Transparency in Agency: The Constant Elasticity Case and Extensions

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Abstract

This paper considers a hidden action agency problem where the principal has a single source of hidden information concerning the agent’s utility, the agent’s effort productivity, or the agent’s cost of effort. We examine whether the principal should precommit to disclosing these different single sources of information to the agent. If the optimal contract is invariant over the hidden information and, thus, the disclosure rules (constant elasticity case), such disclosure increases the agent’s utility, it can raise or lower profit and total surplus depending on the source of hidden information, and non-disclosure can be optimal if disclosure affects the agent’s motivation. If the contract varies with the hidden information and, thus, disclosure rule, disclosure or non-disclosure can be optimal depending on whether the party’s payoff is convex or concave in the information variable, respectively.

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1. Introduction

In this paper, we examine transparency in an agency relationship. We concentrate on incentives for a principal to reveal different types of private information about an agent to that agent in an organizational setting. That is, should different sources of private information, possessed by the principal, result in different prescriptions regarding disclosure versus non-disclosure of that information to the agent?

In many agency situations, the principal may possess or acquire information about agents or about the organizational environment surrounding agents that can be hidden at the principal’s discretion. An interesting question then arises. Under what circumstances, in terms of the type of information, should the principal precommit to divulge that information to agents? If it is optimal for the principal to disclose in terms of profit, will disclosure also be optimal for the agent in terms of utility? If there are divergent welfare effects of disclosure, what is the net effect on welfare? In a given class of hidden action agency problems, this paper will address these questions. We will show that under certain conditions, disclosure is not the best strategy for a principal. In addition, we will extend and apply our results to the case where information revelation by the principal can affect the agent’s motivation which can in turn impact welfare.\footnote{An increase in motivation is modeled as a decrease in the agent’s cost of effort.}

We consider a principal who has hidden information which might come from three different sources, where each source is modeled as a multiplicative shift parameter. Namely, information which affects the agent’s firm specific productivity in the generation of cash flow (pure technological information), the agent’s firm specific cost of effort (difficulty of the job), or the agent’s firm specific gross utility of cash flow (fit). Our model considers a simple two outcome hidden action agency problem with an endogenously optimal agency contract. Letting $a \cdot p(\text{effort})$ represent the agent’s probability of the high outcome, hidden productivity or technological information is given
by the variable \( a \). This is the case where a principal may be better at judging the efficiency of the agent’s effort in a task, because the principal, unlike the agent, has previously done the task or has observed others perform it.\(^2\) The second two sources of hidden information involve the agent’s utility, given by \( \gamma \cdot u(\text{wage}) - c \cdot \tilde{C}(\text{effort}) \), where \( u \) is the utility of income, \( \tilde{C} \) is the cost of effort, \( \gamma \) is hidden information regarding the utility of income, and \( c \) is hidden information regarding effort cost. Hidden information on effort cost, \( c \), arises where the principal has better information on how difficult it will be for the agent to accomplish a task. An example is the sales situation where a sales supervisor knows more about the difficulty in selling to a particular client, because of better personal experience or because of the benefit of past observation of others attempting to sell to this customer. Hidden information about the utility level of the agent resulting from consuming cash flow earned and working in the organization, \( \gamma \), is motivated by a very old and large management literature on person-environment fit. See Kristoff-Brown et al. (2005) for references and a review of this literature. Person-environment fit refers to the congruence between the agent’s characteristics and the characteristics of the job and the organization. Characteristics of the job and the organization include corporate culture, characteristics of co-workers (e.g., personalities and values), characteristics of supervisors (e.g., personalities, degree of delegation, management style, and values), details of the job (precise description of day to day duties and responsibilities), and, possibly, the agent’s relative firm specific ability in the organization.\(^3\) Characteristics of the individual include values, psychological needs, ability, and personality. Because the firm clearly knows the characteristics of the job and organization better than the employee and because the interview and hiring process makes the characteristics of the employee known to the firm, it is reasonable to assume that the firm better knows fit (congruence) than does the employee. Better

\(^2\) These same points are made in Benebou and Tirole (2003)

\(^3\) The relative status variable studied in Marino and Ozbas (2012) falls into the category of hidden information about utility, in this more general setting. An agent knows his own ability but not his ranking in abilities within the organization. The latter typically matters to the agent.
fit is seen to provide the agent greater utility or benefit, assuming that monetary compensation is fixed. Given that better person-environment fit has to do with a better feeling of well being on the job, we model this as a positive gross utility shift factor. While hidden information on $\gamma$ and $c$ might at first sight seem interchangeable, they are not and each has different implications for disclosure.\textsuperscript{4}

Our base model assumes that the principal and the agent are risk neutral and that the agent has limited liability. Initially, we design a framework which makes the principal’s incentive payment independent of the hidden information variable which in turn makes the incentive payment independent of the disclosure rule. This allows us to isolate the effects of disclosure alone. That is, although the principal is informed of the agent’s type when choosing the optimal contract, the contract will not depend on agent type nor on the timing of information revelation (pre versus post contract) to the principal.\textsuperscript{5} This isolation is achieved by using constant elasticity functions for the cost of effort and the probability of a high cash flow. Such functions are a subset of the class of functions which make the principal’s optimal contract independent of the principal’s hidden information. Consequently, the agent will not be able to draw an inference about his type through the contract, when non-disclosure is used. We also assume that the principal can credibly precommit to disclose or not disclose hidden information, and that full as opposed to partial disclosure is used.\textsuperscript{6} The use of constant elasticity functions is common in the agency literature, and many real world disclosure policies in fact fall into the categories of either full disclosure or non-disclosure. This form also allows a convenient parameterization of the degree of concavity or convexity of cash flow production and effort cost. In a final section, we generalize the model in several directions and

\textsuperscript{4}The fact that asymmetric information regarding benefits versus costs can have different implications for welfare was pointed out by Weitzman (1974) in his classic planning paper.

\textsuperscript{5}That is, the optimal contract will then also not depend on whether the principal knows the agent’s type before or after the contract is constructed.

\textsuperscript{6}We do not consider the case where the principal sends the agent an imperfect signal of type.
discuss how the results change with the introduction of general cost of effort and probability of high cash flow functions, risk aversion and a general distribution function for the hidden information variable. We show that the results of the constant elasticity case can be overturned, when the optimal contract varies with the hidden information variable and, thus, the disclosure rule.

The key factor determining whether disclosure or non disclosure is optimal for an individual is whether that party’s equilibrium payoff function is convex or concave in the hidden information variable. Convexity in the hidden information variable implies that disclosure is best and concavity implies that non-disclosure is optimal. Generally, the source of hidden information (productivity, utility of cash, or cost of effort) can affect the curvature of an equilibrium payoff function in the information variable directly and indirectly through the optimal contract.

The constant elasticity version of the model isolates the direct effects of the source of hidden information, as it eliminates contract changes as a function of the hidden information variable. We show that for this version of the model, the agent’s payoff is convex in the information variable for each of the single source of hidden information considered \((a, \gamma, \text{or } c)\), such that disclosure by the principal increases the agent’s utility in equilibrium. Given that the contract does not change across disclosure rules, the disclosure of information allows the agent to better condition effort and this results in increased rewards. The principal’s payoff is also convex in the information variable if the single source of hidden information is productivity or cost of effort \((a \text{ or } c)\), so that again disclosure is optimal and it increases total surplus. However, with hidden information on utility, the principal’s payoff is concave or convex in the information variable \(\gamma\) depending on the magnitudes of the (constant) elasticities of the probability of success and the cost of effort. When the principal’s production circumstances are "unfavorable" in the sense that the elasticity of cash flow with respect to effort is small and/or the elasticity of effort cost with respect to effort is large, then the principal’s equilibrium profit is concave in the information variable, non-disclosure is optimal for the principal,
and non-disclosure may be optimal in terms of total surplus. The reason why hidden information about utility produces a different result is that, with an unfavorable situation, the agent’s effort is an increasing and concave or weakly convex power function of the information variable $\gamma$. The principal’s payoff is a positive fractional power function of effort (due to diminishing returns), thereby, leading to concavity of profit in $\gamma$. However, with hidden information on the cost of effort, the agent’s effort is a convex negative power function of $c$. Profit is again a positive fractional power function of effort, making profit a convex negative power function of $c$. With hidden information on productivity, effort is a positive power function of $a$ and profit is the product of the productivity index $a^1$ and a positive power function of effort. Thus, profit becomes a power function of $a$ with power greater than unity. That is, the productivity parameter is internalized by both the agent and the principal, inducing convexity of the principal’s payoff in $a$. When we extend and apply the constant elasticity model to the case where the agent’s motivation (effort cost) can vary depending on the state of the world, so as to create two sources of hidden information, we show again that unfavorable production circumstances can lead to situations where non-disclosure is optimal.

Unfavorability says that the cash flow production process is very concave in effort and/or the cost of effort is very convex in effort. In the generalized version of the model considered in the last section of the paper, we find that, when we extend from the constant elasticity version of the model, the contract optimally depends on the hidden information and varies with the disclosure rule. Here, both the agent and the principal can benefit from non-disclosure when these conditions on diminishing returns to effort in production and rising marginal cost of effort are met. Such conditions can lead to concavity of the principal’s equilibrium profit or the agent’s equilibrium utility in the hidden information variable, depending on the source of hidden information, implying that non-disclosure is optimal.

Section 2 reviews the related literature. Section 3 presents the constant elasticity model and
outlines the three types of hidden information. Section 3.1 focuses on hidden information regarding the agent’s utility, and Section 3.2 considers the cases of hidden information on the agent’s effort cost and the on the productivity of the agent’s effort. Section 3.3 applies and generalizes our analysis of the constant elasticity model to the case where information disclosure can affect the agent’s motivation. Section 4 discusses a generalization of the constant elasticity model. Section 5 concludes.

2. Related Literature

The theoretical economics literature on disclosure includes a discussion of the rationales for non-transparency in politics, in delegated portfolio management, in the finance and accounting literature on corporate governance and capital markets, and in agency relationships. In reality, we find pervasive and systematic departures from full transparency in all of the above situations.

In politics, the paper by Clukierman and Meltzer (1986) discusses a positive theory to explain the lack of transparency in government organizations. The papers by Morris and Shin (2002) and Chen, Lewis and Zhang (2012) provide a normative theory for restricting public disclosure.

In the area of delegated portfolio management there have been calls by the government for more frequent and accurate disclosure of portfolio composition, but industry has resisted these demands. See Tyle (2001). Villatoro (2009) points out that there is a trade-off between protecting investors by demanding more transparency from fund managers and encouraging herding by free-riders for whom imitating portfolio decisions would be easier under more frequent portfolio disclosure.

The accounting and finance literatures have long been concerned with the role of information disclosure in allowing capital providers to more accurately judge the returns of possible investment opportunities and the role of accounting information in permitting capital providers to monitor the use of their money once it has been invested in a firm. See Beyer et al. (2010) for a recent review,
Verrecchia (2001) for an earlier survey of the accounting literature on disclosure, and Christensen and Feltham (2005), Part F, for a textbook discussion. Unlike our paper this literature is concerned with an uninformed principal. In the finance literature, the paper by Hermelin and Weisbach (2012) provides an example of some ill effects of disclosure in the area of corporate governance.

The literature studying transparency in principal-agent relationships is rich in papers and ideas. Prendergast (1993) studies a problem where the agent biases his signal towards that of the principal (a yes man), causing the principal to counter with a contract where pay is not dependent on the agent’s action. Cremer (1995) shows that the principal can be harmed when a more precise signal of performance is observed, because it makes commitment to non-renegotiation of the contract less believable. Dewatripont et al. (1999) present cases where the agent exerts more effort if the principal receives a coarser signal of performance. Holmstrom (1999) points out that more precision in the principal’s belief of the agent’s ability can induce the agent to exert less effort to prove his value to the firm. Maier and Ottaviani (2008) look at information sharing by two principals, and they show that if a less informed principal cares less than the other principal about the agent’s output, information sharing can reduce welfare. Prat (2005) employs a career concerns model and distinguishes between transparency regarding the consequence of the agent’s action, which is always good, and transparency regarding the agent’s action which may have bad effects for the firm. Bar Isaac (2012) looks at a similar problem but allows transparency on actions to affect the agent’s information gathering activities.

The agency literature examines the timing of a given type of information revelation. Sobel (1993) looks at the principal’s payoff under three different assumptions: First, the state cannot be observed by the principal or the agent (analogous to symmetric non-disclosure); Second, the state can be observed by the agent after contracting and before choosing effort level; Third, the state is observed by the agent before contracting. The principal can never observe the state of
nature. Sobel shows that the principal prefers post contract to pre-contract revelation and that the principal facing two possible outcomes prefers an informed agent to an uninformed one regardless of the timing. However, he shows, by way of example, that with three outcomes the latter result can be overturned. This says that the principal can prefer an ignorant agent to an informed one, even though the principal is uninformed and does not invoke the revelation of information. A more recent paper on information timing is by Nafziger (2009). She, unlike Sobel, assumes that the principal and the agent observe an additional signal and she compares ex ante (before effort choice) to ex post (after effort choice) revelation of signals. In the context of incentive problems, she shows that the principal’s preference for ex ante versus ex post revelation can go either way depending on informativeness of the signal with regard to the agent’s effort. Both of these papers involve symmetric information, whereas, in an earlier paper, Baiman and Evans (1983) consider timing of the revelation of information when the agent has private information, when the information is public, and when there is no information. They study the welfare effects of installing different combinations of ex ante information revelation, communication systems, and ex post information revelation. See Nafziger for a summary of related papers on the timing of information in agency problems.

The dynamic tournament literature considers interim (relative performance) information disclosure by the principal and its effect on profit. This literature includes the papers by Lizzeri et al. (2002), Crutzen et al. (2010), Ederer (2010), Aoyagi (2010) and Goltsman and Mukherjee (2011).

Silver (2012a) considers a hidden action principal-agent problem with hidden information about a stochastic cash flow technology. A signal about the technology is observed before the contract is offered. The signal is uninformative (null), it is informative only to the principal (equivalent to our non-disclosure), or it is public (equivalent to our disclosure case). He shows that the agent prefers non-disclosure to disclosure. If the principal prefers disclosure to null, the principal prefers disclo-
sure to non-disclosure. Silvers (2012b) sets up a similar problem as in his (2012a) paper except that the signal about the technology is received after the principal offers a menu of contracts. Once the signal is obtained, the principal selects from the menu. He shows that if with public information the principal does not condition the action implemented on the signal, non-disclosure is preferred to disclosure by the principal. These papers and their results are different than ours, because we do not allow signalling by the principal when information is private to the principal. We then isolate the pure disclosure versus non-disclosure effects and prevent signalling with nondisclosure. In addition, we consider and contrast three different sources of hidden information. Silvers considers just one source.

The paper by Benabou and Tirole (2003) is not about transparency per se, but it is related because it assumes that the principal has superior information about the agent’s cost of effort or the agent’s productivity. Hidden information on the agent’s utility is not considered. The agent forms beliefs about the principal’s knowledge, and such beliefs are a function of the principal’s contract and policies. Their focus is on how the optimal contract is conditioned by such beliefs. In their paper, the notion of motivation or self-confidence is portrayed as the agent’s perceived prospects from undertaking the firm’s task. Higher self-confidence or motivation is triggered by a better signal on information hidden to the agent, and such an increase can lead to an increase or a decrease in the principal’s payoff.

Our paper considers a different problem from the many studies above where the principal has imperfect information about the agent, but it is akin to but different than problems studied in the dynamic tournament literature and the papers by Benabou and Tirole and Silvers where the principal has hidden information about the agent. Our approach also differs from that of the timing

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7 In Chade and Silvers (2002) a principal has private information about which of two possible technologies obtains in a principal agent problem. They show that a principal with a more informative technology earns less than one with a less informative technology and that an agent can end up better off when the principal has private information.
literature, (e.g., Sobel and Nafziger) in that we are interested in the differential welfare effects of the disclosure of different types of information as opposed to the timing of disclosure of a given type of information.

### 3. The Constant Elasticity Model

Consider a principal-agent setting where the agent exerts effort to produce cash flow. Both the agent and the principal are risk neutral. There are two outcomes for cash flow given by \( \hat{x} \in \{0, x\} \).

Let the agent’s effort be denoted \( e \). The probability that cash flow is \( x \) is given by \( ae^e \), where \( e, \varepsilon \in (0, 1) \) and \( \varepsilon \) is the agent’s elasticity of cash flow with respect to the agent’s effort. If the principal’s hidden information is with respect to the productivity of cash flow, then the parameter \( a \in \{a_L, a_H\}, a_i \in (0, 1), a_H > a_L \), is a productivity variable which is known by the principal but unknown to the agent. The agent’s prior probability that productivity is high, \( a_H \), is \( p \). If there is no hidden information with respect to productivity, then we set \( a = 1 \), with probability one.

Let \( w \) represent the compensation paid to the agent by the principal. The agent is risk neutral with a utility function given by \( \gamma w \). If there is hidden information about the agent’s utility, the variable \( \gamma \in \{\gamma_L, \gamma_H\} \), where \( \gamma_H > \gamma_L \geq 1 \), is present and known by the principal. From the viewpoint of the agent, the probability that \( \gamma = \gamma_H \) is \( q \). If such hidden information is not present, \( \gamma = 1 \), with probability 1. The agent’s cost of effort is given by \( ce^v \), where \( v > 1 \) is the elasticity of cost with respect to effort. The variable \( c \) denotes hidden information about the agent’s cost of effort. If such hidden information is present, \( c \in \{c_L, c_H\} \) with \( c_H > c_L \) and the agent’s prior probability that \( c = c_H \) is \( r \), while if such hidden information is not present, \( c = 1 \), with probability 1. In what follows, we will consider each type of hidden information separately, except for the analysis of motivation where there are two types of hidden information. The agent’s cost function
is assumed to measure effort cost in terms of cash. Thus, net utility,

$$\hat{u} = \gamma w - ce^v,$$

is measured in terms of money. The agent’s outside option for expected utility is assumed to be 0. Hidden information $c$ which affects the cost of effort in a positive multiplicative way has different implications for disclosure than that of information on $\gamma$ which impacts the agent’s gross utility of cash flow.\(^8\) We could multiply $\hat{u}$ by $1/\gamma$ such that utility is $w - e^v/\gamma$. This formulation of person-environment fit says that there is hidden multiplicative information on effort cost which has the effect of reducing effort cost. It is equivalent to our formulation which asserts hidden information on utility which multiplicatively raises utility. We believe that the notion of better fit seems more appropriately described by our utility enhancement approach. Likewise, our cost enhancement formulation is equivalent to hidden information which discounts utility, $w/c - e^v$. The notion of "higher difficulty of a task" again seems better described by our effort cost enhancement formulation.

The principal offers a contract to the agent which specifies a flat wage $\alpha$ and an incentive payment $\beta$ which represents a percentage of cash flow. Given our two outcome technology, this contract is fully general. The two outcome technology allows us to derive a simple explicit and general contract for the agent. With a continuum of outcomes or multiple outcomes this simple explicit solution for the contract is not possible. Our simplification allows us to better focus on disclosure as opposed to the contracting problem. However, our conclusion that concavity of a payoff function in an information variable merits nondisclosure (and conversely for convexity) holds in the more general setting. We will require that all payments, $\alpha, \beta$, made to the agent by the principal

\(^8\)See Weitzman (1974) for a similar conclusion.
be non-negative. The timing of information and contracting is as follows:

- At stage 0, the principal precommits to a policy of disclosure or non-disclosure;
- At stage 1, the principal meets with the agent and learns the agent’s information;
- At stage 2, the principal specifies the contract and discloses or does not disclose the information that he has gleaned regarding the agent to the agent;
- At stage 3, the agent optimizes with respect to effort, given the principal’s contract and the possible information provided;
- At stage 4, returns accrue.

The equilibrium does not change in the constant elasticity model, if the time line is changed such that information learning is post contract. That is, stage 0 is the precommitment stage, stage 1 involves the principal setting the contract, stage 2 involves the principal becoming informed and disclosing or not disclosing, and stage 3 involves the agent optimizing. This narrative might even be more compelling, because the post contract stage would correspond to a real world observation phase where the principal garners information. When we generalize the model in Section 5, we will use this post contract time line.

3.1. Hidden Information Regarding the Agent’s Utility

Here we set $a = c = 1$ and $\gamma \in \{\gamma_L, \gamma_H\}$. If the principal’s policy is one of non-disclosure, the agent will solve

$$\max_{\{e\}} e^\gamma E(\gamma)(\beta x + \alpha) + (1 - e^\gamma)E(\gamma)\alpha - e^\nu,$$

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9 This is a strong form of limited liability. This assumption prevents the principal from selling the firm to the agent in which case disclosure would be trivially optimal.
yielding
\[ e = \left[ \frac{\varepsilon \beta x E(\gamma)}{v} \right]^{\frac{1}{\gamma}}. \] (1)

If the principal has a policy of disclosure, the \( \gamma \) replaces \( E(\gamma) \) in (1).\(^{10}\)

Under a policy of non-disclosure, the principal’s problem is specified as

\[ \max_{\{\alpha, \beta\}} (1 - \beta)e^\varepsilon x - \alpha \]

subject to (1), the participation constraint

\[ e^\varepsilon E(\gamma)\beta x + E(\gamma)\alpha - e^v \geq 0, \] (2)

and limited liability

\[ \alpha, \beta \geq 0. \]

For the case of disclosure, \( \gamma \) replaces \( E(\gamma) \) in (2). At an optimum to the principal’s problem, we can show that the following result holds. All proofs are provided in the Appendix.

**Lemma 1.** Let the source of hidden information be the agent’s utility. At an optimum to the principal’s problem, the participation constraint is non-binding and the optimal flat salary is \( \alpha = 0 \).

Lemma 1 reduces the principal’s problem to

\[ \max_{\{\beta\}} (1 - \beta)[\frac{\varepsilon \beta x E(\gamma)}{v}]^{\frac{\varepsilon}{v-\varepsilon}} x. \] (3)

Define

\[ t = \frac{\varepsilon}{v - \varepsilon}. \] (4)

\(^{10}\)It is easy to show that the second order condition for the agent’s problem is met. We assume that the parameters of the model are such that \( e \in (0, 1) \).
Solving for the optimal $\beta$ we have that

$$\beta = \frac{\varepsilon}{v} = \frac{t}{1 + t}^{11} \quad (5)$$

Note that, from (5), the principal’s optimal share is not dependent on the agent’s hidden information parameter, $\gamma$. This simplification is a consequence of our constant elasticity modeling assumption, and it provides the advantage that only the disclosure or non-disclosure of information makes the principal’s and the agent’s expected welfare vary. That is, we isolate the effect of information disclosure. Further, we have that

$$\partial \beta(t)/\partial t = 1/(1 + t)^2 > 0. \quad (6)$$

The parameter $t$ is decreasing in $v$, which is in turn a measure of responsiveness of the agent’s effort cost to increases in effort. It is also increasing in $\varepsilon$, which measures the responsiveness of the agent’s expected cash flow to a change in effort. Condition (6) tells us that the incentive share to the agent goes up if, other things equal, $\varepsilon$ increases or $v$ decreases. We will term an increase in $t$ as an increase in the "favorability" of the agency situation. Either an increase in $\varepsilon$ or a decrease in $v$ would make the circumstances more favorable in our terminology. That is, the firm faces a more favorable situation if the agent has greater cash flow response to effort or less effort cost response to effort. In more favorable circumstances, agents receive greater incentive shares and conversely in less favorable circumstances.

Next let us compare the agent’s ex ante expected utility under the two regimes of disclosure versus non-disclosure. Let $U(\gamma) \equiv (a^{t+1})(\frac{t^{t+1}}{(1+t)^{1+t}})(\gamma)^{t+1}$ define the agent’s equilibrium expected utility as a function of the information variable. If the principal precommits to non-disclosure, the

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11 It is easy to show that the second order condition to the principal’s problem is met at the point where $\beta = t/(1+t)$. 
agent’s equilibrium expected utility is given by

\[ E^n(\hat{u}) = U(E(\gamma)). \] (7)

If the principal precommits to disclosure, the agent’s ex ante equilibrium expected utility is

\[ E^d(\hat{u}) = qU(\gamma_H) + (1 - q)U(\gamma_L). \] (8)

Note that because \( U \) is a strictly convex function of \( \gamma \), (8) is strictly greater than (7) such that

\[ E^d(\hat{u}) > E^n(\hat{u}). \]

We summarize this result in

**Proposition 1.** If hidden information concerns the agent’s utility, then the agent always has greater expected utility under a policy of disclosure. The value of disclosure, \( E^d(\hat{u}) - E^n(\hat{u}) \), is increasing in favorability, \( t > 0 \), if \( x \geq 1 \).

Disclosure of information always helps the agent because (i) the contract is invariant across states, (ii) the participation constraint is non-binding so that the agent receives rent in equilibrium, and (iii) it allows better effort conditioning in each state so as to increase the agent’s rent in each state. Non-disclosure forces the agent to over supply effort in the bad state and under supply it in the good state. This lowers expected utility, given the above equilibrium conditions. The value of disclosure increases in the favorability of the production situation if the cash gain in the good state is sufficiently great, \( x \geq 1 \). In this case, \( U \) is strictly convex in \( \gamma \) such that the agent gets greater utility from the expected utility of the two states than from the utility of the expected state.

Next, consider the impact of disclosure on the principal’s ex ante profit. Define equilibrium
profit as a function of the information variable as \( \Pi(\gamma) \equiv x^{t+1} + \frac{t^2}{(1+t)^{2t}} \gamma^t \). The principal’s expected equilibrium profit under disclosure is

\[
E^n(\pi) = \Pi(E(\gamma)), \quad (9)
\]

and under non-disclosure it is

\[
E^d(\pi) = q\Pi(\gamma_H) + (1-q)\Pi(\gamma_L). \quad (10)
\]

In this case, \( \Pi(\gamma) \) is a strictly convex function of \( \gamma \) if \( t \) is greater than one and it is strictly concave if \( t \) is less than one. It is clear, from (9) and (10) that disclosure dominates in the former case and non-disclosure dominates in the latter case. We can summarize the results for the principal in

**Proposition 2.** If hidden information concerns the agent’s utility, then the principal has greater expected profit under a policy of non-disclosure if the favorability parameter is low, \( t < 1 \), and has greater expected profit under a policy of disclosure if favorability is high, \( t > 1 \). Let \( x \geq 1 \). The value of disclosure to the principal, \( E^d(\pi) - E^n(\pi) \), is increasing in favorability, for \( t > 1 \). The value of non-disclosure, for \( t \in (0,1) \), is increasing for \( t \in (0,t') \) and decreasing for \( t \in (t'',1) \), where \( 0 < t' < t'' < 1 \).

For the purpose of discussion, let us say that the situation is unfavorable if \( t \in (0,1) \) and favorable otherwise. Low favorability (strong concavity of the cash flow production function and/or strong convexity of effort cost) makes \( \Pi(\gamma) \) a strictly concave function of the information variable. Non-disclosure makes expected profit the image value of the expectation of the information variable under \( \Pi \), whereas disclosure takes a convex combination of \( \Pi \) across the two states. Whence, non-disclosure dominates by Jensen’s inequality. Ex ante, the principal wants to avoid variability in the agent’s choice of effort between the low and high states of \( \gamma \). The principal accomplishes this
by keeping the agent’s view of $\gamma$ at the prior. For the case where $t > 1$, the reverse argument holds. Our more general condition for the optimality of non-disclosure is related to a result in the dynamic tournament literature which is that non-disclosure of interim performance information is more likely optimal when the agent’s marginal cost of effort function is convex. See, for example, Ederer (2010) and Lizzeri et al. (2002). The results on the principal’s profit are again true due to the equilibrium conditions that (i) the optimal contract is invariant across states and (ii) the participation constraint is non-binding so that the agent receives rent in equilibrium. The principal then can achieve higher profit with non-disclosure even though the agent’s payoff goes down because he is taking a larger share of total surplus.

In the unfavorable region, there is a non-monotone comparative static result. If favorability is sufficiently low, then increases in favorability increase the value of non-transparency relative to transparency. Conversely, if favorability is relatively higher and the situation is unfavorable but closer to being favorable, then increases in favorability decrease the value of non-transparency relative to transparency where, none the less, non-transparency is optimal. If the situation is favorable, $t > 1$, then transparency is optimal for the principal, and increases in favorability make the value of transparency even greater.

Clearly if there is a favorable production situation, then total welfare is enhanced by a policy of transparency as both the principal and the agent gain. If the circumstances are unfavorable, then there is a trade off in that the agent is worse off with non-transparency while the principal is better off. It is of interest to determine which effect dominates in terms of total welfare. The following proposition addresses this issue.

Proposition 3. Let the source of hidden information be the agent’s utility. If $t > 1$, then total welfare is greater under disclosure. If $t \in (0,1)$, then total welfare is greater under disclosure if $t$ is close to unity, but total welfare is greater under non-disclosure if $t$ is close to zero.
We see that non-transparency increases total welfare if the production situation is sufficiently unfavorable. The gains due to increased profit outweigh the losses due to decreased utility of the agent in this case.\textsuperscript{12}

The overall message from this analysis is that if the informational asymmetry between the principal and the agent is characterized by the agent having incomplete information about his own utility and the principal has complete information, it can be privately optimal for the principal to withhold this information and in some cases it is optimal in terms of total welfare for the principal to withhold this information. A policy of non-transparency makes sense, if the agent has low effort elasticity in producing cash flow and/or high effort cost elasticity in generating cash flow. Intuitively, this means that the agent’s extra effort has a small effect on the probability of success in the project and/or when the agent does exert effort it has a large effect on the agent’s effort cost. For example, in sales, a high \( v \) and a low \( \varepsilon \) arise if the potential customer is predisposed to another rival product and not likely to switch despite how hard the sales person tries to make the sale. In portfolio management, it might be descriptive of a situation where active management is less productive than passive management (\( \varepsilon \) low) and it is personally costly for the active manager to exert extra effort to actively manage (\( v \) high). In the case of a new teaching assignment for a junior professor, an unfavorable situation is created when the junior professor is asked to teach a new required course with students who feel that the material is irrelevant to their future career. Here, the responsiveness of success to effort,\( \varepsilon \), is again low and the responsiveness of effort cost to effort,\( v \), is high. In each of these cases, the principal is better off being opaque about the fit of the employee in the respective organization.

\textsuperscript{12}This condition is also sufficient for the optimality of non-disclosure of relative status in Marino and Ozbas (2012).
3.2. Hidden Information Regarding the Productivity of Effort in Cash Flow or the Cost of Effort

If there is hidden information regarding the productivity of effort, \( \gamma = c = 1 \) and \( a \in \{a_L, a_H\} \).

Under non-disclosure, the agent’s problem is given by

\[
\max_{\{e\}} E(a)e^\varepsilon(\beta x + \alpha) + (1 - E(a)e^\varepsilon)\alpha - e^\nu.
\]

Solving for effort

\[
e = \frac{\varepsilon \beta x E(a)}{v} \frac{1}{e^\varepsilon}.
\] (9)

If there is hidden information regarding effort cost, \( \gamma = a = 1 \) and \( c \in \{c_L, c_H\} \). The agent’s problem with non-disclosure is then transformed to

\[
\max_{\{e\}} e^\varepsilon(\beta x + \alpha) + (1 - e^\varepsilon)\alpha - E(c)e^\nu,
\]

and optimal effort is

\[
e = \frac{\varepsilon \beta x}{E(c)v} \frac{1}{e^\varepsilon}.
\] (10)

Solution (9) is identical to (1) for the hidden information on utility and (10) differs from these only in that the expectation of cost appears in the denominator of the expression for \( e \) as opposed to the numerator. The case of disclosure is characterized by replacing the expectation of a state with the actual state.

With either type of hidden information, the principal’s problem is unchanged except for the participation constraint. In the case of hidden information regarding productivity of cash flow, it is

\[
E(a)e^\varepsilon \beta x + \alpha - e^\nu \geq 0,
\] (11)
while for the case of hidden information regarding effort cost it is

\[ e^\xi \beta x + \alpha - E(c)e^\nu \geq 0. \] \hspace{1cm} (12)

The results of Lemma 1 are replicated for participation constraints (11) and (12).

**Lemma 2.** At an optimum to the principal’s problem with hidden information regarding the agent’s productivity in cash flow or effort cost, the participation constraint is non-binding and the optimal flat salary is \( \alpha = 0 \).

Using these results, it is easy to show that under either type of hidden information and under either disclosure rule, the principal’s optimal sharing rule is \( \beta = \frac{1}{1+\xi} = \frac{\xi}{\nu} \), as before.

With hidden information regarding the agent’s productivity of cash flow, the agent’s ex ante expected utility under non-disclosure and disclosure are, respectively,

\[ E^n(\hat{u}) = U(E(a)) \text{ and } E^d(\hat{u}) = pU(a_H) + (1-p)U(a_L). \] \hspace{1cm} (13)

Expressions (13) are identical to (7) and (8), so that it follows that, for the agent, disclosure is always optimal. Given that \( U \) is strictly convex in \( a \) for \( t > 0 \), \( E^d(\hat{u}) > E^n(\hat{u}) \). With hidden information regarding the agent’s effort cost, we can define equilibrium utility as a function of the information variable as \( \tilde{U}(c) \equiv \frac{\xi}{1+t} \frac{(t+1)^{t+1}}{(1+\xi)^{t+2}} (c)^{-t} \). Then competing ex ante utilities are

\[ E^n(\hat{u}) = \tilde{U}(E(c)) \text{ and } E^d(\hat{u}) = r\tilde{U}(c_H) + (1-r)\tilde{U}(c_L). \] \hspace{1cm} (14)

Note that the function \( \tilde{U}(c) \) is strictly convex in \( c \) for \( t > 0 \), so that disclosure again dominates non-disclosure, with hidden information regarding effort cost.

Ex ante profit comparisons for the principal will be considered next. Define equilibrium profit
as a function of the information variable as \( \tilde{\Pi}(a) \equiv x^{t+1} \frac{t^{2t}}{(1+t)^{2t+1}}(a)^{t+1} \). With hidden information regarding the agent’s productivity of cash flow, we have

\[
E^u(\tau) = \tilde{\Pi}(E(a)) \quad \text{and} \quad E^d(\tau) = p\tilde{\Pi}(a_H) + (1-p)\tilde{\Pi}(a_L).
\]

This comparison immediately reveals that disclosure dominates for the principal, as \((t + 1) > 1\) and the principal’s ex ante profit is convex in the agent’s hidden information variable. Define equilibrium profit as a function of \( c \) as \( \tilde{\Pi}(c) \equiv x^{t+1} \frac{t^{2t}}{(1+t)^{2t+1}}(c)^{-1} \). In the case of hidden information regarding effort cost, ex ante profits under the two regimes are given by

\[
E^u(\tau) = \tilde{\Pi}(E(c)) \quad \text{and} \quad E^d(\tau) = r\tilde{\Pi}(c_H) + (1-r)\tilde{\Pi}(c_L).
\]

Again, we have that profit is convex in the information variable and disclosure dominates.

Summarizing, we have

**Proposition 4.** Utility, profit and, thus, total welfare are greater under disclosure if the hidden information is with respect to the productivity of effort or the cost of effort.

The above analysis points out that the source of hidden information matters because it determines the curvature of a party’s payoff function in the hidden information variable. Analytically, hidden information on cost and productivity of cash flow are opposite sides of the same coin, so that it is not surprising that the curvature results are the same. Why do these differ from hidden information on utility, when it comes to the principal’s profit? For any given set of parameter values, \( \gamma, a, c \), the agent’s effort is given by

\[
e = \left( \frac{\gamma a \epsilon \beta x}{cv} \right)^{\frac{1}{1-\epsilon}},
\]
and profit to the principal is

$$(1 - \beta)ae^\varepsilon x.$$  \hspace{1cm} (15)$$

Using $\beta = \varepsilon/v = t/(1 + t)$, we have that (15) can be rewritten as

$$\frac{t^{2t}}{(1 + t)^{2t+1}} x^{t+1} [a(\frac{\gamma a}{c})^t].$$  \hspace{1cm} (16)$$

The results on disclosure then depend on the crucial term $[a(\frac{\gamma a}{c})^t]$. Because $\gamma$ influences effort only, its effect on profit is simply $\gamma^t$, which is convex or concave depending on the magnitude of $t$ relative to unity.\(^{13}\) Next, consider $a$. Note that the effect on effort is the same as with $\gamma$, but there is an additional multiplicative effect of $a$ internalized directly on productivity by the principal. That is, the agent and the principal both internalize the effect of productivity. The total effect then is transformed from $a^t$ to $a^{t+1}$ which is always convex, making transparency optimal. On the cost of effort side, we have that effort is inversely related to cost and it is convex in the cost parameter. The effect on profit is $c^{-t}$ which is convex, for all $t \geq 0$, as is the case of a productivity effect.\(^{14}\) Whence, transparency is optimal in each of the latter two cases. The core issue is whether the equilibrium payoff function is concave (non-disclosure is best) or convex (disclosure is best) in the information variable and the source of the hidden information determines this in the constant elasticity model.

### 3.3. Information and Motivation in the Constant Elasticity Model

In this section, we generalize our constant elasticity model to the case of two sources of hidden information and apply it to the situation where the release of "bad" or "discouraging" information can de-motivate the agent, whereas the release of good news can lead to greater motivation. Sup-

\(^{13}\)If we had modeled better fit as a decrease in effort cost in the form of hidden information entering as $e^\gamma/\mu$, then $\mu$ would replace $\gamma$ in the crucial term in (16). The results are the same.

\(^{14}\)Replacing cost enhancing hidden information with utility discounting hidden information of the form $w/\eta - e^\gamma$, results in $\eta$ replacing $c$ in the crucial term (16). The results are the same.
pose that greater motivation leads to a deterministic decrease in the agent’s effort cost and that
demotivation leads to an increase in effort cost. Moreover, suppose that good news takes the
form of a greater productivity of generating cash flow or a greater utility and conversely for bad
news. If news and motivation are connected in this manner, then how is the optimality of disclosure
affected? Our constant elasticity model can be altered to consider this question.

Let good news take the form of $i_H$ and bad news $i_L$, where $i = \gamma, a$. Assume that with probability
$p$ the agent will experience good news and high motivation (low effort cost), $(i_H, c_L)$, and with
probability $(1 - p)$ the agent experiences bad news and low motivation (high effort cost), $(i_L, c_H)$.
The agent’s problem in any given state $(i, c)$ for the case of non-disclosure can be written as

$$
\max_{\{e\}} p(\beta i H e^S x - c_L e^V) + (1 - p)(\beta i L e^S x - c_H e^V).
$$

The solution is

$$
e = e^{x \beta E(i)} \frac{v}{E(c)^{e}}.
$$

For the case of disclosure, we replace $\frac{E(i)}{E(c)}$ with the actual state $\frac{i_H}{c_L}$ or $\frac{i_L}{c_H}$. It is clear that the results
on the optimality of $\alpha = 0$ and the fact that the participation constraint is non-binding, which
hold true in the case of hidden information on productivity, hold true in this case. Further, from
previous cases, the principal’s optimal $\beta$ is given by $t/(1 + t) = e/v$.

Now let us compare utilities and profits under disclosure versus non-disclosure. For the case of
utility, the source of news is irrelevant. We have

$$
E^d(\tilde{u}) - E^n(\tilde{u}) = (x^{t + 1}) \left( \frac{t^{2t + 1}}{(1 + t)^{2t + 2}} \right) \left[ \frac{E(i)^{t + 1}}{E(c)^{t + 1}} - p \frac{t^{2t + 1}}{t L e^S} - (1 - p) \frac{t^{2t + 1}}{t H e^S} \right], \text{ for } i = \gamma, a.
$$

\footnote{As pointed out above, in Benabou and Tirole (2003), more motivation or self confidence is modeled as a better signal on the information hidden to the agent which could be hidden information on effort cost or hidden information on cash flow productivity. A better signal on effort cost or productivity is then analogous to our deterministic decrease in effort cost.}
For profit, the source of news does matter as in the above. If news concerns productivity we have

\[ E^n(\pi) - E^d(\pi) = a^{t+1} \frac{t^2}{(1+t)^{2t+1}} \left[ \frac{E(a)^{t+1}}{E(c)^t} - p \frac{a_H^{t+1}}{c_L} - (1-p) \frac{a_L^{t+1}}{c_H} \right], \]

whereas if it concerns utility we have

\[ E^n(\pi) - E^d(\pi) = a^{t+1} \frac{t^2}{(1+t)^{2t+1}} \left[ \frac{E(\gamma)^{t+1}}{E(c)^t} - p \frac{\gamma_H^{t+1}}{c_L} - (1-p) \frac{\gamma_L^{t+1}}{c_H} \right]. \]

For utility, in all cases of the source of news, and for profit, in the case of news about productivity, the question of whether non-disclosure or disclosure is better for profit or utility boils down to

\[ \frac{E(i)^{t+1}}{E(c)^t} - p \frac{i_H^{t+1}}{c_L} - (1-p) \frac{i_L^{t+1}}{c_H} \geq 0, i = a, \gamma. \] (17)

It can be shown that (17) is equivalent to

\[ \frac{E(\gamma)^t}{E(c)^t} - \hat{p} \frac{\gamma_H^t}{c_L} - (1-\hat{p}) \frac{\gamma_L^t}{c_H} \geq 0, \] (17')

where \( \hat{p} \equiv \left( \frac{i_H}{E(i)} \right) p \in (p, 1). \) If the source of news is utility, the effect on profit rests on

\[ \frac{E(\gamma)^t}{E(c)^t} - p \frac{\gamma_H^t}{c_L} - (1-p) \frac{\gamma_L^t}{c_H} \geq 0. \] (18)

Using (17) and (18), we can address the question of transparency when disclosure affects motivation.

Proposition 5. Suppose that the release of information on productivity or on utility impacts the cost of effort through the motivation or demotivation of the agent in the sense that good news generates low effort cost and bad news generates high effort cost. Then we have the following results.
(i) If \( t > 1 \), then it is better to disclose in terms of both utility and profit, regardless of the type of hidden information.

(ii) If \( t < 1 \), then it can be better not to disclose in terms of both utility and profit, regardless of the type of hidden information. Sufficiency conditions for non-disclosure to dominate are as follows:

(a) If there is hidden information on utility, profit is greater under non-disclosure if any one of the factors which makes the variance of \( c_i \) or \( \gamma_i/c_j \) small:

\[
c_H \rightarrow c_L \text{ and/or } \frac{\gamma_H}{c_L} \rightarrow \frac{\gamma_L}{c_H}.
\]

\( (*) \)

(b) If there is hidden information on productivity, then non-disclosure raises utility and profit if \( (*) \) and, in addition, the remaining factor which lowers the variance of \( i_k \) is met:

\[
i_H \rightarrow i_L.
\]

\( (**) \)

If there is hidden information on utility, then non-disclosure raises utility if the same conditions are met.

Non-disclosure dominates when motivation comes into play only if production circumstances are unfavorable, and otherwise, disclosure is best for profit and utility. If production circumstances are unfavorable, then non-disclosure can raise both profit and utility. If the hidden information is utility (Proposition 5 (ii)(a)), then conditions conducive to having non-disclosure raise profit are a small spread between high and low effort cost (little effect of motivation) or a small spread between the ratio of high utility to low effort cost and low utility to high effort cost. The former condition allows the beneficial effects of non-disclosure to dominate as before when there was no effect of high or low \( \gamma \) on effort cost. The latter condition guarantees that there is little difference between the
expectation of the ratio $E(i/c)$ and the ratio of the expectations $E(i)/E(c)$. This allows the low $t$ to induce concavity into the equilibrium profit function in the information variable so that non-disclosure dominates. If again production circumstances are unfavorable and hidden information is utility or productivity of effort (Proposition 5 (ii)(b)), then non-disclosure raises utility and profit if these same conditions are met and there is a small spread between high and low utility or productivity (little effect of good versus bad news on productivity or utility). This condition guarantees that there is little difference between $\hat{p}\gamma_L^{1/\gamma} - (1 - \hat{p})\gamma_H^{1/\gamma}$ and $p\gamma_L^{1/\gamma} - (1 - p)\gamma_H^{1/\gamma}$, through making $\hat{p} \to p$, so that when combined with either of the conditions of Proposition 5 (ii)(a), the low $t$ can induce concavity into objective functions and allow non-disclosure to dominate. Each of these conditions has the effect of lowering the variance of the motivation effect on cost or the effect of good news on productivity or utility.

4. Extensions

Do the results for the constant elasticity case generalize to more general cost of effort function and a probability of high cash flow function, the case of risk aversion on the part of the agent, and a more general probability distribution for the hidden information variable? This section address these questions.

In order to suppress the signalling of information to the agent, let us consider the alternative time line discussed above where the principal constructs the contract before learning the hidden information of the agent. In stage 0, the principal commits to disclosure or non-disclosure. In stage 1, the principal sets the contract, which, in the case of disclosure, is a menu of contracts with each component of the menu depending on the hidden information and, in the case of non-disclosure it is a contract based on the prior of the hidden information variable. In stage 2, the principal becomes informed and discloses or does not disclose that information, and, in stage 3, the agent
selects effort.

We will formulate the generalized model under the assumption of hidden information regarding utility and later point out how the results are modified with the other two types of hidden information. Let the agent’s effort now be denoted $E$ and let the probability that the return is high be given by $p(E)$, where $p(0) = 0$, $p' > 0$, and $p'' < 0$. The cost of effort is given by $\tilde{C}(E)$, where $\tilde{C}(0) = 0$, $\tilde{C}'$, $\tilde{C}'' > 0$. Under these assumptions the agent’s net utility is $\hat{u} = \gamma u(w) − \tilde{C}(E)$, if $\gamma$ is known, where $u(0) = 0$, $u' > 0$, and $u'' \leq 0$. Let $\gamma$ be a draw of a random variable with density (or probability function in the discrete case) $q(\gamma)$. Let $E(\gamma) \equiv \tilde{\gamma}$.

For the case of disclosure, the principal specifies a $(\beta(\gamma), \alpha(\gamma))$ for each $\gamma$. When the agent is notified of type, he would solve

$$\max_{\{E\}} \gamma u(\alpha(\gamma) + \beta(\gamma)x)p(E) + (1 − p(E))u(\alpha(\gamma)) − \tilde{C}(E).$$

We will use a change of variable to simplify this problem. Define $e \equiv p(E)$, so that $E = p^{-1}(e)$. Then define $C(e) \equiv \tilde{C}(p^{-1}(e))$. The agent’s problem is then modified to read

$$\max_{\{e\}} \gamma u(\alpha(\gamma) + \beta(\gamma)x)e + (1 − e)u(\alpha(\gamma)) − C(e).$$

The function $p^{-1}(e)$ is strictly convex and satisfies $p^{-1}(0) = 0$, so that under our assumptions on $\tilde{C}$, $C$ is an increasing composition of a strictly convex function, whence it is strictly convex with $C(0) = 0$, and $C'$, $C'' > 0$. Let $\Delta_u \equiv u(\beta(\gamma)x + \alpha(\gamma)) − u(\alpha)$. The first order condition to the agent’s problem is

$$\gamma \Delta_u = C''(e).$$

We can now define $e(\gamma \Delta_u) = C''^{-1}(\gamma \Delta_u)$.  

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Note that the effective marginal cost function \( C' \) is increasing \( (C'' > 0) \) and that our assumptions permit it to be convex or concave. We wish to consider these two cases. If \( C' \) is convex, then the inverse marginal cost \( e(\gamma \Delta_u) \) is concave, \( e'' < 0 \). Intuitively, this is the case where \( p \) is very concave and/or \( \tilde{C} \) is very convex. For the constant elasticity case, this would constitute an unfavorable situation, \( t < 1 \). If \( C' \) is concave, then \( e(\gamma \Delta_u) \) is convex, \( e'' > 0 \). This is the case where \( p \) is not very concave and and/or \( C' \) is not very convex, so that in the constant elasticity case this is a favorable situation, \( t > 1 \).

Next, we want to consider the principal’s participation constraint. Here, as in the simple model, we have

**Lemma 3.** At an optimum to the principal’s problem with hidden information regarding the agent’s utility, the participation constraint is non-binding and the optimal flat salary is \( \alpha = 0 \).

The principal’s problem can be reduced to

\[
\max_{\{\beta\}} (1 - \beta)x e(\gamma u(x\beta)).
\]

The first order condition \(-xe' + (1 - \beta)e'\gamma u'x^2 = 0\) implicitly defines the optimal contract as a function of \( \gamma, \beta = \beta(\gamma) \), with

\[
\frac{\partial \beta}{\partial \gamma} = \frac{xe'(u - (1 - \beta) xu') - (1 - \beta)x^2 u' \gamma e''u}{-2x^2 e' \gamma u' + (1 - \beta)x^2 \gamma^2 (u')^2 e''}. \tag{19}
\]

Given that the second order condition is met and the denominator of (19) is negative, the numerator can be positive or negative because \( e'' \) and \( u - (1 - \beta) xu' \) can take on either sign.\(^\text{16}\) If non-disclosure is the regime, then replace \( \gamma \) in the principal’s and the agent’s problem with the prior \( \bar{\gamma} \).

As we have seen in the constant elasticity case, the optimality of disclosure versus non-disclosure

\(^{16}\text{For example, in the case of risk neutrality, } u - (1 - \beta) xu' = x(1 - 2\beta) \text{ and the latter can be of either sign.} \)
depends on the core condition regarding the curvature (concavity versus convexity) of the equilibrium payoff functions. If a party’s payoff is concave in the information variable, then non-disclosure is optimal for that party, and the converse holds if it is convex. For hidden information on utility, equilibrium profit is \( \Pi(\gamma) = (1 - \beta(\gamma))xe(\gamma u(x\beta(\gamma))) \), while equilibrium utility is \( U(\gamma) = \gamma u(\beta(\gamma)x)e(\gamma u(x\beta(\gamma))) - C(e(\gamma u(x\beta(\gamma)))) \). To examine curvature we compute the second derivative of each of these expressions. After simplification, we have, in equilibrium,

\[
\Pi''(\gamma) = \beta' xe'(-u + (1 - \beta)u'x) + (1 - \beta)ux(u + \gamma u'x \beta')e'', \tag{20}
\]

\[
U''(\gamma) = (2u'\beta' + \gamma(\beta')^2 xu'' + \gamma u'\beta'')xe + (u + \gamma xu'\beta')^2 e'. \tag{21}
\]

In the special case where \( \beta' = 0 \) (the constant elasticity model implies this case), we have that the sign of \( \Pi'' \) is that of \( e'' \). It follows that if inverse effective marginal cost, \( e \), is concave in \( \gamma \), so is profit, and non-disclosure dominates. The converse holds if inverse marginal cost is convex, so that disclosure is optimal for the principal. In this same case, (21) says that \( U \) is convex in \( \gamma \), so that disclosure is better for the agent. These are our previous results. However, if \( \beta' \neq 0 \), it is clear from (20)-(21) that disclosure or non-disclosure can dominate depending on functional forms. Most important is that the agent can be hurt by disclosure if the contract (\( \beta \)) varies with the disclosure rule. That is, it is possible for \( U \) to be concave in the information variable. An example makes the point. If \( C(e) = \exp(e) \), and the agent is risk neutral, then \( e(\gamma u) = \ln(\gamma x\beta) \). We have that \( \beta \) is implicitly defined by \( (\beta + \beta \ln x\beta \gamma - 1) = 0 \) and that \( U'' = x \frac{\beta^2}{\gamma(\beta+1)} (x(1 + \beta) - \ln x\beta \gamma) \). The sign of this expression depends on the term \( x(1 + \beta) - \ln x\beta \gamma \). It is possible to find an \( x \) such that for an interval of \( \gamma \in [\underline{\gamma}, \bar{\gamma}] \), \( U'' < 0 \). By making this interval a superset of the support of \( \gamma \), we would have that non-disclosure dominates. For example, \( x = 1.2 \) and \( \underline{\gamma} = 15, \bar{\gamma} = 50 \) generate this
result.\footnote{For these parameter values, $E$ is greater than unity. However, we can measure $E$ in percentage points and rescale the units of $x$.} This exponential cost example (with a risk neutral agent) will be used in what follows to generate a very concave inverse marginal cost, $e(\cdot)$, which in turn can induce the optimality of non-disclosure.

Next, consider the case where there is hidden information regarding productivity. Using the same techniques as above, profit and utility are given by $\Pi(a) = (1 - \beta(a))xe(au(x\beta(a)))$ and $U(a) = au(\beta(a))e(au(x\beta(a))) - C(e(au(x\beta(a))))$.\footnote{Lemma 3 can be modified to include the cases of hidden information on productivity or cost.} Utility is identical in functional form to the case of hidden information regarding utility, so that the same analysis and conclusions as above apply. Profit’s functional structure has been altered by the multiplicative term $a$. The pertinent derivative for determining the curvature of $\Pi$ is

$$\Pi''(a) = -\beta'xa(eu + (1 - \beta)xe'u') + (1 - \beta)x(2e'u + au''(u + au'x\beta')).$$

(22)

If we have the special case where $\beta' = 0$, then the sign of (22) depends on $(2e' + au'')$ which can be positive or negative. If we specialize even further to the case of constant elasticity model with $\beta' = 0$, $\text{sign}(2e' + au'') = \text{sign}(2 + 1/(v - \varepsilon)) > 0$ and disclosure is optimal as was shown above in the basic model. What is interesting is that even when the source of information is about productivity and we deviate from the constant elasticity model, it is possible for non-disclosure to be optimal. For the general case, where the contract exhibits $\beta' \neq 0$, expression (22) can be positive or negative. For the exponential cost example above, the sign of (22) can be shown to be negative for $x = 30$ and $\gamma \in (0.06, 9)$.

Finally, suppose that the hidden information emanates from the agent’s cost of effort. In this case, profit and utility are given by $\tilde{\Pi}(c) = (1 - \beta(c))xe(c^{-1}u(x\beta(c)))$ and $\tilde{U}(c) = u(\beta(c)x)e(c^{-1}u(x\beta(c)))$—
\[ eC(e(c^{-1}u(x;\beta(c)))) \], such that

\begin{align*}
\tilde{\Pi}''(c) &= c^{-2}\beta'xe'(u - (1 - \beta)u'x) + 2(1 - \beta)c^{-3}uxe' - (1 - \beta)uxe^{-2}e''(-c^{-2}u + c^{-1}u'\beta'x), \\
\tilde{U}''(c) &= (u''(x;\beta')^2 + u'u\beta''e + e'(u'x;\beta' - C')((-c^{-2}u + c^{-1}u'x;\beta').
\end{align*}

If \( \beta' = 0 \), then \( \tilde{\Pi}'' = 2(1 - \beta)c^{-3}uxe' + (1 - \beta)u^2xc^{-4}e'' \) which can be positive or negative, but in the special case of constant elasticity, \( \text{sign}(\tilde{\Pi}'') = \text{sign}(1 + 1/(u - \varepsilon)) > 0 \), as we saw above. Disclosure is optimal for the principal. With \( \beta' = 0 \), \( \tilde{U}'' = (-e'C''(-c^{-2}u) > 0 \), so that disclosure is best for the agent. However, if \( \beta' \neq 0 \), surprising results can obtain. Consider profit in our exponential cost example. It can be shown that for \( x = 10 \) and \( \gamma \in [0.13, 1) \), we have that \( \tilde{\Pi}'' < 0 \). With respect to utility, in the same example, it can be shown that \( \tilde{U}'' < 0 \), for all \( \gamma \). Thus, non-disclosure is optimal for the agent.

What we take away from the generalized model is that in cases where the contract optimally varies with hidden information variable and the disclosure regime, strong diminishing returns to effort in the production of expected cash flow and/or strongly rising marginal cost of effort can lead to profit and/or utility being concave in the hidden information variable. When this is true, non-disclosure is optimal. Although the source of hidden information will change the forms of the principal's and agent's payoff functions, the possibility of the optimality of non-disclosure is present for all three hidden information sources, in contrast to the constant elasticity version of the problem.

5. Conclusion

This paper illustrates the point that, depending on the source of hidden information, non-transparency in agency relationships can be optimal. We initially formulate a model in which the principal's in-
centive payment does not depend on the information variable and, thus, the disclosure policy. This formulation isolates the pure effect of the disclosure rule. We accomplish this by assuming that the cash flow technology and cost of effort take on the constant elasticity functional form. Moreover, we assume risk neutrality of all parties and limited liability on the part of the agent. In this basic model, the agent always benefits from more transparency and so does the principal if the hidden information concerns the agent’s effort cost or productivity in producing cash flow. However, if there is a single source of hidden information and the hidden information concerns the agent’s utility of cash flow, non-transparency is better for the principal if the firm faces an unfavorable set of circumstances in the sense that the agent’s effort elasticity is low or his effort cost elasticity is high. Such assumptions make the principal’s payoff concave in the information variable. If there is sufficient unfavorability or concavity, then total surplus can be greater with non-disclosure. In the case where the agent is risk neutral and the production situation is quite unfavorable, decreases in favorability can actually increase the value of non-disclosure. Conversely, if the production situation is favorable, then increases in favorability increase the value of disclosure. If the release of good news concerning the agent’s productivity or utility generates greater motivation of the agent which manifests itself in lower effort cost and conversely for bad news, then non-disclosure can be optimal for both the principal and the agent. It is necessary that production circumstances be unfavorable and, given this condition, non-transparency is best if the variances of the hidden information variables are small. A key message of the basic model is that when the principal’s payoff function is concave in the hidden information variable, non-disclosure can be optimal.

If we alter the basic model to allow for general cost of effort and probability of high cash flow functions, a general probability distribution for the hidden information variable and risk aversion on the part of the agent, then we find that the results of the constant elasticity model can be overturned as a result of the fact that the principal’s optimal contract changes with hidden information and
the disclosure rule. In fact, if the cash flow technology is sufficiently concave and/or effort cost sufficiently convex, the principal’s and the agent’s payoff functions can be concave in the information variable making non-disclosure optimal for either or both agents.

Appendix

Proof of Lemma 1: We show the result for the case of non-disclosure. The case of disclosure is identical with \( \gamma \) replacing \( E(\gamma) \). Divide both sides of (2) by \( e^\varepsilon \) and we have, using (1), that

\[
E(\gamma) \beta x - \left[ \frac{\varepsilon \beta x E(\gamma)}{\varepsilon} \right] \geq - \frac{E(\gamma) \alpha}{e^\varepsilon}.
\]

Rewriting

\[
E(\gamma) \beta x (1 - \varepsilon/v) \geq - \frac{E(\gamma) \alpha}{e^\varepsilon}.
\]

The left side of this expression is strictly positive while the right side is non-positive so that strict inequality holds and (2) is non-binding.

Take the derivative of the principal’s objective function with respect to \( \alpha \) and we obtain

\[
\varepsilon (1 - \beta) e^{\varepsilon - 1} x \frac{\partial e}{\partial \alpha} - 1,
\]

where, from (1),

\[
\frac{\partial e}{\partial \alpha} = 0.
\]

It follows that the first order condition for the optimal \( \alpha \) implies

\[
\varepsilon (1 - \beta) e^{\varepsilon - 1} x \frac{\partial e}{\partial \alpha} - 1 = -1 < 0,
\]
so that \( \alpha = 0 \), given (2). \( \blacksquare \)

**Proof of Proposition 1:** We have shown that the value of disclosure is positive. We next show that \( E^d(\hat{u}) - E^n(\hat{u}) \) is increasing in \( t \) under the conditions specified. Write

\[
E^d(\hat{u}) - E^n(\hat{u}) = \{(x^{t+1})(\frac{t^{2t+1}}{(1+t)^{2t+2}})\}\{(q\gamma_H^{t+1} + (1-q)\gamma_L^{t+1}) - [q\gamma_H + (1-q)\gamma_L]^{t+1}\}. \tag{a.1}
\]

The first term, \( (x^{t+1}) \), and the second term, \( (\frac{t^{2t+1}}{(1+t)^{2t+2}})J \), where \( J \equiv [(q\gamma_H^{t+1} + (1-q)\gamma_L^{t+1}) - (q\gamma_H + (1-q)\gamma_L)]^{t+1} \), are strictly positive. We have that (a.1) becomes

\[
\{(x^{t+1})(\frac{t^{2t+1}}{(1+t)^{2t+2}})J\}.
\]

Given \( x \geq 1 \), \( x^{t+1} \) is non-decreasing in \( t \), so it suffices to show that the second term is increasing in \( t \). Taking the derivative

\[
\frac{\partial}{\partial t}[(\frac{t^{2t+1}}{(1+t)^{2t+2}})J] > 0 \text{ iff } \frac{d}{dt}(\frac{t^{2t+1}}{(1+t)^{2t+2}})J + \frac{\partial J}{\partial t}(\frac{t^{2t+1}}{(1+t)^{2t+2}}) > 0. \tag{a.2}
\]

We have that \( \frac{d}{dt}(\frac{t^{2t+1}}{(1+t)^{2t+2}}) = (\frac{t^{2t+1}}{(1+t)^{2t+2}})(1/t + 2 \ln t - 2 \ln(1+t)) \) and \( \frac{\partial J}{\partial t} = q\gamma_H^{t+1} \ln \gamma_H + (1-q)\gamma_L^{t+1} \ln \gamma_L - (q\gamma_H + (1-q)\gamma_L)^{t+1} \ln(q\gamma_H + (1-q)\gamma_L) \). Using these results, (a.2) can be rewritten as

\[
q\gamma_H^{t+1}(\ln \gamma_H - z) + (1-q)\gamma_L^{t+1}(\ln \gamma_L - z) - (q\gamma_H + (1-q)\gamma_L)^{t+1}(\ln(q\gamma_H + (1-q)\gamma_L) - z) > 0, \tag{a.3}
\]

where \( z \equiv (2 \ln(t+1) - 1/t - 2 \ln t) \). First note that (a.3) = 0, if \( q \in \{0, 1\} \). Given this result, if the left side of (a.3) is strictly concave in \( q \), for all \( t \), then it is positive for all \( q \in (0, 1) \) and all \( t > 0 \), so that the result would hold. Let \( G \equiv (\gamma_L + q(\gamma_H - \gamma_L)) > 1 \). Compute the second order partial
derivative of the left side of (a.3), \( LS(a.3) \), with respect to \( q \) to see if it is negative. We have

\[
\frac{\partial^2 LS(a.3)}{\partial q^2} = -(\gamma_H - \gamma_L)^2 G^{t-1}(2 + 3t + t(t + 1) \ln G + 2t(t + 1)(\ln t - \ln(t + 1)) < 0.
\]

Given \( \gamma_L \geq 1 \), \( \frac{\partial^2 LS(a.3)}{\partial q} \) is strictly negative for all \( t > 0 \). To see this note that \( -(\gamma_H - \gamma_L)^2 G^{t-1} < 0 \), for all \( t \geq 0 \) so that it suffices to show that \( (2 + 3t + t(t + 1) \ln G + 2t(t + 1)(\ln t - \ln(t + 1)) > 0, \)

for \( t \geq 0 \). At \( t = 0 \), the latter is equal to 2, and, for \( t \to \infty \) it tends to \(+\infty\). It suffices to show that at any \( \hat{t} \) such that

\[
\frac{\partial}{\partial \hat{t}}(2 + 3\hat{t} + t(\hat{t} + 1) \ln G + 2\hat{t}(\hat{t} + 1)(\ln \hat{t} - \ln(\hat{t} + 1)) = 0,
\]

the value of \((2 + 3\hat{t} + \hat{t}(\hat{t} + 1) \ln G + 2\hat{t}(\hat{t} + 1)(\ln \hat{t} - \ln(\hat{t} + 1)) > 0 \). Computing

\[
\frac{\partial}{\partial \hat{t}}(2 + 3\hat{t} + t(\hat{t} + 1) \ln G + 2\hat{t}(\hat{t} + 1)(\ln \hat{t} - \ln(\hat{t} + 1)) = 5 + (1 + 2\hat{t}) \ln G + (2 + 4\hat{t})(\ln t - \ln(1 + t)) = 0.
\]

Solve this equation for \((\ln \hat{t} - \ln(1 + \hat{t})) = (-5 - (1 + 2\hat{t}) \ln G)/(2 + 4\hat{t}) \) and substitute into \((2 + 3\hat{t} + \hat{t}(\hat{t} + 1) \ln G + 2\hat{t}(\hat{t} + 1)(\ln \hat{t} - \ln(\hat{t} + 1)) \) so as to obtain

\[
\frac{(2 + 2\hat{t} + \hat{t}^2)}{(1 + 2\hat{t})} > 0.
\]

The result holds.  ■

**Proof of Proposition 2:** The first part of the proposition is shown in the text from (9) and (10). The comparative static part follows the same logic as in the proof of Proposition 1.

Let \( t > 1 \) and define \( \hat{J} \equiv [(q\gamma^t_H + (1 - q)\gamma^t_L) - (q\gamma_H + (1 - q)\gamma_L)^t]. \) We have

\[
E^d(\pi) - E^n(\pi) = x^{t+1} \frac{\hat{t}^{2t}}{(1 + \hat{t})^{2t+1}} \hat{J}.
\] (a.4)
Because $x \geq 1$, $x^{t+1}$ is non-decreasing and all terms in (a.4) are strictly positive, it suffices to show that

$$\frac{\partial}{\partial t} \left[ \frac{t^2}{(1+t)^{2t+1}} \right] = \frac{d}{dt} \left( \frac{t^2}{(1+t)^{2t+1}} \right) + \frac{\partial}{\partial t} \left( \frac{t^2}{(1+t)^{2t+1}} \right) > 0. \quad (a.5)$$

We have that

$$\frac{d}{dt} \left( \frac{t^2}{(1+t)^{2t+1}} \right) = \left( \frac{t^2}{(1+t)^{2t+2}} \right) \left( 1 + 2(1+t) \ln t - 2(1+t) \ln[1+t] \right) \frac{(1+t)}{(1+t)}$$

and

$$\frac{\partial}{\partial t} = q^t_H \ln \gamma_H + (1-q) \gamma_L^t \ln \gamma_L - (q^t_H + (1-q) \gamma_L)^t \ln(q^t_H + (1-q) \gamma_L).$$

Then (a.5) can be rewritten as

$$q^t_H \gamma_H^t (\ln \gamma_H - \hat{z}) + (1-q) \gamma_L^t (\ln \gamma_L - \hat{z}) - (q^t_H + (1-q) \gamma_L)^t (\ln(q^t_H + (1-q) \gamma_L) - \hat{z}) > 0, \quad (a.6)$$

where $\hat{z} = -\frac{(1+2(1+t) \ln t - 2(1+t) \ln[1+t])}{(1+t)}$. Note that (a.6) $= 0$, if $q \in \{0,1\}$. Given this result, if the left side of (a.6) is strictly concave in $q$, for all $t$, then it is positive for all $q \in (0,1)$ and all $t > 0$, so that the result would hold. Again let $G \equiv (\gamma_L + q(\gamma_H - \gamma_L)) > 1$. Compute the second order partial derivative of the left side of (a.6), $LS(a.5)$, with respect to $q$ to see if it is negative. We have

$$\frac{\partial^2 LS(a.5)}{\partial q^2} = -\frac{(-\gamma_H - \gamma_L)^2 G_t^{-2}[-1 + 3t^2 + t(t^2 - 1) \ln G + 2t(t^2 - 1)(\ln t - \ln(1+t))]}{(1+t)}.$$

With $-(-\gamma_H - \gamma_L)^2 G_t^{-1}/(1+t) < 0$, it suffices to show that

$$[-1 + 3t^2 + t(t^2 - 1) \ln G + 2t(t^2 - 1)(\ln t - \ln(1+t))] > 0. \quad (a.7)$$
As \( t \to 1 \), (a.7) \( \to 2 \), as \( t \to \infty \), (a.7) \( \to \infty \), and \( \frac{\partial}{\partial t}(a.7) = (3t^2 - 1) \ln G + 2[-1 + 4t + (3t^2 - 1)(\ln t + \ln(t + 1))] > 0 \), for \( t > 1 \). Thus, (a.7) holds.

Next let \( t < 1 \) consider the value of non-disclosure \( \Omega(t) \equiv E^n(\pi) - E^d(\pi) = v(t)\tilde{J}(t) \), where \( \tilde{J}(t) \equiv [(q\gamma_H + (1 - q)\gamma_L)^t - (q\gamma_H(1 - q)\gamma_L^t)] > 0 \) and \( v(t) \equiv x^{t+1}\frac{t^2}{(1+t)^{2+1}} \). We have

\[
\Omega'(t) = [G^t \ln G - (q\gamma_H \ln \gamma_H + (1 - q)\gamma_L \ln \gamma_L)]v(t)
+ v(t)[1 - 2(1 + t)(\ln(1 + t) - \ln t) + (1 + t)\ln x]\tilde{J}(t)
\]

(a.8)

Take the following limits. First,

\[
\Omega'(0) = [\ln G - (q \ln \gamma_H + (1 - q) \ln \gamma_L)]x > 0,
\]

by the concavity of \( \ln x \) in \( x \). Second,

\[
\Omega'(1) = [\ln(G^1) - (q \ln \gamma_H^1 + (1 - q) \gamma_L^1)]^2 < 0,
\]

by the convexity of \( \ln x^x \) in \( x \). Given that \( \Omega \) is continuous in \( t \), there is a \( t' \) and a \( t'' > t' \), \( t', t'' \in (0, 1) \) such that \( \Omega'(t) > 0 \) if \( t \in (0, t') \) and \( \Omega'(t) < 0 \) if \( t \in (t'', 1) \).

**Proof of Proposition 3:** Let \( TS^i \) denote total surplus under policy \( i = n, d \). Construct

\[
TS^n - TS^d = [E^n(\pi) - E^d(\pi)] + [E^n(\tilde{u}) - E^d(\tilde{u})] = \frac{x^{t+1}t^{2t}}{(1 + t)^{2+1}}[\tilde{J} + \frac{t}{(1 + t)}(-J)].
\]

We have that \( \lim_{t \to 1}[TS^n - TS^d] = \frac{x^2}{10}(0 + \frac{1}{2}[(q\gamma_H + (1 - q)\gamma_L)^2 - q\gamma_H^2 + (1 - q)\gamma_L^2]) < 0 \). Thus, the result holds for \( t \) close to unity. Next, consider small \( t \). It suffices to show that \( TS^n(0) - TS^d(0) = 0 \) and that \( TS^n(t) - TS^d(t) > 0 \). We have \( \lim_{t \to 0}[TS^n - TS^d] = 1[0 + 0 \cdot 0] = 0 \). Compute \( TS^n(0) - TS^d(0) = 0 \).
\[ v'[\bar{J} + \frac{t}{(1+t)^2}(-J)] + v[d\bar{J}/dt + \frac{1}{(1+t)^2}(-J) + \frac{t}{(1+t)}(-dJ/dt)], \] where, again, \( v = \frac{x^{t+1}2t}{(1+t)^2} \). We have that

\[
v' = -2(1 + t)^{-2t-1} \ln(1 + t) \cdot (x^{t+1}t^{2t}) - (2t + 1)(1 + t)^{-2t-t}(x^{t+1}t^{2t}) + x^{t+1} \ln x \cdot (1 + t)^{-2t-1}t^{2t} + [2t^2 \ln t + 2t(t^{2t-1})](1 + t)^{-2t-1}x^{t+1}.
\]

The \( \lim_{t \to 0} v' = 0 - x + x \ln x + (-\infty)(x) = -\infty \). Further, \( v(0) = x \) and \([\bar{J}(0) + \frac{0}{1+0}(-J(0))] = 0\).

Compute the derivative

\[
[d\bar{J}/dt + \frac{1}{(1+t)^2}(-J) + \frac{t}{(1+t)}(-dJ/dt)] = E(\gamma)^t \ln E(\gamma) - q\gamma_H^t \ln \gamma_H - (1 - q)\gamma_L^t \ln \gamma_L + \frac{1}{(1+t)^2}(E(\gamma)^{t+1} - q\gamma_H^{t+1} - (1 - q)\gamma_L^{t+1}) + \frac{t}{(1+t)}(E(\gamma)^{t+1} \ln E(\gamma) - q\gamma_H^{t+1} \ln \gamma_H - (1 - q)\gamma_L^{t+1} \ln \gamma_L).
\]

The \( \lim_{t \to 0} [d\bar{J}/dt + \frac{1}{(1+t)^2}(-J) + \frac{t}{(1+t)}(-dJ/dt)] = \ln E(\gamma) - q \ln \gamma_H - (1 - q) \ln \gamma_L > 0 \), by concavity of \( \ln x \). Combining terms

\[
\lim_{t \to 0} (TS^{\alpha t} - TS^{\alpha t}) = x(\ln E(\gamma) - q \ln \gamma_H - (1 - q) \ln \gamma_L) > 0.
\]

The result then holds. ■

**Proof of Lemma 2:** Dividing (11) by \( e^\varepsilon \) and rearranging

\[
E(a)\beta x - e^{v-\varepsilon} \geq -\frac{\alpha}{e^\varepsilon}.
\]

Substitute for \( e \) from (9)

\[
E(a)\beta x - \frac{\varepsilon x\beta}{v}E(a) \geq -\frac{\alpha}{e^\varepsilon}.
\]
The left side of this expression is $E(a)\beta x(1 - \frac{v}{\bar{v}}) > 0$, while the right side is $-\frac{\alpha}{E(c)e^\varepsilon} \leq 0$. Thus, (11) is non-binding.

Next, divide (12) by $e^\varepsilon$ and rewrite

\[
\frac{\beta x}{E(c)} - e^{v-\varepsilon} \geq -\frac{\alpha}{E(c)e^\varepsilon}.
\]

Substitute for $e$ from (10)

\[
\frac{\beta x}{E(c)} - \varepsilon e^{v-\varepsilon} \geq -\frac{\alpha}{E(c)e^\varepsilon}.
\]

The left side of this expression is $\frac{\beta x}{E(c)}(1 - \frac{v}{\bar{v}}) > 0$, while the right side is $-\frac{\alpha}{E(c)e^\varepsilon} \leq 0$. It follows that (12) is non-binding.

The same argument as in Lemma 1 can be used to show that $\alpha = 0$. The case where the principal discloses $a$ or $c$ can be shown by replacing the expectation with the proper state value. Thus, the results hold. ■

**Proof of Proposition 4:** This proof is contained in the text.

**Proof of Proposition 5:** (i) Algebraic manipulation yields the result

\[
\frac{E(i)}{E(c)} - p \frac{i_H}{c_L} - (1 - p) \frac{i_L}{c_H} < 0, i = a, \gamma,
\]

so that

\[
\left(\frac{E(i)}{E(c)}\right)^t - [p \frac{i_H}{c_L} - (1 - p) \frac{i_L}{c_H}]^t < 0, i = a, \gamma, t > 0.
\] (a.9)

If $t > 1$, then

\[
[p \frac{i_H}{c_L} - (1 - p) \frac{i_L}{c_H}]^t < p \frac{\gamma_L}{c_{L}} - (1 - p) \frac{\gamma_L}{c_{H}}, i = a, \gamma
\]

It follows from (18) and (a.9) that profit is greater under disclosure of information about utility/cash.
flow. Next, consider (17) for $t > 1$. Rewriting, we have that (17) holds iff

$$\frac{E(i)^t}{E(c)^t} - \left( \frac{i_H}{E(i)} \right)^t c_H^t - \left( \frac{i_L}{E(i)} \right)^t (1 - p) c_L^t \leq 0,$$

(a.10)

where

$$\left( \frac{i_H}{E(i)} \right)^t c_H^t - \left( \frac{i_L}{E(i)} \right)^t (1 - p) c_L^t > \frac{\gamma^t_H}{c_L^t} - (1 - p) \frac{\gamma^t_L}{c_L^t} \in \left( \frac{i_L}{c_L}, \frac{i_H}{c_L} \right)$$

(a.11)

Condition (a.11) is true because

$$\left( \frac{i_H}{E(i)} \right)^t + \left( \frac{i_H}{E(i)} \right)^t (1 - p) = 1, \left( \frac{i_H}{E(i)} \right)^t (1 - p) = p(1 - p) (i_H - i_L) / E(i) > 0, $$

and

$$1 - p (\frac{i_H}{E(i)} - 1 - p) = -p(1 - p)(i_H - i_L) / E(i) < 0. $$

Using these results (a.11), and (a.10) we have that

$$\frac{E(i)^t}{E(c)^t} - \left( \frac{i_H}{E(i)} \right)^t c_H^t - \left( \frac{i_L}{E(i)} \right)^t (1 - p) c_L^t < 0,$$

so that disclosure dominates non-disclosure with respect to profit and utility/cash flow for the case of hidden information on productivity and also does so with respect to utility when there is hidden information on utility/cash flow.

(ii) Let $t < 1$. Consider the case of hidden information on utility/cash flow and the effect of disclosure on profit. We have that, by concavity,

$$[p(\frac{\gamma_H}{c_L}) - (1 - p)(\frac{\gamma_L}{c_H})]^t > p(\frac{\gamma_H}{c_L})^t + (1 - p)(\frac{\gamma_L}{c_H})^t$$

and that

$$[p(\frac{\gamma_H}{c_L}) - (1 - p)(\frac{\gamma_L}{c_H})]^t > \frac{E(\gamma)^t}{E(c)^t}$$

(a.12)

For non-disclosure to dominate, $\frac{E(\gamma)^t}{E(c)^t} > p(\frac{\gamma_H}{c_L}) + (1 - p)(\frac{\gamma_L}{c_H})$, it suffices that

$$[p(\frac{i_H}{c_L} - (1 - p)(\frac{i_L}{c_H})] - \frac{E(i)}{E(c)} = \frac{(1 - p)(c_L - c_H)(\frac{i_H}{c_L} - \frac{i_L}{c_H})}{p_c + (1 - p)c_H} \equiv \Delta^i, \ i = \gamma,$$
be small. From (a.13), $\Delta^i \to 0$ as $c_H \to c_L$ and $\Delta^i \to 0$ as $\frac{c_H}{c_L} \to \frac{c_L}{c_H}$. Each these conditions is sufficient to lower the $\text{Var}(c) = [1 - 2p(1-p)](c_H - c_L)^2$ or the $\text{Var}(\gamma/c) = [1 - 2p(1-p)](\gamma_H/c_L - \gamma_L/c_H)^2$. Next consider the case of hidden information on utility/cash flow and the effect on utility and the cases of hidden information on productivity and the effects on utility/cash flow and profit.

For these cases, non-disclosure is optimal if

$$\frac{E(i)^t}{E(i)^t} - (\frac{i_H}{E(i)})p(\frac{i_H}{i_L}) - (\frac{i_L}{E(i)})(1-p)(\frac{i_L}{c_H}) > 0, i = \gamma, a.$$  (a.14)

Using (a.12)-(a.14), non-disclosure dominates if both $\Delta^i, i = \gamma, a,$ and

$$p(1-p)(i_H - i_L) \geq 0, i = \gamma, a,$$  (a.15)

are small. For the expressions in (a.13) and (a.14) to be small it suffices to have, in addition to the above conditions for (a.13) to be small, the condition that $i_H \to i_L$. ■

**Proof of Lemma 3:** The principal faces the participation constraint

$$\gamma u(\alpha(\gamma) + \beta(\gamma)x)e + (1 - e)u(\alpha(\gamma)) - c(e) \geq 0.$$  

Divide by $e$ and rewrite

$$\gamma \Delta_u + \frac{u(\alpha(\gamma))}{e} - \frac{c(e)}{e} \geq 0.$$  

Clearly, $\frac{u(\alpha(\gamma))}{e} \geq 0$, so that the participation constraint is non-binding if $\gamma \Delta_u \geq \frac{c(e)}{e}$. From the agent’s incentive compatibility constraint, $\gamma \Delta_u = c'$. Whence the constraint is non-binding if $c'(e) > c(e)/e$. This is true under $c(0) = 0, c', c'' > 0$.

Given this result, the principal’s problem is max $\{\alpha, \beta\} (1 - \beta)x e(\gamma \Delta_u) - \alpha + \lambda_0 \alpha + \lambda_\beta \beta$ with (FOC)
for $\alpha$

$$(1 - \beta)xe'(\gamma(u'(x\beta + \alpha) - u'(\alpha))) - 1 + \lambda_\alpha = 0,$$

with $\lambda_\alpha \geq 0$ and $\lambda_\alpha \alpha = 0$. Because $u'' \leq 0$, we have $(u'(x\beta + \alpha) - u'(\alpha)) \leq 0$. With $(1 - \beta)xe' > 0$, we know that $\lambda_\alpha > 0$ which implies that $\alpha = 0$. 

References


