} + \mu. \tag{10}$$

This expression is similar to that found in standard cheap talk models with one modification: the principal knows that the manager's signal is only informative with probability p, and so discounts the information provided accordingly.

Moreover, the manager exhibits the curse of knowledge, and so believes that the principal's action will hew more closely to his beliefs about θ i.e., his conditional expectation of her action is given by:

$$\mathbb{E}_m \left[k^p \left(d\left(n\right)\right) | \mathcal{I}_m\right] = \left[\left(1-\omega\right) \mathbb{E}\left[\theta | d\left(n\right)\right] + \omega \mathbb{E}\left[\theta | x\right]\right] + \mu \tag{11}$$

$$= p\left[\left(1-\omega\right) \frac{s\left(n-1\right)+s\left(n\right)}{2} + \omega x\right] + \mu. \tag{12}$$

As such, the manager mistakenly believes that the principal's action will be better aligned with his conditional expectation of the true productivity, $\mu + \theta$. As the following proposition shows, this distortion in beliefs limits the manager's ability to convey information in equilibrium.

Proposition 1. *There exists a positive integer $N_{max} \equiv ceil\left(-\frac{1}{2}+\frac{1}{2}\sqrt{1+2\sigma\frac{p(1-\omega)}{b}}\right)$, such that for every N, with $1 \leq N \leq N_{max}$, there exists at least one cheap talk equilibrium with N partitions and cutoffs*

$$s\left(n\right) = \sigma\left(\frac{n}{N}-\frac{1}{2}\right) + 2n\left(n-N\right)\frac{b}{p\left(1-\omega\right)}. \tag{13}$$

When $b > \frac{\sigma p(1-\omega)}{4}$, then the only equilibrium is uninformative (i.e., $N_{max} = 1$).

All proofs are in the appendix. The above result corresponds directly that in Crawford and Sobel (1982), except that the manager's *effective* bias is now $\frac{b}{p(1-\omega)}$. The effective bias reflects the manager's inability to communicate effectively due to (i) the bias b in preferences, (ii) the (imperfect) precision p of his private signal, and (iii) the degree ω of curse of knowledge.

First, the effective bias increases with the bias b in preferences - the stronger this bias, the less the manager is able to convey in equilibrium. Next, note that the effective bias decreases with the precision p of the manager's signal. This is intuitive: when the manager's signal is more noisy, the principal correctly puts less weight on his message, which limits the extent of communication between the two. Finally, the effective bias is increasing in the degree of the manager's curse of knowledge, ω. This reflects the manager's mistaken beliefs about the principal's conditional expectation: as (4) makes clear, the manager perceives that the principal's beliefs place more weight on his private information and less weight on his message as the curse of knowledge grows. This creates a stronger incentive for the manager to distort his message in an effort to increase investment which, in turn, makes his message less informative (less credible) to the principal.

Note that the curse of knowledge reduces the ability of the manager to communicate effectively along two dimensions. First, as the curse of knowledge increases (i.e., ω increases), the maximum bias for which informative communication is feasible (i.e., $\frac{\sigma p(1-\omega)}{4}$), shrinks. In other words, informative cheap talk is less likely to arise. Second, even when informative communication is feasible, an increase in the degree of distortion, ω, increases the size of the partitions, for any $N \leq N_{max}$, which reduces the amount of information that can be conveyed via cheap talk. In turn, this implies that the expected value of the firm decreases with the degree to which the manager exhibits the curse of knowledge, as summarized by the following corollary.

Corollary 1. *Fixing the precision, p, of the manager's signal, in any cheap talk equilibrium, the informativeness of communication and the expected firm value decrease (weakly) in the degree, ω, of the manager's curse of knowledge.*

As we show in the proof of Corollary 1, and as is standard in "cheap talk" equilibria, the value of the firm is increasing in the informativeness of the manager's communication. Specifically, the expected value of the firm is

$$\mathbb{E}\left[V\left(R,k\right)\right] = \tfrac{1}{2}\left(\mu^2 + \mathrm{var}\left(\theta\right) - \mathbb{E}\left[\mathrm{var}\left(\theta|d\right)\right]\right) \tag{14}$$

Thus, firm value increases when the principal faces less uncertainty, in expectation, about the firm's productivity, i.e., as $\mathbb{E}\left[\mathrm{var}\left(\theta|d\right)\right]$ falls. Because the curse of knowledge effectively amplifies the manager's bias, it (i) reduces the informativeness of a given partition equilibrium and (ii) can eliminate the existence of the most informative equilibria. Taken together, the expected value of the firm decreases.

For the manager, however, the effects are more nuanced. Let $u^m\left(d\left(x\right);x\right)$ denote the manager's utility, conditional on observing x and sending a message $d\left(x\right)$. Then,

$$\mathbb{E}_m\left[u^m\left(d\left(x\right);x\right)\right] = \tfrac{1}{2}\mathbb{E}_m\left[\mathbb{E}_m\left[\left(R+b\right)\middle|x\right]^2 - \left(\mathbb{E}_m\left[\left(R+b\right)\middle|x\right] - k^p\left(d\left(x\right)\right)\right)^2\right] \tag{15}$$

Holding fixed the bias in his preferences, the manager would like the principal to make a more informed investment decision, i.e., he wants to minimize the distance between $\mathbb{E}_m\left[\left(R+b\right)\middle|x\right]$ and $k^p\left(d\left(x\right)\right)$. As a result, he prefers both a more informative signal (an increase in p) and the most informative equilibrium (where $N = N_{max}$). Somewhat surprisingly, however, this also implies that the manager's expected utility is increasing in the degree to which he exhibits the curse of knowledge, holding fixed the number of partitions. The manager's belief about the principal's investment decision, $k^p(d(x))$ is distorted: as ω increases, he expects the principal's beliefs (and therefore, the level of investment she chooses) will be closer to his conditional expectation, i.e., $\mathbb{E}_m\left[(R+b)\,|x\right]$. We establish these results in the proof of the following lemma.

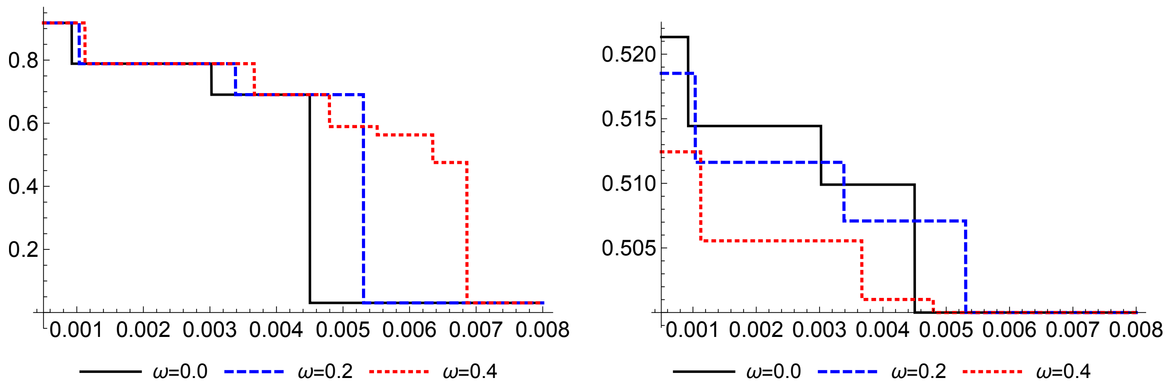
Lemma 1. *The manager's expected utility is increasing in the number of partitions (N). Holding N fixed,* $\frac{\partial \mathbb{E}[u^m(x)]}{\partial \omega}, \frac{\partial \mathbb{E}[u^m(x)]}{\partial p},$ *and* $\frac{\partial^2 \mathbb{E}[u^m(x)]}{\partial \omega \partial p} > 0$.

As emphasized above, the nature of the informative communication equilibrium depends upon the effective bias, $\frac{b}{p(1-\omega)}$, suggesting that the manager's bias for over-investment (b) and the curse of knowledge (ω) act as substitutes. However, Lemma 1 highlights one differential impact of these two distortions. Because an increase in the curse of knowledge also distorts how the manager *perceives* his communication, we show that the manager's perception of his expected utility, $\mathbb{E}_m\left[u^m(d(x);x)\right]$, rises even as his ability to communicate effectively falls. In short, he fails to fully internalize the information lost when he communicates with the principal. In contrast, the manager fully internalizes the impact of his bias towards over-investment and so, holding fixed the expected non-pecuniary benefits from investment ($b\mu$), an increase in b lowers his expected utility.

In many settings, the manager is not endowed with his private information, but must acquire it through costly effort / investment. Lemma 1 suggests that the curse of knowledge can increase information acquisition. In particular, as long as the number of partitions remains fixed, the manager finds more value in increasing the precision of his private signal as the curse of knowledge grows. This relies on the same channel as above – the manager believes that he will be able to communicate more effectively than he does in practice, which increases the value of the information he acquires.

Thus, with endogenous learning, there is a countervailing, indirect effect to the negative, direct, effect on communication generated by the curse of knowledge: an increase in p can increase N_{max} and lower the effective bias As a result, depending upon the information technology (e.g., the cost of effort or information acquisition), an increase in the curse of knowledge could increase N_{max} *and* lower the effective bias in communication: firm value could potentially increase. There is, however, a limit to this channel: note that, even if the manager is perfectly informed, i.e., $p = 1$, there always exists a level of ω such that informative communication is not feasible (and so eventually, firm value must fall as ω increases). Figure 1 provides an illustration of this effect on the expected value of the firm. We assume that the manager optimally chooses p subject to a cost of the form: $c(p) = c_0 \frac{p}{1-p}$. The figure plots the optimally chosen precision and the expected value of the firm, under the

Figure 1: Optimal precision choice and expected value under cheap talk
The figure plots the expected value of the firm with cheap talk communication as a function of the cost c_0, where the manager optimally chooses p subject to a cost $c(p) = c_0 \frac{p}{1-p}$. The other parameters of the model are set to: $\mu = 1$, $b = 0.1$, $\sigma = 1$.



(a) Optimal precision p vs c_0

(b) Expected Value vs c_0

maximally informative (i.e., $N = N_{max}$), feasible cheap talk equilibrium, for different values of ω, as a function of the cost parameter c_0. The solid line corresponds to the benchmark with no curse of knowledge ($\omega = 0$), the dashed line corresponds to $\omega = 0.2$ and the dotted line corresponds to $\omega = 0.4$. Not surprisingly, the expected value of the firm is (weakly) decreasing as the cost of information precision increases (i.e., c_0 increases). Moreover, holding the cost fixed, a higher degree of the curse of knowledge ω usually decreases expected value. However, there are instances when this is not true. In particular, there are ranges of the cost parameter for which the expected value is higher for $\omega = 0.2$ (dashed) than with $\omega = 0$ (solid). In these regions, the optimal choice of p is sufficiently higher under $\omega = 0.2$ than under $\omega = 0$ so as to sustain a more informative cheap talk equilibrium.

4 Verifiable Disclosure

We now analyze how curse of knowledge affects strategic communication in a setting where the manager can disclose a costless but verifiable message. Suppose that the manager observes x with probability q (i.e., $s = x$) and nothing with probability $1 - q$ (i.e., $s = \emptyset$). An informed manager (one who observed $s = x$) can choose to either disclose nothing (i.e., $d = \emptyset$) or to disclose his information truthfully (i.e., $d = x$). An uninformed manager (one who observed $s = \emptyset$) cannot, however, verifiably disclose that he did not observe an informative signal.

Let $\mu_\emptyset \equiv \mathbb{E}[\theta | d = \emptyset]$ denote the principal's equilibrium belief about θ when the manager discloses no information. The optimal action for the principal is

$$k^p(d) = \mathbb{E}[R|d] = \begin{cases} px + \mu & \text{if } d = x \\ \mu_\emptyset + \mu & \text{if } d = \emptyset \end{cases} \tag{16}$$

However, because he suffers from the curse of knowledge, an informed manager believes

$$\mathbb{E}_m[k^p(d)|x, d = \emptyset] = (1-\omega)\mu_\emptyset + \omega px + \mu. \tag{17}$$

The following result characterizes the verifiable disclosure equilibria in this setting.

Proposition 2. *There exist cutoffs $x_l, x_h \in \left[-\frac{\sigma}{2}, \frac{\sigma}{2}\right]$ and $x_l \leq x_h$ such that an informed manager does not disclose her signal x (i.e., sends a message $d(x) = \emptyset$) iff $x \in [x_l, x_h]$.*

(i) If $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, then the cutoffs are $x_h = \sigma\frac{2\sqrt{1-q}-(2-q)}{2q}$ and $x_l = -\frac{\sigma}{2}$.

(ii) If $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, then the cutoffs are $x_h = -\frac{2q}{(1-q)\sigma}\left(\frac{b}{p(1-\omega)}\right)^2$ and $x_l = x_h - \frac{2b}{p(1-\omega)}$.

The above result highlights that the verifiable disclosure equilibrium is one of two types. When the effective bias $\frac{b}{p(1-\omega)}$ is sufficiently large (case (i)), there is disclosure by managers who have sufficiently high signals. This is similar to the equilibria characterized by Dye (1985) and others. On the other hand, when the effective bias is sufficiently small (case (ii)), there is disclosure by managers with extreme signals but no disclosure for those with intermediate signals.

To gain some intuition for the nature of these equilibria, it is useful to consider the difference in the manager's expected utility from disclosing versus not, given a signal x. Specifically, given the expression for expected utility in (15), one can show that the expected utility benefit from not disclosing can be expressed as:

$$\Delta(\emptyset, x; x) \equiv \mathbb{E}_m[u^m(d = \emptyset; x)] - \mathbb{E}_m[u^m(d = x; x)] \tag{18}$$

$$= \mathbb{E}_m\left[(k^p(d = \emptyset) - k^p(d = x))\left(R + b - \frac{k^p(d = \emptyset) + k^p(d = x)}{2}\right)\right] \tag{19}$$

$$= (1-\omega)^2(\mu_\emptyset - px)\left(\frac{b}{(1-\omega)} + px - \frac{\mu_\emptyset + px}{2}\right) \tag{20}$$

The above expression is a concave, quadratic function of the manager's signal x. Intuitively, it reflects the two components of the manager's utility characterized by equation (7): (i) the private benefits he receives from higher investment (i.e., a higher bk term), and (ii) higher firm value generated by more efficient investment (i.e., a lower $(R-k)^2$ term). Not disclosing his signal is only optimal if the benefit from higher investment from being pooled with uninformed managers offsets the loss due to less efficient investment. This implies that managers with extreme signals are more likely to prefer disclosure while managers with intermediate signals are more likely to prefer pooling, as suggested by the shape of Δ in (20).

The region of non-disclosure (and therefore, pooling) is driven by the magnitude of the effective bias $\frac{b}{p(1-\omega)}$. First, note that managers with very high signals always prefer to disclose — this ensures higher and more efficient investment than pooling with lower types. As such, the upper boundary of nondisclosure x_h is always strictly below $\sigma/2$. Second, when the effective bias is sufficiently large (i.e., $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$), managers with the lowest possible signal ($x = -\sigma/2$) prefer pooling to disclosure because the benefit from pooling with higher types more than offsets the cost from inefficient investment. This leads to the single cutoff equilibrium characterized by case (i) of Proposition 2. On the other hand, when the bias is sufficiently small, low types prefer disclosing their signal — the loss from lower investment is dominated by the gain from more efficient investment. In the limit, as $b \to 0$, note that $x_l = x_h = 0$. Intuitively when the bias is arbitrarily small, almost all managers prefer disclosure to pooling.

Analogous to the equilibria with cheap talk, the curse of knowledge ω affects the informativeness of communication through two channels. First, a higher curse of knowledge increases the effective bias, which increases the likelihood of the less informative equilibrium arising (i.e., more likely to have case (i)). Second, even when the bias is low enough to sustain the more informative equilibrium, an increase in ω reduces the informativeness of the manager's disclosure policy, as summarized by the following corollary.

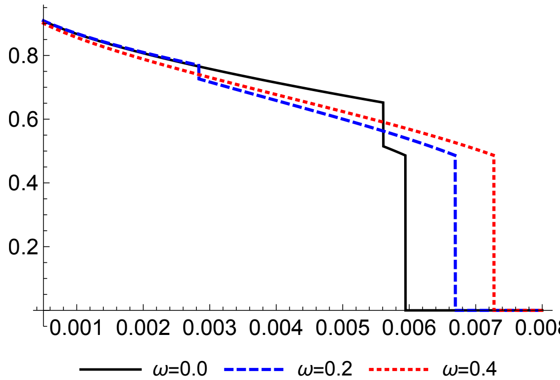
Corollary 2. *If $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$ and the manager's communication is verifiable, the informativeness of communication and the expected firm value decrease in the degree, ω, of the manager's curse of knowledge.*

This expansion of the non-disclosure interval is one reason why the curse of knowledge reduces the expected quality of the manager's message to the principal: in expectation, it is more likely that the manager chooses not to share his private information. The change in the effective bias also changes *when* the manager chooses not to disclose. In particular, as $\frac{b}{p(1-\omega)}$ grows, the manager chooses not to reveal increasingly negative information about the firm's productivity; however, since such signals are more informative for the principal (since these realizations are further from his prior belief, $\mathbb{E}[\theta]$), this reduces the informativeness of the manager's message. As above, when the informativeness of the manager's message falls, $\mathbb{E}[\text{var}(\theta|d)]$ increases, which decreases the expected value of the firm: the principal faces more uncertainty and invests less efficiently in expectation.

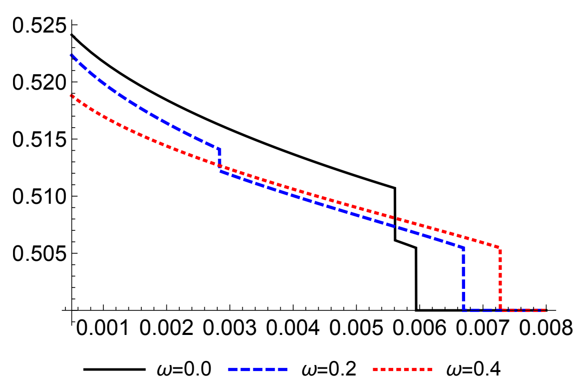
Lemma 2. *The manager's expected utility is higher if $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$ (i.e., if the* *manager utilizes a two-sided disclosure policy). Holding the type of equilibrium fixed,* $\frac{\partial \mathbb{E}[u^m]}{\partial \omega}$, , $\frac{\partial \mathbb{E}[u^m]}{\partial p}$, *and* $\frac{\partial^2 \mathbb{E}[u^m]}{\partial \omega \partial p} > 0$.

Just as in the setting with cheap talk, Lemma 1 implies that the curse of knowledge can increase information acquisition when the manager's disclosure is verifiable. The curse of knowledge leads the manager to believe that he communicates more effectively: as a result, the marginal value of the information he acquires (and communicates to the principal) increases. As with cheap talk, increasing the curse of knowledge increases the manager's effective bias (and can shift the equilibrium disclosure policy), while endogenous learning generates a countervailing effect and so the impact of an increase in ω can be reduced, or even reversed, by an increase in p.

Figure 2: Optimal precision choice and expected value under verifiable disclosure
The figure plots the expected value of the firm with cheap talk communication as a function of the cost c_0, where the manager optimally chooses p subject to a cost $c(p) = c_0 \frac{p}{1-p}$. The other parameters of the model are set to: $\mu = 1$, $b = 0.1$, $\sigma = 1$ and $q = 0.75$.



(a) Optimal precision p vs c_0



(b) Expected Value vs c_0

Figure 2 provides an illustration of this effect on the expected value of the firm. As before, we assume that the manager optimally chooses p subject to a cost of the form: $c(p) = c_0 \frac{p}{1-p}$. The figure plots the optimal choice of precision and the expected value of the firm for different values of ω, as a function of the cost parameter c_0. The solid line corresponds to the benchmark with no curse of knowledge ($\omega = 0$), the dashed line corresponds to $\omega = 0.2$, and the dotted line corresponds to $\omega = 0.4$. A higher cost of information decreases the expected value of the firm by (i) decreasing the precision of the acquired signal and (ii) causing a switch from the more informative equilibrium to the less informative equilibrium (corresponding to the downward jumps in the curves).

However, the curse of knowledge has an offsetting effect. Because the marginal utility of acquiring information is higher for higher ω, there are ranges of the cost parameter for which the expected value is higher for higher values of ω (e.g., when the dashed line is higher than the solid, or when the dotted line is higher than the dashed). In these regions, the increase in the precision of the manager's signal outweighs the impact of his distorted beliefs (i.e., his effective bias $\frac{b}{p(1-\omega)}$) falls which, in turn, ensures that the more informative equilibrium is sustained. As in the case with cheap talk, while higher curse of knowledge leads to less informative communication, the acquisition of higher precision information can, consequently, lead to higher expected value.

5 Delegation versus Communication

In this section, we consider the implications for firm value when the principal delegates the investment decision to the manager. While the principal knows that manager is biased towards over-investment, delegation allows the manager to utilize his private signal instead of forcing him to communicate a noisy version to the principal.

Recall from (7) that the manager optimally chooses the investment to maximize firm value while also accounting for the non-pecuniary benefits he receives. As a result, given his information set $\mathcal{I}_m$, he chooses to invest

$$k^m = \mathbb{E}_m \left[R + b | \mathcal{I}_m \right] = \mu + \mathbb{E}_m \left[\theta | \mathcal{I}_m \right] + b. \tag{21}$$

Thus, the expected value of the firm when the manager invests is

$$\begin{aligned} \mathbb{E} \left[V \left(R, k^m \right) \right] &= \mathbb{E} \left[R k^m - \tfrac{1}{2} \left(k^m \right)^2 \right] & (22) \\ &= \tfrac{1}{2} \left(\mu^2 - b^2 + \operatorname{var}(\theta) - \mathbb{E} \left[\operatorname{var} \left(\theta | \mathcal{I}_m \right) \right] \right). & (23) \end{aligned}$$

Notably, the expected value of the firm under delegation is unaffected by the degree of the manager's curse of knowledge ω. Comparing this equation to firm value under communication, found in (14), makes stark the principal's tradeoff. On the one hand, the manager over-invests which decreases firm value by $\frac{b^2}{2}$. On the other hand, the manager bases his investment decision off more precise information, which increases firm value by $\frac{\mathbb{E}[\operatorname{var}(\theta|d)] - \mathbb{E}[\operatorname{var}(\theta|\mathcal{I}_m)]}{2}$.

5.1 Delegation versus Non-verifiable Disclosure

Suppose that the principal is considering whether or not to delegate when the manager can only engage in cheap talk communication, as in Section 3. In this case, firm value with delegation, V_m, is

$$V_{m,c} \equiv \tfrac{1}{2}\left(\mu^2 - b^2 + \frac{p^2\sigma^2}{12}\right), \tag{24}$$

while firm value with communication, V_c, which we derive in the proof of Corollary 1, can be written as

$$V_c \equiv \tfrac{1}{2}\left(\mu^2 + \frac{p^2\sigma^2}{12}\left(1 - \left(\frac{1}{N^2} + \frac{4b^2\left(N^2-1\right)}{p^2(1-\omega)^2\sigma^2}\right)\right)\right). \tag{25}$$

Taken together, this implies that the principal prefers to delegate as long as

$$\underbrace{\frac{p^2\sigma^2}{12}\left(\frac{1}{N^2} + \frac{4b^2\left(N^2-1\right)}{p^2(1-\omega)^2\sigma^2}\right)}_{\text{loss through communication}} > \underbrace{b^2}_{\text{loss due to bias}}. \tag{26}$$

Lemma 3. *The principal retains control over the investment decision if the manager's investment bias is sufficiently large, i.e., if $b > \frac{p\sigma}{2\sqrt{3}}$. Otherwise, she delegates to the manager.*

If the manager's bias is too large, the principal prefers to invest, even though she is using a coarser information set. In fact, in this setting, if the principal retains control, it must also the be the case that the manager cannot credibly send an uninformative signal, i.e., there is only a "babbling" communication equilibrium.[4] Equivalently, the principal prefers to invest using only her prior beliefs rather than allow a (biased) manager to invest using his private information.

Lemma 3 also implies that the curse of knowledge does not impact the delegation decision when the precision of the manager's private signal is exogenously specified. The manager's effective bias ($\frac{b}{p(1-\omega)}$) determines the nature of the communication equilibrium. Suppose the curse of knowledge increases sufficiently such that the communication equilibrium shifts from informative ($\frac{b}{p(1-\omega)} < \frac{\sigma}{4}$) to uninformative. Despite this, the principal would still prefer to delegate, because the manager's *actual* bias is unchanged. As (26) makes clear, an increase in ω harms the manager's ability to communicate but does not affect the efficiency of the manager's investment decision.

[4] This is because the principal retains control if $b > \frac{p\sigma}{2\sqrt{3}} > \frac{p\sigma(1-\omega)}{4}$, where the second inequality implies that any communication from the manager is uninformative, by Proposition 1.

5.2 Delegation versus Verifiable Disclosure

Suppose instead that the principal can either delegate or allow the manager to send a verifiable message. If the manager observes the signal x with probability q, then firm value with delegation is

$$V_{m,d} \equiv \tfrac{q}{2}\left(\mu^2 - b^2 + \frac{p^2\sigma^2}{12}\right) + \tfrac{1-q}{2}\left(\mu^2 - b^2\right) \tag{27}$$

$$= \tfrac{1}{2}\left(\mu^2 - b^2 + \frac{qp^2\sigma^2}{12}\right). \tag{28}$$

On the other hand, as we show in the proof of Corollary 2, firm value with verifiable communication, V_d, depends upon the nature of the communication equilibrium. If $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$,the manager only discloses sufficiently high values of x. In this case, firm value is

$$V_{d,1} \equiv \tfrac{1}{2}\left(\mu^2 + \frac{qp^2\sigma^2}{12}\left(1 - \left(\frac{(1-q)\left(8\left(1-\sqrt{1-q}\right) - q^2 - 4q\right)}{q^3}\right)\right)\right). \tag{29}$$

If $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$,then there is communication for both low and high values of x. Firm value in this case is

$$V_{d,2} \equiv \tfrac{1}{2}\left(\mu^2 + \frac{qp^2\sigma^2}{12}\left(1 - \left(\frac{48b^4q}{p^4\sigma^4(1-q)(1-\omega)^4} + \frac{32b^3}{p^3\sigma^3(1-\omega)^3}\right)\right)\right). \tag{30}$$

Comparing these expectations yields the following result.

Lemma 4. *(i) If $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, the principal retains control over the investment decision if the agent's true bias is sufficiently large, i.e., if*

$$b > \tfrac{p\sigma}{2\sqrt{3}}\frac{\sqrt{(1-q)\left(8\left(1-\sqrt{1-q}\right) - q^2 - 4q\right)}}{q}. \tag{31}$$

(ii) If $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, the principal retains control over the investment decision if and only if the curse of knowledge is sufficiently small, i.e., if

$$(1-\omega)^2 > \frac{4q^2}{\sigma^2(1-q)}\left(\frac{b}{p\,(1-\omega)}\right)^2 + \frac{8q}{3\sigma}\left(\frac{b}{p\,(1-\omega)}\right). \tag{32}$$

As discussed in Section 4, when $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, there is only one-sided disclosure.

If that is the case, the manager's threshold for disclosure depends only upon the likelihood he is informed, q, and the prior uncertainty both the principal and manager face, σ. As a result, if the *effective* bias is sufficiently high, then the delegation decision depends only upon the *true* bias of the manager: both the quality of communication and the degree of over-investment are unaffected by the curse of knowledge. This result is similar to what arises with non-verifiable communication.

On the other hand, when $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, there is two-sided disclosure, and both (i) the thresholds for communication and (ii) the size of the non-disclosure region depend upon the curse of knowledge. In this setting, the principal evaluates whether the manager's effective bias is driven more by his desire to over-invest (b) or by the curse of knowledge (ω). All else equal, if the manager's *effective* bias is largely driven by the curse of knowledge, i.e., if ω is sufficiently large such that does not (32) hold, then the principal prefers to delegate: the distortion in communication will be larger than the distortion in the manager's investment decision.

Figure 3: Delegation versus communication

The figure plots the region of the $b-\omega$ parameter space in which delegation is preferred to communication (shaded in blue), and the region in which the less informative equilibrium is sustained (shaded in peach). The other parameter values are set to: $\mu = 1$, $p = 0.7$, $\sigma = 1$ and $q = 0.75$.

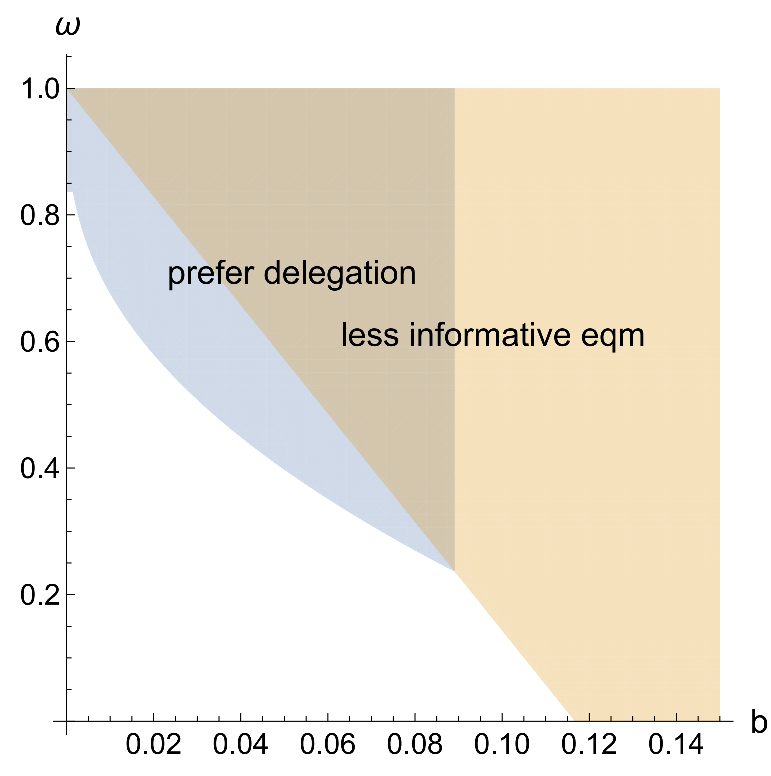


Figure 3 illustrates these results through a numerical example. The figure overlays the region of the $b-\omega$ parameter space in which delegation is preferred to communication, which is shaded in blue, with the region where the less informative equilibrium is sustained (i.e., where $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$), which is shaded in peach. In the region of the less informative equilibrium, the decision of whether or not to delegate depends only on whether the bias b is sufficiently large. In this case, when the bias is sufficiently low, the principal prefers to delegate (overlapped region), but when the bias is high, she prefers to take the action herself. In the region of the more informative equilibrium, the delegation decision depends on both the investment bias, b, and the curse of knowledge. For a fixed investment bias, b, the manager prefers to delegate the investment decision when the curse of knowledge is sufficiently severe because the loss from the distortion in communication overwhelms the loss due to the preference bias.

6 Conclusions

We study the effect of the curse of knowledge on communication within a firm and the resulting efficiency of the firm's investment policy. In our setting, a principal, who must choose how much to invest in a new project, communicates with a manager, who is privately informed about the project's productivity and also exhibits the curse of knowledge. We show that the curse of knowledge leads the manager to overestimate the effectiveness of his communication, which amplifies his effective bias towards over-investment and decreases the informativeness of equilibrium communication. As a result, when the precision of the manager's information is fixed, the curse of knowledge reduces firm value by reducing investment efficiency. However, when the manager can exert costly effort to acquire more precise information, the same bias in his beliefs leads him to overestimate the value of his information and, consequently, over-invest in information acquisition. In some settings, we show that this implies that the curse of knowledge can lead to higher firm value, even when it makes communication less effective.

Our analysis of how the curse of knowledge affects investment efficiency and the decision to delegate suggests a number of directions for future work. It would be interesting to study whether one could design an internal reporting system which mitigates the negative effects on informativeness of communication, but amplifies the benefits of more precise information acquisition. Another natural extension would be to explore the implications in a setting with multiple, division managers whose objectives are partially aligned. Finally, in a multi-firm setting with strategic complementarities and public information, one would expect the curse of knowledge to affect not only communication within a given firm, but also investment decisions across firms in the economy. We hope to explore these ideas in future work.

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A Proofs

Proof of Lemma 1

Proof. In the analysis that follows, it will be useful to characterize the difference in the manager's expected utility from sending messages d_1 and d_2. Specifically, let $u^m(d;\theta)$ denote the manager's expected utility from sending a message d, i.e.,

$$u^m(d;x) \equiv \mathbb{E}_m\left[(R+b)\,k^p(d) - \tfrac{1}{2}k^p(d)^2\,\middle|x\right] \tag{33}$$
$$= \mathbb{E}_m\left[\tfrac{1}{2}(R+b)^2 - \tfrac{1}{2}(R+b-k^p(d))^2\,\middle|x\right] \tag{34}$$

and let $\Delta(d_1,d_2;x) \equiv u^m(d_1;x) - u^m(d_2;x)$. A useful characterization is given by

$$\Delta(d_1,d_2;x) = \mathbb{E}_m\left[-\tfrac{1}{2}(R+b-k^p(d_1))^2 + \tfrac{1}{2}(R+b-k^p(d_2))^2\,\middle|x\right] \tag{35}$$
$$= \mathbb{E}_i^m\left[(k^p(d_1)-k^p(d_2))\left(R+b-\tfrac{k^p(d_1)+k^p(d_2)}{2}\right)\middle|\,x\right] \tag{36}$$

Recall that $k^p(d) = \mathbb{E}[\theta|d]+\mu$ and since the manager exhibits the curse of knowledge, we have:

$$\mathbb{E}_m[k^p(d)\,|x] = (1-\omega)\,\mathbb{E}\left[\theta\middle|d_i\right] + \omega\mathbb{E}[\theta|x_i] + \mu. \tag{37}$$

Moreover,

$$\mathbb{E}_m\left[R+b\middle|x\right] = \mu + \mathbb{E}[\theta|x] + b \tag{38}$$

This implies:

$$\Delta_i(d_1,d_2;x_i) = \begin{array}{c}(1-\omega)\left(\mathbb{E}\left[\theta\middle|d_1\right]-\mathbb{E}\left[\theta\middle|d_2\right]\right)\\ \times\left(\mathbb{E}[\theta|x]+b-\frac{\left((1-\omega)\left(\mathbb{E}\left[\theta\middle|d_1\right]+\mathbb{E}\left[\theta\middle|d_2\right]\right)+2\omega\mathbb{E}[\theta|x]\right)}{2}\right)\end{array} \tag{39}$$

$$= \begin{array}{c}(1-\omega)^2\left(\mathbb{E}\left[\theta\middle|d_1\right]-\mathbb{E}\left[\theta\middle|d_2\right]\right)\\ \times\left(\frac{b}{(1-\omega)}+\mathbb{E}[\theta|x]-\frac{\left(\mathbb{E}\left[\theta\middle|d_1\right]+\mathbb{E}\left[\theta\middle|d_2\right]\right)}{2}\right)\end{array} \tag{40}$$

which one can derive by (i) substituting the optimal investment choice, k^p and (ii) recognizing that since the manager exhibits curse of knowledge,

$$\mathbb{E}_m\left[\mathbb{E}[\theta|d]\,\middle|x\right] = (1-\omega)\,\mathbb{E}\left[\theta\middle|d\right] + \omega\mathbb{E}[\theta|x]\,. \tag{41}$$

The cutoffs $s(n)$ are pinned down by the conditions:

$$\Delta\left(d(n), d(n+1); s(n)\right) = 0, \tag{42}$$

where $\mathbb{E}\left[\theta | d(n)\right] = p\frac{s(n-1)+s(n)}{2}$. Imposing that the cutoffs are distinct (i.e., $s(n) \neq s(n+1)$) implies that they need to satisfy:

$$0 = \tfrac{b}{(1-\omega)} + ps(n) - \tfrac{1}{2}\left(p\tfrac{s(n-1)+s(n)}{2} + p\tfrac{s(n)+s(n+1)}{2}\right) \tag{43}$$

which implies the sequence satisfies the difference equation:

$$s(n+1) - s(n) = s(n) - s(n-1) + \tfrac{4b}{p(1-\omega)}, \tag{44}$$

which is analogous to the difference equation in Crawford and Sobel (1982). If $s(0) = -\frac{\sigma}{2}$, then it is straightforward to show that a solution to this second-order difference equation can be written as

$$s(n) = ns(1) - \tfrac{\sigma}{2} + 2n(n-1)\frac{b}{p(1-\omega)} \tag{45}$$

We also know that $s(N) = \frac{\sigma}{2}$, which implies that

$$s(N) = \tfrac{\sigma}{2} = Ns(1) - \tfrac{\sigma}{2} + 2N(N-1)\frac{b}{p(1-\omega)} \implies \tag{46}$$

$$s(1) = \tfrac{\sigma}{N} - 2(N-1)\frac{b}{p(1-\omega)} \implies \tag{47}$$

$$s(n) = n\tfrac{\sigma}{N} - \tfrac{\sigma}{2} + 2n(n-N)\frac{b}{p(1-\omega)} \tag{48}$$

This implies that under the assumption that $s(0) = -\frac{\sigma}{2}$ such an equilibrium exists for any $N \leq N_{max}$, where we need

$$\tfrac{\sigma}{2} > -\tfrac{\sigma}{2} + 2n(n-1)\frac{b}{p(1-\omega)} \implies \tag{49}$$

$$N_{max} \equiv \text{ceil}\left(\frac{2\frac{b}{p(1-\omega)} + \sqrt{\left(2\frac{b}{p(1-\omega)}\right)^2 + 4\sigma\left(2\frac{b}{p(1-\omega)}\right)}}{4\frac{b}{(1-\omega)p}} - 1\right) \tag{50}$$

$$= \text{ceil}\left(-\tfrac{1}{2} + \tfrac{1}{2}\sqrt{1 + 2\sigma\tfrac{p(1-\omega)}{b}}\right) \tag{51}$$

where ceil(x) is the smallest integer greater than or equal to x. In order for there to be an informative equilibrium, N_{max} must be greater than one, which implies that it must be that $b < \sigma\frac{p(1-\omega)}{4}$. $\square$

Proof of Corollary 1

Proof. The expected value of the firm is given by:

$$
\begin{aligned}
\mathbb{E}\left[V\left(R,k\right)\right] &= \mathbb{E}\left[Rk - \tfrac{1}{2}k^2\right] && (52)\\
&= \tfrac{1}{2}\mathbb{E}\left[R^2\right] - \tfrac{1}{2}\mathbb{E}\left[\left(R-k\right)^2\right] && (53)\\
&= \tfrac{1}{2}\left(\mathbb{E}\left[R^2\right] - \mathbb{E}\left[\left(R - \mathbb{E}\left[R\middle|d\right]\right)^2\right]\right) && (54)\\
&= \tfrac{1}{2}\left(\mathbb{E}\left[R^2\right] - \mathbb{E}\left[\operatorname{var}\left(R\middle|d\right)\right]\right) && (55)\\
&= \tfrac{1}{2}\left(\mu^2 + \operatorname{var}\left(R\right) - \left(\operatorname{var}\left(R\right) - \operatorname{var}\left(\mathbb{E}\left[R\middle|d\right]\right)\right)\right) && (56)\\
&= \tfrac{1}{2}\left(\mu^2 + \operatorname{var}\left(\mathbb{E}\left[R\middle|d\right]\right)\right) \implies && (57)\\
\mathbb{E}\left[V\left(R,k\right)\right] &= \tfrac{1}{2}\left(\mu^2 + \operatorname{var}\left(\mathbb{E}\left[\theta\middle|d\right]\right)\right) && (58)
\end{aligned}
$$

Note that, $\mathbb{E}\left[\mathbb{E}\left[\theta|d\right]\right] = 0$ and so

$$
\begin{aligned}
\operatorname{var}\left(\mathbb{E}\left[\theta\middle|d\right]\right) &= \sum_{n=1}^{N}\left(\frac{s\left(n\right) - s\left(n-1\right)}{\sigma}\right)\left(p\tfrac{s(n-1)+s(n)}{2} - 0\right)^2 && (59)\\
&= \frac{p^2\sigma^2}{12}\left(N^2 - 1\right)\left(\frac{1}{N^2} - \tfrac{4b^2}{p^2(1-\omega)^2\sigma^2}\right) && (60)
\end{aligned}
$$

It is clear that $\frac{\partial \operatorname{var}\left(\mathbb{E}\left[\theta\middle|d\right]\right)}{\partial\omega} < 0$ and $\frac{\partial \operatorname{var}\left(\mathbb{E}\left[\theta\middle|d\right]\right)}{\partial p} > 0$, which implies that both informativeness and $\mathbb{E}\left[V\left(R,k\right)\right]$ are decreasing (increasing) in the curse of knowledge (in the quality of the manager's signal), holding Nfixed. Finally,

$$
\begin{aligned}
\frac{\partial \operatorname{var}\left(\mathbb{E}\left[\theta\middle|d\right]\right)}{\partial N} \propto \frac{2}{N^3} - \tfrac{8b^2N}{p^2(1-\omega)^2\sigma^2} > 0 \iff && (61)\\
\frac{1}{N^4} > \tfrac{4b^2}{p^2(1-\omega)^2\sigma^2} && (62)
\end{aligned}
$$

Note that $b < \sigma\frac{p(1-\omega)}{4}$ and so

$$1 > \frac{4b}{p\left(1-\omega\right)\sigma} \implies \tag{63}$$

$$1 > \left(\frac{4b}{p\left(1-\omega\right)\sigma}\right)^2 \implies \tag{64}$$

$$\frac{1}{N^4} > \tfrac{4b^2}{p^2\left(1-\omega\right)^2\sigma^2}. \tag{65}$$

As a result, firm value is highest when $N = N_{max}$. Because the curse of knowledge weakly lowers N_{max}, it also decreases firm value by reducing the maximum number of partitions. Finally, note that firm value can be written

$$\mathbb{E}\left[V\left(R,k\right)\right] = \tfrac{1}{2}\left(\mu^2 + \frac{p^2\sigma^2}{12}\left(1 - \left(\frac{1}{N^2} + \tfrac{4b^2\left(N^2-1\right)}{p^2\left(1-\omega\right)^2\sigma^2}\right)\right)\right) \tag{66}$$

□

Proof of Lemma 1

Proof. Conditional on observing x, the manager's expected utility is given by:

$$\begin{aligned} u^m\left(x\right) &\equiv \mathbb{E}_m\left[\left(R+b\right)k^p\left(d\left(x\right)\right) - \tfrac{1}{2}k^p\left(d\left(x\right)\right)^2 \middle| x\right] && (67)\\ &= \mathbb{E}_m\left[\left(R+b\right)\middle| x\right]k^p\left(d\left(x\right)\right) - \tfrac{1}{2}k^p\left(d\left(x\right)\right)^2 && (68)\\ &= \tfrac{1}{2}\left(\mathbb{E}_m\left[\left(R+b\right)\middle| x\right]\right)^2 - \tfrac{1}{2}\left(\mathbb{E}_m\left[\left(R+b\right)\middle| x\right] - k^p\left(d\left(x\right)\right)\right)^2 && (69)\end{aligned}$$

Note that

$$\mathbb{E}_m\left[\left(R+b\right)\middle| x\right] = b + \mu + px \tag{70}$$

and

$$\mathbb{E}_m\left[k^p\left(d\left(n\right)\right)\right] = \left(1-\omega\right)p\left(\tfrac{s(n-1)+s(n)}{2}\right) + \omega px + \mu \tag{71}$$

which implies:

$$u^m\left(x\right) = \tfrac{1}{2}\left(b+\mu+px\right)^2 - \tfrac{1}{2}\left(b + \left(1-\omega\right)p\left(x - \tfrac{s(n-1)+s(n)}{2}\right)\right)^2 \tag{72}$$

Thus,

$$\mathbb{E}\left[u^m(x)\right] = \mathbb{E}\left[\tfrac{1}{2}(b+\mu+px)^2\right] - \tfrac{1}{2}\sum_{n=1}^{N}\int_{s(n-1)}^{s(n)} \tfrac{1}{\sigma}\left(b+(1-\omega)p\left(x-\tfrac{s(n)+s(n+1)}{2}\right)\right)^2 dx \tag{73}$$

$$= \tfrac{1}{2}(b+\mu)^2 + \tfrac{p^2\sigma^2}{24} - \tfrac{1}{2}b^2 - \tfrac{1}{2}(1-\omega)^2 p^2 \sum_{i=1}^{N} \tfrac{1}{\sigma}\tfrac{(s(n+1)-s(n))^3}{12} \tag{74}$$

$$= \tfrac{1}{2}(b+\mu)^2 + \tfrac{p^2\sigma^2}{24} - \tfrac{1}{2}b^2 - \tfrac{1}{24}(1-\omega)^2 p^2 \left(\tfrac{\sigma^2}{N^2} + \tfrac{4b^2\left(N^2-1\right)}{p^2(1-\omega)^2}\right) \tag{75}$$

$$= \frac{1}{2}\left((b+\mu)^2 - b^2\right) + \frac{p^2}{24}\left(\sigma^2 - (1-\omega)^2\left(\frac{\sigma^2}{N^2} + \frac{4b^2\left(N^2-1\right)}{p^2(1-\omega)^2}\right)\right) \tag{76}$$

$$= \frac{1}{2}\left\{2b\mu + \mu^2 + \frac{p^2\sigma^2}{12}\left(1-(1-\omega)^2\left(\frac{1}{N^2} + \frac{4b^2\left(N^2-1\right)}{\sigma^2p^2(1-\omega)^2}\right)\right)\right\} \tag{77}$$

This implies that, holding fixed the number of partitions, N,

$$\frac{\partial\mathbb{E}\left[u^m(x)\right]}{\partial\omega} = \frac{p^2\sigma^2(1-\omega)}{12N^2} > 0 \tag{78}$$

$$\frac{\partial\mathbb{E}\left[u^m(x)\right]}{\partial p} = \frac{p\sigma^2}{12}\left(1-\frac{(1-\omega)^2}{N^2}\right) > 0 \tag{79}$$

$$\frac{\partial^2\mathbb{E}\left[u^m(x)\right]}{\partial\omega\partial p} = \frac{p\sigma^2(1-\omega)}{6N^2} > 0 \tag{80}$$

Note that $N_{max} = \text{ceil}\left(-\tfrac{1}{2}+\tfrac{1}{2}\sqrt{1+2\sigma\tfrac{p(1-\omega)}{b}}\right)$ also depends on both $\omega$and p; it is decreasing in the former and increasing in the latter. □

Proof of Proposition 2

Proof. At each threshold, the manager must be indifferent to disclosing his signal or remaining silent. We can compare the difference in his expected utility under each approach using the expression found in (40):

$$\Delta(d_1=\emptyset, d_2=x; x) = (1-\omega)^2(\mu_\emptyset - px) \times \left(\tfrac{b}{(1-\omega)} + px - \tfrac{(\mu_\emptyset+px)}{2}\right) \tag{81}$$

$$= (1-\omega)^2(\mu_\emptyset - px) \times \left(\tfrac{b}{(1-\omega)} + \tfrac{px-\mu_\emptyset}{2}\right) \tag{82}$$

Note that

$$\Delta_x \equiv \frac{\partial \Delta\left(d_1=\emptyset, d_2=x; x\right)}{\partial x} = -p\left(1-\omega\right)\left(b+\left(1-\omega\right)\left(px-\mu_{\emptyset}\right)\right) \tag{83}$$

$$\Delta_{xx} \equiv \frac{\partial^2 \Delta\left(d_1=\emptyset, d_2=x; x\right)}{\partial x^2} = -p^2\left(1-\omega\right)^2 < 0 \tag{84}$$

This suggests Δ is hump-shaped in x: for sufficiently low x, $\Delta_x > 0$, while for sufficiently high x, $\Delta_x < 0$. Moreover, note that there are two roots $\{x_l, x_h\}$ of $\Delta\left(\emptyset, x; x\right) = 0$, given by

$$x_h = \frac{1}{p}\mu_{\emptyset}, \quad x_l = \frac{1}{p}\left(\mu_{\emptyset} - \tfrac{2b}{(1-\omega)}\right) \tag{85}$$

and note that

$$\Delta_x\left(x_h\right) = -p\left(1-\rho\right)\left(1-\omega\right)b_i < 0 \tag{86}$$

$$\Delta_x\left(x_l\right) = p\left(1-\rho\right)\left(1-\omega\right)b_i > 0 \tag{87}$$

This implies that there are two potential types of equilibria:

Case 1 ($x_l \leq -\frac{\sigma}{2}$): In this case, there would be disclosure above x_h only. As a result,

$$\mu_{\emptyset} = \frac{\left(1-q\right)*0 + \left(q\frac{x_h+\sigma/2}{\sigma}\right)\left(p\frac{x_h-\sigma/2}{2}\right)}{1-q+q\frac{x_h+\sigma/2}{\sigma}} \tag{88}$$

and so

$$x_h = \frac{1}{p}\mu_{\emptyset} \tag{89}$$

$$= \sigma\frac{2\sqrt{1-q}-(2-q)}{2q} \tag{90}$$

Moreover, this implies that

$$x_l = \frac{1}{p}\left(\mu_{\emptyset} - \tfrac{2b}{(1-\omega)}\right) \tag{91}$$

$$= \frac{1}{p}\left(p\frac{\sigma}{2}\frac{2\sqrt{1-q}-(2-q)}{q} - \tfrac{2b}{(1-\omega)}\right) \tag{92}$$

$$= \frac{\sigma}{2}\frac{2\sqrt{1-q}-(2-q)}{q} - \frac{2b}{p\left(1-\omega\right)} \tag{93}$$

We need $x_l \leq -\frac{\sigma}{2}$, which implies that this is an equilibrium if and only if

$$\frac{\sigma}{2}\frac{2\sqrt{1-q}-(2-q)}{q}-\frac{2b}{p\,(1-\omega)} \leq -\frac{\sigma}{2} \tag{94}$$

$$\Leftrightarrow \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q} \leq \frac{b}{p\,(1-\omega)} \tag{95}$$

Case 2 ($x_l > -\frac{\sigma}{2}$): Suppose that (95) does not hold. Then if there is going to be an equilibrium of the posited form, it must be that we disclose truthfully above x_h and below x_l. As a result,

$$\mu_{\emptyset} = \frac{(1-q)\,0+\left(q\frac{x_h-x_l}{\sigma}\right)\left(p\frac{x_h+x_l}{2}\right)}{1-q+q\frac{x_h-x_l}{\sigma}} \tag{96}$$

Note that $x_l = x_h - \frac{2b}{p(1-\omega)}$. Using this and $\mu_{\emptyset}$ we can solve for

$$\Rightarrow x_h = -\frac{2q}{(1-q)\,\sigma}\left(\tfrac{b}{p(1-\omega)}\right)^2 \tag{97}$$

which implies that

$$x_l = -\tfrac{2b}{p(1-\omega)}\left(\frac{q}{(1-q)\,\sigma}\left(\tfrac{b}{p(1-\omega)}\right)+1\right) \tag{98}$$

For this to be an equilibrium, we need $x_h < \frac{\sigma}{2}$ and $-\frac{\sigma}{2} < x_l$, i.e.,

$$-\frac{2q}{(1-q)\,\sigma}\left(\tfrac{b}{p(1-\omega)}\right)^2 < \frac{\sigma}{2} \tag{99}$$

which is always the case and

$$-\frac{\sigma}{2} < -\tfrac{2b}{p(1-\omega)}\left(\frac{q}{(1-q)\,\sigma}\left(\tfrac{b}{p(1-\omega)}\right)+1\right) \tag{100}$$

$$\frac{\sigma}{4} > \tfrac{b}{p(1-\omega)}\left(\frac{q}{(1-q)\,\sigma}\left(\tfrac{b}{p(1-\omega)}\right)+1\right) \tag{101}$$

$$0 > \frac{q}{(1-q)\,\sigma}\left(\tfrac{b}{p(1-\omega)}\right)^2+\tfrac{b}{p(1-\omega)}-\frac{\sigma}{4} \tag{102}$$

This is true if and only if

$$\frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{q} > \tfrac{2b}{p(1-\omega)} \tag{103}$$

Taken together, this establishes the result. □

Proof of Corollary

Proof. The informativeness of the manager's disclosure is $var\left(\mathbb{E}\left[\theta|d\right]\right)$. Moreover, as in the proof of corollary 1, the value of the firm can be written:

$$\begin{aligned} \mathbb{E}\left[V\left(R,k\right)\right] &= \mathbb{E}\left[Rk - \tfrac{1}{2}k^2\right] && (104) \\ &= \tfrac{1}{2}\left(\mu^2 + \text{var}\left(\mathbb{E}\left[\theta\middle|d\right]\right)\right) && (105) \end{aligned}$$

Note that, $\mathbb{E}\left[\mathbb{E}\left[\theta|d\right]\right] = 0$ and so,

$$\begin{aligned} var\left(\mathbb{E}\left[\theta|d\right]\right) &= \tfrac{q}{\sigma}\int_{-\frac{\sigma}{2}}^{x_l}\left(px\right)^2\,dx + \tfrac{q}{\sigma}\int_{x_h}^{\frac{\sigma}{2}}\left(px\right)^2\,dx + \left(q\frac{x_h - x_l}{\sigma} + (1-q)\right)\left(\mu_\emptyset\right)^2 && (106) \\ &= \tfrac{qp^2}{3\sigma}\left[x_l^3 - x_h^3 + \tfrac{\sigma^3}{4}\right] + \left(q\frac{x_h - x_l}{\sigma} + (1-q)\right)\left(\mu_\emptyset\right)^2. && (107) \end{aligned}$$

To simplify, we can rewrite the expectation given no disclosure:

$$\begin{aligned} \mu_\emptyset &= \frac{\left(q\frac{x_h - x_l}{\sigma}\right)\left(p\frac{x_h + x_l}{2}\right)}{1 - q + q\frac{x_h - x_l}{\sigma}} = \frac{\left(\frac{qp}{2\sigma}\left(x_h^2 - x_l^2\right)\right)}{1 - q + q\frac{x_h - x_l}{\sigma}} \implies && (108) \\ var\left(\mathbb{E}\left[\theta|d\right]\right) &= \tfrac{qp^2}{3\sigma}\left[x_l^3 - x_h^3 + \tfrac{\sigma^3}{4}\right] + \frac{qp}{2\sigma}\left[\left(x_h^2 - x_l^2\right)\mu_\emptyset\right] && (109) \\ &= \tfrac{qp^2}{3\sigma}\left[x_l^3 - x_h^3\right] + \frac{\left(\frac{qp}{2\sigma}\left(x_h^2 - x_l^2\right)\right)^2}{1 - q + q\frac{x_h - x_l}{\sigma}} + \tfrac{qp^2\sigma^2}{12}. && (110) \end{aligned}$$

In **case 1** **($x_l \leq -\frac{\sigma}{2}$)**, the value of the firm is independent of ω because x_h doesn't depend on ω. In **case 2** **($x_l > -\frac{\sigma}{2}$)**, this is no longer the case. To simplify, we utilize the fact that $x_h - x_l = \frac{2b}{p(1-\omega)}$ which implies

$$\begin{aligned} var\left(\mathbb{E}\left[\theta|d\right]\right) &= -\tfrac{qp^2}{3\sigma}\tfrac{2b}{p(1-\omega)}\left[x_l^2 + x_h^2 + x_l x_h\right] + \frac{\frac{q^2p^2}{4\sigma^2}\left(\frac{2b}{p(1-\omega)}\right)^2\left(x_h + x_l\right)^2}{1 - q + q\frac{2b}{\sigma p(1-\omega)}} + \tfrac{qp^2\sigma^2}{12} && (111) \\ &= \frac{-q\left(\frac{48b^4q}{(1-q)(1-\omega)^4} + \frac{32b^3p\sigma}{(1-\omega)^3}\right)}{12p^2\sigma^2} + \tfrac{qp^2\sigma^2}{12}. && (112) \end{aligned}$$

Thus, in **case 2,**

$$\frac{\partial var\left(\mathbb{E}\left[\theta|d\right]\right)}{\partial\omega} = \frac{-q}{p^2\sigma^2}\left(\frac{16b^4q}{(1-q)(1-\omega)^5} + \frac{8b^3p\sigma}{(1-\omega)^4}\right) < 0 \qquad (113)$$

By continuity, this implies that firm value in **case 2** exceeds firm value in **case 1**. Finally, using the expressions above the cutoffs for disclosure, firm value in **case 1 is**

$$\mathbb{E}\left[V\left(R,k\right)\right]=\tfrac{1}{2}\left(\mu^{2}+\frac{qp^{2}\sigma^{2}}{12}\left(1-\left(\frac{\left(1-q\right)\left(8\left(1-\sqrt{1-q}\right)-q^{2}-4q\right)}{q^{3}}\right)\right)\right) \tag{114}$$

while in **case 2,**

$$\mathbb{E}\left[V\left(R,k\right)\right]=\tfrac{1}{2}\left(\mu^{2}+\tfrac{qp^{2}\sigma^{2}}{12}\left(1-\left(\frac{48b^{4}q}{p^{4}\sigma^{4}(1-q)(1-\omega)^{4}}+\frac{32b^{3}}{p^{3}\sigma^{3}(1-\omega)^{3}}\right)\right)\right) \tag{115}$$

In both cases, it is clear that $\frac{\partial\mathbb{E}[V(R,k)]}{\partial p}>0$. Finally, note that

$$Z\left(q\right)\equiv\left(8\left(1-\sqrt{1-q}\right)-q^{2}-4q\right)>0\,\forall q\in\left(0,1\right). \tag{116}$$

This can be shown by observing that

$$\frac{\partial Z}{\partial q}=-2q-4+4\left(1-q\right)^{\frac{-1}{2}} \tag{117}$$

$$\frac{\partial^{2}Z}{\partial q^{2}}=-2+2\left(1-q\right)^{\frac{-3}{2}} \tag{118}$$

$$\frac{\partial^{3}Z}{\partial q^{3}}=3\left(1-q\right)^{\frac{-5}{2}} \tag{119}$$

Note that $\frac{\partial Z}{\partial q}$ and $\frac{\partial^2 Z}{\partial q^2}$ are zero when $q=0$, while $\frac{\partial^3 Z}{\partial q^3}>0$ for all $q\in(0,1)$. This implies that $\frac{\partial Z}{\partial q}>0$ for all $q\in(0,1)$ and since $Z\left(0\right)=0$, $Z\left(q\right)>0$ for all $q\in(0,1)$. □

Proof of Lemma

Proof. As above, we can write the manager's expected utility as a function of his disclosure and information set as

$$u^{m}\left(\mathcal{I}_{m},d\right)\equiv\mathbb{E}_{m}\left[\left(R+b\right)k^{p}\left(d\right)-\tfrac{1}{2}k^{p}\left(d\right)^{2}\left|\mathcal{I}_{m}\right.\right] \tag{120}$$

$$=\tfrac{1}{2}\left(\mathbb{E}_{m}\left[\left(R+b\right)\left|\mathcal{I}_{m}\right.\right]\right)^{2}-\tfrac{1}{2}\left(\mathbb{E}_{m}\left[\left(R+b\right)\left|\mathcal{I}_{m}\right.\right]-\mathbb{E}_{m}\left[k^{p}\left(d\right)\left|\mathcal{I}_{m},d\right.\right]\right)^{2}. \tag{121}$$

There are three cases to consider:

(1) If the manager observes nothing (i.e., $s = \emptyset$), then his utility is

$$\begin{aligned} u^m(\emptyset, \emptyset) &= \mathbb{E}\left[\tfrac{1}{2}(\mu+b)^2 - \tfrac{1}{2}(\mu+b-((1-\omega)\mu_\emptyset + \omega(0)+\mu))^2\right] \\ &= \tfrac{1}{2}\left[(\mu+b)^2 - (b-(1-\omega)\mu_\emptyset)^2\right]. \end{aligned}$$

(2) If the manager observes x and discloses it, then his utility is

$$\begin{aligned} u^m(x, x) &= \mathbb{E}\left[\tfrac{1}{2}(b+\mu+px)^2 - \tfrac{1}{2}(b+\mu+px-(\mu+px))^2\right] \\ &= \tfrac{1}{2}\left[(b+\mu+px)^2 - b^2\right] \end{aligned}$$

(3) If the manager observes x and does not disclose it, then his utility is

$$\begin{aligned} u^m(x, \emptyset) &= \mathbb{E}\left[\tfrac{1}{2}(b+\mu+px)^2 - \tfrac{1}{2}(b+\mu+px-(\mu+(1-\omega)\mu_\emptyset+\omega px))^2\right] \\ &= \tfrac{1}{2}\left[(b+\mu+px)^2 - (b+(1-\omega)(px-\mu_\emptyset))^2\right]. \\ &= u^m(x,x) - \tfrac{1}{2}\left[2b(1-\omega)(px-\mu_\emptyset) + ((1-\omega)(px-\mu_\emptyset))^2\right] \end{aligned}$$

Note that if the manager always disclosed, his expected utility would be

$$\begin{aligned} \mathbb{E}\left[u^m(x,x)\right] &= \tfrac{1}{2}\int_{-\frac{\sigma}{2}}^{\frac{\sigma}{2}} \frac{1}{\sigma}\left[(b+\mu+px)^2 - b^2\right]\, dx && (122) \\ &= \tfrac{1}{2}\left\{2b\mu + \mu^2 + \frac{p^2\sigma^2}{12}\right\} && (123) \end{aligned}$$

Thus,

$$\mathbb{E}\left[u^m|x\right] = \mathbb{E}\left[u^m(x,x)\right] - \tfrac{1}{2}\left(\tfrac{1}{\sigma}\int_{x_l}^{x_h} 2b(1-\omega)(px-\mu_\emptyset) + ((1-\omega)(px-\mu_\emptyset))^2\, dx\right), \tag{124}$$

and so,

$$\mathbb{E}\left[u^m\right] = (1-q)\, u^m(\emptyset,\emptyset) + q\mathbb{E}\left[u^m|x\right]. \tag{125}$$

In **case 2**, after substituting in the expressions for $x_l, x_h, \mu_\emptyset$, this reduces to

$$\mathbb{E}\left[u^m\right] = \tfrac{1}{2}\left\{2b\mu + \mu^2 + \frac{qp^2\sigma^2}{12}\left(1-(1-\omega)^2\left(\frac{48b^4q}{p^4\sigma^4(1-q)(1-\omega)^4} + \frac{32b^3}{p^3\sigma^3(1-\omega)^3}\right)\right)\right\}. \tag{126}$$

Therefore, in **case 2**,

$$\frac{\partial \mathbb{E}\left[u^m\right]}{\partial \omega} = \frac{qp^2\sigma^2}{12}\left(\frac{48b^4q}{p^4\sigma^4(1-q)(1-\omega)^3} + \frac{16b^3}{p^3\sigma^3\left(1-\omega\right)^2}\right) \tag{127}$$

$$\frac{\partial \mathbb{E}\left[u^m\right]}{\partial p} = \frac{q\sigma^2}{12}\left(2p + \frac{48b^4q}{p^3\sigma^4(1-q)(1-\omega)^2} + \frac{16b^3}{p^2\sigma^3\left(1-\omega\right)}\right) > 0 \tag{128}$$

$$\frac{\partial^2 \mathbb{E}\left[u^m\right]}{\partial p \partial \omega} = \frac{q\sigma^2}{12}\left(\frac{96b^4q}{p^3\sigma^4(1-q)(1-\omega)^3} + \frac{16b^3}{p^2\sigma^3\left(1-\omega\right)^2}\right) > 0 \tag{129}$$

In **case 1**, after substituting in the expressions for $x_l, x_h, \mu_\emptyset$, this reduces to

$$\mathbb{E}\left[u^m\right] = \frac{1}{2}\left(2b\mu + \mu^2 + \frac{qp^2\sigma^2}{12}\left(1-(1-\omega)^2\left(\frac{(1-q)\left(8\left(1-\sqrt{1-q}\right)-q^2-4q\right)}{q^3}\right)\right)\right). \tag{130}$$

Therefore, in **case 1**,

$$\frac{\partial \mathbb{E}\left[u^m\right]}{\partial \omega} = \frac{qp^2\sigma^2}{12}\left((1-\omega)\left(\frac{(1-q)\left(8\left(1-\sqrt{1-q}\right)-q^2-4q\right)}{q^3}\right)\right) > 0 \tag{131}$$

$$\frac{\partial \mathbb{E}\left[u^m\right]}{\partial p} = \frac{qp\sigma^2}{12}\left(1-(1-\omega)^2\left(\frac{(1-q)\left(8\left(1-\sqrt{1-q}\right)-q^2-4q\right)}{q^3}\right)\right) > 0 \tag{132}$$

$$\frac{\partial^2 \mathbb{E}\left[u^m\right]}{\partial p \partial \omega} = \frac{qp\sigma^2}{6}\left((1-\omega)\left(\frac{(1-q)\left(8\left(1-\sqrt{1-q}\right)-q^2-4q\right)}{q^3}\right)\right) > 0 \tag{133}$$

Finally, as in the proof of Corollary 2, by continuity, these expressions also imply that the manager's expected utility in **case 2** exceeds that in **case 1**.

□

Proof of Lemma 3

Proof. We can rewrite (26) so that the principal should retain control if and only if

$$\frac{\sigma^2}{12}\left(\frac{p\left(1-\omega\right)}{b}\right)^2 < N^2\left(\left(1-\omega\right)^2 - \frac{\left(N^2-1\right)}{3}\right). \tag{134}$$

There are two cases to consider. If $b < \frac{\sigma p(1-\omega)}{4}$, communication is informative i.e., $N \geq 2$. In this case, equation 134 never holds because $\frac{\sigma^2}{12}\left(\frac{p(1-\omega)}{b}\right)^2 > 0 \geq N^2\left(\left(1-\omega\right)^2 - \frac{\left(N^2-1\right)}{3}\right)$. As a result, the principal always delegates.

If $b > \frac{\sigma p(1-\omega)}{4}$, then communication is uninformative (as shown in the proof of Proposition 1), i.e., $N = 1$. In this case, equation 134 holds (and the principal retains control) as long as

$$\frac{p\sigma}{2\sqrt{3}} < b. \tag{135}$$

The curse of knowledge could only reduce delegation if $b < \frac{\sigma p}{4}$ so that absent the curse of knowledge, communication would be informative (and therefore the principal delegates). But if this is true, then even if $b > \frac{\sigma p(1-\omega)}{4}$, so that any communication would be uninformative, the principal will still choose to delegate since (135) holds. □

Proof of Lemma 4

Proof. There are two cases to consider. If $\frac{b}{p(1-\omega)} \geq \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, then the principal should retain control if and only if

$$b^2 > \left(\frac{qp^2\sigma^2}{12}\right)\frac{(1-q)\left(8\left(1-\sqrt{1-q}\right)-q^2-4q\right)}{q^3} \iff \tag{136}$$

$$b = \frac{p\sigma}{2\sqrt{3}}\chi(q) \tag{137}$$

$$\chi(q) \equiv \frac{\sqrt{(1-q)\left(8\left(1-\sqrt{1-q}\right)-q^2-4q\right)}}{q} \tag{138}$$

If $\frac{b}{p(1-\omega)} < \frac{\sigma\left(\sqrt{1-q}-(1-q)\right)}{2q}$, then the principal should retain control if and only if

$$b^2 > \frac{qp^2\sigma^2}{12}\left(\frac{48b^4q}{p^4\sigma^4(1-q)(1-\omega)^4} + \frac{32b^3}{p^3\sigma^3(1-\omega)^3}\right) \tag{139}$$

$$(1-\omega)^2 > \frac{4b^2q^2}{p^2\sigma^2(1-q)(1-\omega)^2} + \frac{8bq}{3p\sigma(1-\omega)} \tag{140}$$

$$(1-\omega)^2 > \frac{4q^2}{\sigma^2(1-q)}\left(\frac{b}{p\,(1-\omega)}\right)^2 + \frac{8q}{3\sigma}\left(\frac{b}{p\,(1-\omega)}\right) \tag{141}$$

□