Cognition-intensive Contracting*

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Abstract

The paper studies cognition-intensive contracting. Parties to a contract covertly engage in information acquisition prior to designing the contract. The paper demonstrates that a single variable, the "relative exposure to the unexpected", underlies a variety of concepts such as expectation conformity (the parties' tendency to conform to the level of cognition that is expected of them), over-cognition and the desirability of mandatory disclosure laws.

Keywords: cognition, expectation conformity, contracts, adverse selection.
JEL numbers: C72; C78; D82; D83; D86.

1 Introduction

A key activity of public and private decision-makers is to design, negotiate, and enter contractual agreements, such as private contracts, laws or international treaties. To this purpose, they set aside other activities in order to think and brainstorm with colleagues about the implications of alternative designs, they allocate scarce cognitive resources to remembering central features, and they hire engineering, financial or legal experts. Cognitive activities simultaneously determine the degree of contract incompleteness and condition transactional frictions that arise from asymmetric information. They are therefore central to the functioning of markets, regulation and political decisions.

The paper studies simple contracting environments in which the parties covertly engage in information acquisition prior to designing the contract, and cognition changes the nature of the contract between the two parties. Its contribution is two-fold. First, it brings together within a unified framework and generalizes a number of otherwise disconnected contributions. Second, it obtains new results, in particular by extending the analysis to the absence of good-faith bargaining requirement and to two-sided cognition. It also demonstrates that a single parameter, the "relative exposure to the unexpected", underlies a variety of concepts such as expectation

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conformity (the parties' tendency to conform to the level of cognition that is expected of them), over-cognition and the desirability of mandatory disclosure laws.

In the model, parties can opt for a standard contract. This contract may or may not be adequate. If it is not, the parties will be exposed to a loss of efficiency, whose incidence will turn out to be crucial; for example, the physical design may turn out to be inappropriate for the buyer's needs or unexpectedly costly for the seller to produce; or the parties may omit to index the contract on some key contingencies, with serious impact on risk-sharing or behavior. Cognition can allow them to prevent such inefficiencies and write a better contract. It however involves both efficiency and rent-seeking aspects. The contract therefore may be too complete or too incomplete.

The paper is organized as follows. Section 2 describes the model and a few illustrative examples. Section 3 analyses the case in which only one party acquires information. Both the incentive to acquire the information and that to disclose it hinge on the exposure to the unexpected. Expectation conformity and its corollary (possibility of multiple equilibrium cognitive patterns) obtain if and only if the information acquirer has a relative positive exposure to the unexpected; in this case, this party is always better off in a low-cognition equilibrium.

Section 3 then allows for the possibility of delay in disclosure; in some cases, indeed, a party may refrain from disclosing at the contractual stage, but then disclose and renegotiate before the contractual inefficiencies accrue. In these cases, he has an incentive to delay disclosure if and only if he is relatively exposed to the unexpected. This raises the issue of good faith bargaining and the legal treatment thereof, which with Section 3 concludes.

Section 4 extends the analysis to two-sided cognition and analyses contract completeness. It finds that the cognitive pattern is skewed (only one party acquires information) if and only if the information acquirer socially overinvests in information acquisition. And it considers the broader impact of disclosure laws. Section 5 concludes.

Relationship to the literature. The paper is related to several literatures. The informal literature on transaction costs economics (e.g. Williamson 1975, 1985) and the more formal work on ownership (e.g. Grossman-Hart 1986, Hart-Moore 1990) identified the difficulty of foreseeing actions and contingencies as a foundation for otherwise unsatisfactory contracts. More recently and more closely related to this work, Gabaix and Laibson (2006) emphasized the strategic lack of disclosure in an environment with "shrouded attributes", but did not analyze information acquisition. The cognitive approach to incomplete contracting is taken up in Bolton and Faure-Grimaud (2010), Tirole (2009), Von Thadden and Zhao (2012) and Zhao (2014). Relative to these papers, we bring a unifying framework and obtain new insights regarding two-sided cognition, disclosure and regulation.

Disclosure games, in which a sender holds hard (verifiable) information and decides whether to reveal it to a receiver who then takes an action affecting both, have received particular attention.[1] The corresponding literature has investigated factors that prevent unraveling (uncertainty

[1] See Sobel (2013) for a recent survey. Okuno-Fujiwara et al (1990) assumes that cognition is exogenous and contains a general analysis of when voluntary disclosure leads to full disclosure. Shavell (1994) provides the basic analysis of costly information acquisition prior to disclosure (earlier work on the topic is Farrell 1985 and Sobel 1989). He however does not emphasize strategic complementarities between anticipated and optimal cognition.

as to whether the sender has received information or costly disclosure) or lead to the disclosure of bad news (various forms of reputation, see Bourjade and Jullien 2011, Dziuda 2011, Grubb 2011 and Ispano 2012). Most papers on disclosure games take the information structure as given; exceptions include Matthews and Postlewaite (1985), Shavell (1994) and Dang (2008).

In parallel, the information transmission literature pioneered by Crawford and Sobel (1982) posits that the sender holds soft (unverifiable) information and transmits a message to the receiver, who then takes an action affecting both.[2] Reviewing this equally rich literature lies outside the scope of this brief overview. Most papers again take the information structure as given.[3]

2 Model

The sample space is binary: $\Omega = \{\omega, \widehat{\omega}\}$ (with common knowledge prior probabilities q and $\widehat{q}$ such that $q + \widehat{q} = 1$). In state of nature ω, the players' initial and final information is Ω, regardless of any cognitive effort incurred (there is no snag/flaw to be discovered, say). In state of nature $\widehat{\omega}$, then player i learns $\widehat{\omega}$ with probability ρ_i and nothing (keeps information set Ω) with probability $1 - \rho_i$. The draws are conditionally independent (although this plays no substantive role for what follows and will not be used until Section 4.2). Information $\widehat{\omega}$ is hard information and therefore can be disclosed to player $j \neq i$ if player i decides so. The cognition cost is $C_i(\rho_i)$ with $C_i' > 0$, $C_i'' > 0$, $C_i'(0) = C_i(0) = 0$, $C_i'(1) = \infty$.

A prominent interpretation of this information structure goes as follows: Knowing the state of nature allows a trade, a technological choice or a contract design to match the state. Furthermore, state $\widehat{\omega}$ is initially off the radar of players, although they are aware that "they may not have thought about something". In state ω, a known ("business as usual" or "boiler plate") choice, a, is optimal. By contrast, state $\widehat{\omega}$ requires an original and yet unknown response, $\widehat{a}$, furthermore the very act of conceptualizing state $\widehat{\omega}$ also reveals the nature of this unknown response. The model is Bayesian: Players are uninformed, but rational, in that they know that they don't know.

Rather, he provides a careful analysis of an informal idea of Kronman, according to which mandated information disclosure is likely to reduce incentives for information acquisition; he further shows that the impact of required disclosure is rather asymmetric: It discourages buyers but not sellers from acquiring socially valuable information. Kartik et al (2014) consider a multi-sender model of disclosure of hard information; among other results, they show that disclosure strategies are strategic substitutes under a disclosure cost and strategic complements under a concealment cost. Another recent contribution to the literature is Hoffmann et al (2014) in which the sender secretly collects information about receiver preferences and selectively discloses, perhaps subject to absorption capacity constraints limiting the number of dimensions over which information can be disclosed (which is another impediment to unraveling).

[2] Much of the attention has focused on the polar cases of hard and soft information. In general how hard (per se informative) communicated information is depends on the – endogenous – communication efforts exerted by the sender and the receiver (Dewatripont and Tirole 2005).

[3] An exception is Pei (2013), who allows the sender to choose his information structure from a "rich set" (if a partition belongs to the sender's choice set, then any coarser partition also does belong to this set), shows that in contrast with Crawford and Sobel, all equilibria are such that the sender communicates all he knows to the receiver, and characterizes the equilibrium outcomes. Gentzkow and Kamenica (2012) obtain a related result in a game with hard information. They show that if information acquisition is costly and observable by the decision maker (who observes the information structure, but not the realized signal), then disclosure requirements have no effect on the set of pure-strategy equilibria.

Contracts are most often "incomplete": They fail to describe some states of nature or actions to be undertaken in certain states of nature. Incompleteness is often motivated by the presence of "unforeseen contingencies". The question as to whether omitted contingencies are truly unforeseeable or just extremely costly to foresee can be sidestepped under an approach in terms of "I did not think about/I did not have this in mind when making the decision". Accordingly, beliefs will be taken to be a martingale.

Two risk-neutral parties can jointly contract on an action in $\{a, \hat{a}\}$ and transfer money between themselves. As already mentioned, action a (respectively $\hat{a}$) is jointly optimal, i.e., maximizes the joint surplus, in state ω (respectively $\widehat{\omega}$). Initially only the sample space and action a are known to the two players. Searching for information leads them to either learn nothing, or to learn both $\widehat{\omega}$ and $\hat{a}$: As we noted, becoming aware of the state of nature $\widehat{\omega}$ also reveals what's to be done in that state of nature, and conversely.[4]

Figure 1 represents the joint surplus of the two players. $\delta \geq 0$ here stands for the deadweight loss associated with choosing action a in state $\widehat{\omega}$.

		state of nature	
		ω	$\widehat{\omega}$
action	a	U	$\widehat{U} - \delta$
	$\widehat{a}$		$\widehat{U}$

Figure 1: joint surplus

We let U_i (respectively, $\widehat{U}_i$) denote player i's *gross* surplus if the optimal action is chosen in state of nature ω (respectively $\widehat{\omega}$): $\Sigma_i U_i = U$ and $\Sigma_i \widehat{U}_i = \widehat{U}$. Similarly, we can decompose the respective losses (or gains) of both players when the wrong action is selected: $\Sigma_i \delta_i = \delta$.

The following notation will play an important role in what follows:

- w_i denotes player i's bargaining power or weight in any negotiation; that is, player i reaps a fraction w_i of (expected) gains from trade: $\Sigma_i w_i = 1$.[5]

- σ_i denotes player i's *relative exposure to the unexpected*:

$$\sigma_i \equiv \Big[U_i - \big(\widehat{U}_i - \delta_i\big)\Big] - w_i\Big[U - \big(\widehat{U} - \delta\big)\Big],$$

and so

$$\Sigma_i \sigma_i = 0.$$

[4]This can easily be extended to multi-stage cognition: The first search may reveal that "something is fishy" with design a. The player can then continue searching, and so forth.

An even richer environment would add a trust dimension as in Dziuda (2011), who shows that in the presence of multi-dimensional adverse selection, a sender may want to engage in partial disclosure of information that she would not normally disclose, so as to inspire trust.

[5]That is, transfers negotiated at the initial bargaining stage ensure that player i receives a fraction w_i of the expected total surplus from a given action. If there is ex-post renegotiation, we assume that party i receives the same fraction w_i of the extra surplus from moving from the default action a to the new action $\widehat{a}$.

Intuitively, player i loses (or gains) gross surplus $U_i - (\widehat{U}_i - \delta_i)$ when a is selected and the realized state is $\widehat{\omega}$ rather than ω; from an ex-ante viewpoint, his internalization of the anticipated total loss (or gain) depends on this bargaining power w_i.

The timing is summarized in Figure 2.

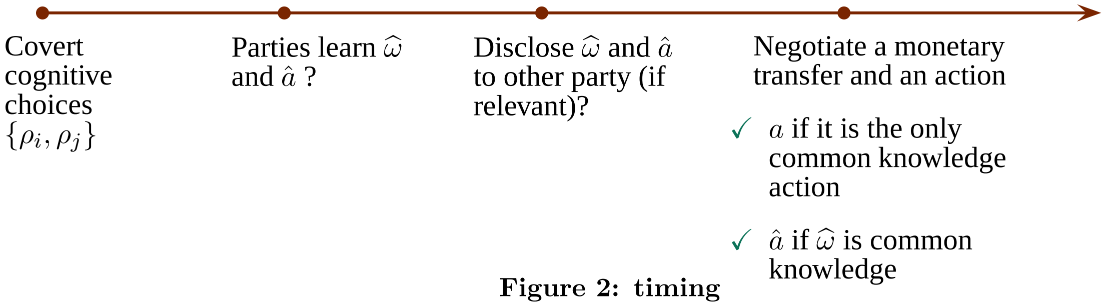

Figure 2: timing

We will look for pure-strategy equilibria in cognitive choices. When a is the only common knowledge action, and assuming that disclosure of $\widehat{\omega}$ is optimal (which we will need to verify), we still need to discuss how the beliefs of an uniformed party are updated within the bargaining process when there is no disclosure. A party who has not learnt $\widehat{\omega}$ computes a posterior belief about $\widehat{\omega}$ conditional on the equilibrium cognition intensity of the other party. He then does not update this point belief in the bargaining process (passive beliefs).

Example 1: the buyer-seller game.

Consider the celebrated buyer-seller paradigm. The seller's cost of supplying the buyer is known and equal to c. In the paradigm's "symmetric version", the buyer's gross surplus is B if the design matches the state of nature, but only $b < B$ if design a is chosen in state $\widehat{\omega}$. If design a is chosen and state $\widehat{\omega}$ is revealed, the buyer can enjoy full surplus B only if the seller incurs some adjustment cost $\alpha \geq 0$. Figures 3 and 4 summarize the gross payoffs of the two parties without and with renegotiation, respectively.

(a) *No renegotiation* (or large ex-post adjustment cost $\alpha \geq B - b$)

	ω	$\widehat{\omega}$
a	$B, -c$	$b, -c$
$\hat{a}$		$B, -c$

Figure 3: Buyer-seller game in absence of renegotiation

Then

$$U = \widehat{U} = B - c \quad ; \quad \delta_B = \delta = B - b \quad \text{and} \quad \delta_S = 0$$

and

$$\sigma_B = \delta_B - w_B \delta = w_S \delta = w_S (B - b).$$

(b) *Ex-post renegotiation* (adjustment cost $\alpha < B - b$)

	ω	$\widehat{\omega}$
a	$B, -c$	$b + w_B(B - b - \alpha)$, $-c + w_S(B - b - \alpha)$
$\hat{a}$		$B, -c$

Figure 4: Buyer-seller game with renegotiation

Then

$$\delta = \alpha \qquad \text{and} \quad \sigma_B = w_S(B - b).$$

This model allows one to get at the notion of contract incompleteness in an otherwise familiar environment. "Contract incompleteness" is then related to the amount of pre-contractual cognition and is measured by the probability that the wrong design is adopted in state of nature ω; this is a rather natural definition, especially when some adjustment/renegotiation occurs in that configuration.

Figures 3 and 4 describe *symmetric* versions of the buyer-seller game: The players' payoffs are state independent provided that the action matches the state of nature. More generally, one can allow these payoffs to depend on the state of nature; a case in point is the shrouded attributes model, to which we now turn.

Example 2: The generalized Gabaix-Laibson (2006) shrouded attributes model

Gabaix and Laibson (GL) analyze a seller's incentive to disclose to a buyer the possibility that the satisfactory consumption of a "basic good" requires access to an "unanticipated" add-on also controlled by the seller. Although their model is phrased in terms of a boundedly rational behavior, Gabaix and Laibson's key insights can be illustrated in our framework. Furthermore, their model is extended to allow for pre-contracting cognition.

In the GL model, the seller sells a basic good to a buyer; this basic good's unit production cost is denoted c. An add-on may or may not be needed to be able to enjoy the basic good. The prior probability that an add-on is needed is denoted $\hat{q}$. If needed, the unit cost of the add-on is $\hat{c}$; thus the add-on is bad news (it involves an extra cost). The buyer knows neither the state of nature nor the nature of the add-on. By contrast, the seller is perfectly informed. That is, GL assumes exogenous one-sided cognition, with $\rho_S = 1$ and $\rho_B = 0$, and focus on the disclosure decision.

The timing is described in Figure 5. Note that we assume for notational simplicity that in the bad state of nature (the add-on is needed) the basic good brings no value unless combined with the add-on. The motivation behind a random willingness to pay for the buyer is that it generates a downward sloping demand (and hence a monopoly distortion) without introducing adverse selection on the buyer side at the ex-ante contracting stage. Let r^m denote the monopoly

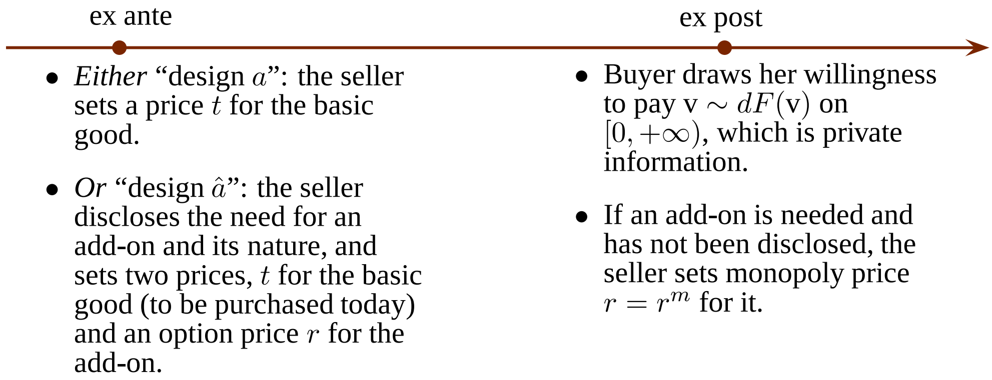

Figure 5: Timing in the shrouded-attributes model

price for the add-on, i.e. the price that maximizes $(r - \widehat{c})[1 - F(r)]$. The lack of ex-ante adverse selection implies that if the add-on is disclosed, then it is optimal for the seller to price it at marginal cost ($r = \hat{c}$), and so there is then no distortion. Let $\mathcal{S}(r) = \int_r^{\infty} (\mathrm{v} - r) dF(\mathrm{v})$ denote the buyer's net surplus.[6]

GL's model is a buyer-seller game, asymmetric as long as $\hat{c} > 0$, as then the payoffs are not the same in both states of nature for the appropriate design:

	ω	$\widehat{\omega}$
a	$\int_0^{\infty} \mathrm{v} dF(\mathrm{v})\,, \; -c$	$\int_{r^m}^{\infty} (\mathrm{v} - r^m) dF(\mathrm{v})\,,$ $-c + (r^m - \hat{c})[1 - F(r^m)]$
$\hat{a}$		$\int_{\hat{c}}^{\infty} (\mathrm{v} - \hat{c}) dF(\mathrm{v}), \; -c$

Figure 6: Payoffs in the GL model
(these payoffs do not include the ex-ante transfer)

In the general notation:

- $w_S = 1$ (the seller is a price setter),
- $\delta = \big[\mathcal{S}(\hat{c}) - \mathcal{S}(r^m)\big] - (r^m - \hat{c})\big[1 - F(r^m)\big]$ is the deadweight loss associated with non-disclosure and ex-post monopoly pricing (so the "wrong design" de facto corresponds to a contractual failure in which the seller, by not disclosing, fails to commit to the cost-based add-on price),
- $\sigma_B = \int_0^{r^m} \mathrm{v}\, dF(\mathrm{v}) + \big[1 - F(r^m)\big] r^m$, the buyer's relative exposure to the unexpected, is equal to the buyer's loss of utility between the good state and the bad state under monopoly

[6] This is an ex-post surplus, in that it does not include the purchase price for the basic good.

pricing; this loss is decomposed into foregone consumption ($\text{v} \leq r^m$) and extra payment ($\text{v} > r^m$).

3 One-sided cognition

Suppose, first, that only player i can search for state of nature $\widehat{\omega}$ ("j" will then stand for the other player). For example, only the seller is able to find out whether a design flaw may prevent the buyer from fully enjoying the consumption experience. Conversely, only the buyer may invest in learning whether the design matches her own needs. Let $\rho_i = \rho^*$ in equilibrium. Let us assume for the moment that it is optimal for player i to disclose $\widehat{\omega}$ when he learns it.[7]

Following a lack of disclosure, the other player, player j, forms posterior beliefs that the state of nature is $\widehat{\omega}$:

$$\hat{q}'(\rho^*) = \frac{\hat{q}(1-\rho^*)}{1-\hat{q}\rho^*} \leq \hat{q}.$$

As mentioned, we assume "passive beliefs" in the bargaining process: Player j sticks to equilibrium posterior beliefs $\hat{q}'$ about state $\widehat{\omega}$ (where a prime denotes a posterior belief) and so demands a share w_j of the corresponding expected surplus. Such passive beliefs seem reasonable given that on the equilibrium path player i discloses $\widehat{\omega}$ when he learns it.

3.1 Disclosure decision

In this subsection we take the cognitive effort ρ^* and thus posterior beliefs $\hat{q}' = \widehat{q}'(\rho^*)$ and $q' = 1 - \widehat{q}'$ as exogenous, and we investigate player i's incentive to disclose. Suppose player i learns that the state is $\widehat{\omega}$. By disclosing this information, he obtains $w_i\widehat{U}$, that is share w_i of the total surplus $\widehat{U}$. By not revealing his information, he obtains

$$\left[\widehat{U}_i - \delta_i\right] + t_i$$

where t_i is the monetary transfer to i when agreeing on design a ($t_i + t_j = 0$). Given posterior beliefs $(q', \hat{q}')$, this transfer is given by the equalization of each player's expected utility with his due share of total surplus:

$$q'U_i + \hat{q}'\left(\widehat{U}_i - \delta_i\right) + t_i = w_i\left[q'U + \hat{q}'\left(\widehat{U} - \delta\right)\right].$$

After some manipulations, player i discloses $\widehat{\omega}$ when learning it if and only if:

$$w_i\delta \geq q'(\rho^*)\sigma_j \tag{1}$$

where

$$\sigma_j \equiv \left[U_j - \left(\widehat{U}_j - \delta_j\right)\right] - w_j\left[U - \left(\widehat{U} - \delta\right)\right],$$

is player j's relative exposure to the unexpected.

[7] There are two possible motivations for player i to acquire information. The first (on which we focus here) is that it leads to communication and a different design/contract. The second is to decide whether to interact at all with player j (this alternative motivation can be ruled out if there is enough surplus).

Condition (1) says that player i is willing to disclose state $\widehat{\omega}$ whenever his share of the deadweight loss, $w_i\delta$, exceeds the cross-subsidy embodied in the transfer, namely $q'\sigma_j$. This cross-subsidy is proportional to the other party's posterior probability of the erroneous state ω, q', that player j faces when not informed that the true state of nature is $\widehat{\omega}$.

If (1) is violated, then disclosure with probability 1 is not an equilibrium. If $q\sigma_j \geq w_i\delta$, then the (unique) equilibrium has no disclosure at all. If $q\sigma_j < w_i\delta < q'\sigma_j$, then the (unique) equilibrium has player i randomize between disclosing and not disclosing; posterior beliefs that the state is ω in the absence of disclosure are then q'' such that $q''\sigma_j = w_i\delta$.

Proposition 1 (incentive to disclose prior to contracting). *For given presumed cognition $\rho_i = \rho^*$, the equilibrium disclosure behavior is unique. Player i's willingness to disclose is driven by two factors: his share, w_i, of the resulting deadweight loss, δ, and player j's relative exposure to the unexpected, $\sigma_j = \Big[U_j - (\widehat{U}_j - \delta_j)\Big] - w_j\Big[U - (\widehat{U} - \delta)\Big]$, times the extent $q'(\rho^*) \geq q$ of player's j misperception in the absence of disclosure (when disclosure occurs with probability 1).*

(i) Player i discloses if $w_i\delta \geq q'(\rho^*)\sigma_j$

(ii) Player i does not disclose if $w_i\delta \leq q\sigma_j$

(iii) Player i plays a unique mixed disclosure strategy if $q\sigma_j < w_i\delta < q'(\rho^*)\sigma_j$.

3.2 Applications

- *Price setting.*

In some applications, the informed player is a price setting seller, and so $w_i = 1$. Formula (1) then simplifies to:

$$\delta \geq q'\big[U_j - (\widehat{U}_j - \delta_j)\big].$$

The right-hand side of this inequality is equal to the posterior probability of state ω times player j's "disappointment" or loss of utility when the state turns out to be $\widehat{\omega}$ rather than ω.

- *Symmetric buyer-seller game.*

In the symmetric buyer-seller game, $\sigma_B \equiv w_S(B - b)$. So, in the absence of renegotiation (1) boils down to:

$$\begin{cases} w_B \geq -q'w_S & \text{if} \quad i = B \\ w_S \geq q'w_S & \text{if} \quad i = S \end{cases}$$

Player i, whether he is the buyer or the seller, always discloses.

In the presence of renegotiation, the buyer always discloses, but the seller discloses only if the deadweight loss (then equal to the adjustment cost α) is large enough: $\alpha \geq q'(B - b)$.

- *Gabaix-Laibson model.*

The general formula implies that the seller in the GL model opts for shrouded attributes (does not disclose the existence of the add-on when one is needed) if and only if $w_S\delta \leq q\sigma_B$, or, applying the specific expressions for these variables:

$$\int_{\hat{c}}^{r^m} (\mathrm{v} - \hat{c}) dF(\mathrm{v}) \leq q \Big[\int_0^{r^m} \mathrm{v} dF(\mathrm{v}) + \big[1 - F(r^m)\big] r^m \Big]. \tag{2}$$

The left-hand side of this inequality is equal to the deadweight loss associated with non-disclosure and the concomitant monopoly pricing; this loss is entirely borne by the seller who has full bargaining power as a price setter. The right-hand side is the product of the posterior probability of the good state (which is equal to the prior probability in a no-disclosure equilibrium) and the buyer's loss of utility between state ω and state $\widehat{\omega}$ under monopoly pricing; this loss is decomposed into foregone consumption ($\mathrm{v} \leq r^m$) and extra payment ($\mathrm{v} > r^m$).

3.3 Choice of cognition

Next, we can analyze player i's choice of cognition, assuming disclosure upon learning that the state is $\widehat{\omega}$.[8] Letting

$$t_i(\rho^*) \equiv w_i U - U_i + \hat{q}'(\rho^*)\sigma_i$$

(where the posterior belief $\hat{q}'$ is decreasing in ρ^*), player i's utility is:

$$V_i(\rho_i, \rho^*) \equiv \hat{q} \Big[\rho_i \big(w_i \widehat{U} \big) + (1 - \rho_i) \big(U_i - \delta_i + t_i(\rho^*) \big) \Big] + q \big[U_i + t_i(\rho^*) \big] - C_i(\rho_i). \tag{3}$$

In equilibrium the maximization of V_i yields $\rho_i = \rho^*$, where

$$C_i'(\rho^*) = \hat{q} \Big[w_i \widehat{U} - \big(\widehat{U}_i - \delta_i + t_i(\rho^*) \big) \Big]$$

or, plugging the formula for $t_i(\rho^*)$ and using $\sigma_i = -\sigma_j$,

$$C_i'(\rho^*) = \hat{q} \Big[w_i \delta - q'(\rho^*)\sigma_j \Big], \tag{4}$$

whenever the right-hand side is positive. Unsurprisingly, this right-hand side is positive if and only if (1) is satisfied: The stake in acquiring information is positive if and only if disclosure brings a benefit to player i. Note, furthermore, that ρ^* is unique if $\sigma_j \geq 0$.

We can define expectation conformity in the following way: Consider two levels of cognition ρ_i and μ_i. We will say that expectation conformity prevails if player i has more incentive to choose μ_i when expected to choose μ_i than when expected to choose ρ_i.[9] That is,

$$\begin{aligned} \Gamma_i^{EC} &\equiv \big[V_i(\mu_i, \mu_i) - V_i(\rho_i, \mu_i) \big] - \big[V_i(\mu_i, \rho_i) - V_i(\rho_i, \rho_i) \big] \\ &> 0. \end{aligned}$$

[8] That is $w_i \delta \geq q'(\rho^*)\sigma_j$. Note that the mixed-strategy region exhibited in (iii) of Proposition 1 can exist only if information is exogenous. Player i will put zero effort in acquiring information if one of his optimal ex-post strategies is not to disclose.

[9] See Tirole (2015) for a definition for arbitrary games.

Simple computations show that

$$\Gamma_i^{EC}(\rho_i\,,\mu_i) = q\hat{q}(\mu_i - \rho_i)\left[\frac{1}{1-\hat{q}\mu_i} - \frac{1}{1-\hat{q}\rho_i}\right]\sigma_i.$$

Thus expectation conformity is satisfied provided that $\sigma_i \geq 0$. The higher the anticipated cognition effort, the higher the probability of the bad state in the absence of disclosure and so the less favorable the agreement to player i whenever the latter is relatively exposed to the unexpected. This raises player i's stake in information acquisition.

Finally, we show that the exposure to the unexpected is also the key to the existence of "cognitive traps", that is the co-existence of multiple cognition equilibrium such that player i is better off in the low cognition outcome. To demonstrate this, note that

$$sign\Big(\frac{\partial V_i}{\partial \rho^*}\Big) = sign\Big(\frac{dt_i}{d\rho^*}\Big) = -sign(\sigma_i).$$

Summarizing this analysis:

Proposition 2 (necessary and sufficient condition for expectation conformity).
Consider one-sided cognition in the incomplete contract game.
(i) Cognition level: Player i acquires information and discloses for sure if and only if (1) *is satisfied for equilibrium cognition effort ρ^*.*
(ii) Expectation conformity. Player j's anticipation of a higher cognitive effort by player i increases the latter's stake in cognition (raising the possibility of multiple equilibria) if and only if player i is relatively exposed to the unexpected ($\sigma_i > 0$) .
(iii) Cognitive traps: In case of multiple equilibria, player i is better off in a low-cognition equilibrium.

3.4 Strategic delay in disclosure and good faith in bargaining

Until now, a party acquiring information disclosed it before contracting if he disclosed it at all; in the absence of intent of pre-contractual disclosure, he would not even try to acquire this information. Either the parties have a reputation for not coming up with bad surprises just after contracting (before reliance), or a mandatory-disclosure/good-faith-bargaining law can be enforced.[10] Would the analysis be altered if we allowed player i to delay disclosure until after the contract is signed? That is, suppose that after agreeing on design a, player i can disclose that the state of nature is $\widehat{\omega}$ and offer to costlessly renegotiate to design $\widehat{a}$.

In other words, we here study the other polar case of strategic delay, which corresponds to a situation in which such good-faith bargaining laws are unenforceable (it is hard to prove that the party had the information prior to contracting) and reputation concerns are weak. This sub-section can thus be viewed as studying the impact of a mandatory disclosure law.

[10]The notion of mandatory disclosure is a complex one, and has been the object of tensions in contract law for a long time (see Kronman's 1978 seminal paper on the topic). For example, in Macquarie International Health Clinic Pty Ltd v Sydney South West Area Health Service (2010, NSWCA 268), the Court held that the obligation of "good faith" does not require parties to compromise their own commercial interests, but that parties must cooperate, including disclosing information, in a reasonable way to achieve the contract's objectives.

Upon disclosing immediately after contracting that the state is $\widehat{\omega}$, player i receives

$$\Big[\big(U_i - \delta_i\big) + t_i\Big] + w_i\delta.$$

The incentive to disclose then no longer accounts for the realized deadweight loss, as no deadweight loss materializes. It is optimal for player i to disclose prior to contracting if and only if:

$$0 \geq q'\sigma_j,$$

or

$$\sigma_i \geq 0. \tag{5}$$

Thus player i discloses prior to contracting if and only if he is relatively exposed to the unexpected. Note that (5) is just a special case of (1), for deadweight loss $\delta = 0$ (the specification of the contracting terms is then just a zero-sum game). If $0 < q'\sigma_j < w_i\delta$, then player i discloses after contracting while he would disclose prior to contracting if delayed disclosure were unfeasible.[11]

Proposition 3 (absence of good faith bargaining). *Under early renegotiation (the design can be costlessly altered after the contract is signed):*

(i) Player i discloses prior to contracting if and only if he is relatively exposed to the unexpected: $\sigma_i \geq 0$. The equilibrium set is then the same as under mandatory disclosure.

(ii) If $\sigma_i \leq 0$, the equilibrium cognition in the absence of mandatory disclosure is unique and given by

$$C_i'(\rho^*) = \hat{q}[w_i\delta]. \tag{6}$$

It exceeds the (also unique) equilibrium level of cognition under mandatory disclosure. Both parties are better off in the absence of a good faith bargaining requirement.

Part ii) of Proposition 3 formalizes Kronman (1978)'s and Eisenberg (2003)'s informal argument that mandatory-disclosure laws must distinguish between the cases of casually acquired information and information that results from deliberate search (which according to Kronman, must benefit from a legal non-disclosure privilege, in effect a property right). When $\sigma_i < 0$, i.e. when mandatory disclosure matters, mandatory disclosure reduces the incentive of party i to acquire information. In the end, player i receives a share w_i of total surplus, minus the information cost:

$$w_i\big[qU + \hat{q}\widehat{U} - \hat{q}(1-\rho^*)\delta\big] - C_i(\rho^*),$$

[11] Suppose the absence of disclosure and that parties contract on a. Then the transfer is given by

$$t_i + qU_i + \hat{q}[\widehat{U}_i - \delta_i + \rho^* w_i\delta] = w_i\big[(qU + \hat{q}[\widehat{U} - (1-\rho^*)\delta]\big].$$

Agent i strictly prefers not to disclose if

$$t_i + \widehat{U}_i - \delta_i + w_i\delta > w_i\widehat{U} \iff \sigma_i < 0.$$

which is maximized at the level given by (6). Player j's welfare,

$$w_j\left[qU + \hat{q}\widehat{U} - \hat{q}(1-\rho^*)\delta\right]$$

is obviously increasing in ρ^*.

By contrast, if information were *exogenous*, mandatory disclosure would be irrelevant if the contract can be renegotiated before reliance (as in this section), but would improve welfare in the benchmark case in which a deadweight loss δ is actually incurred if no disclosure of state $\widehat{\omega}$ occurs before contracting.

Finally, we can compare equilibrium cognition levels to the socially efficient one. The first best level of cognition ρ^{FB} under one-sided cognition by party i is given by

$$C_i'(\rho^{FB}) = \hat{q}\delta.$$

Under good faith bargaining, one-sided cognition by player i results in excessive cognition ($\rho^{FB} < \rho^*$, the contract is "too complete") if and only if

$$\delta < w_i\delta - q'\sigma_j \quad \text{or} \quad w_j\delta < q'\sigma_i. \tag{7}$$

Figure 7 captures some of the main insights of this section.

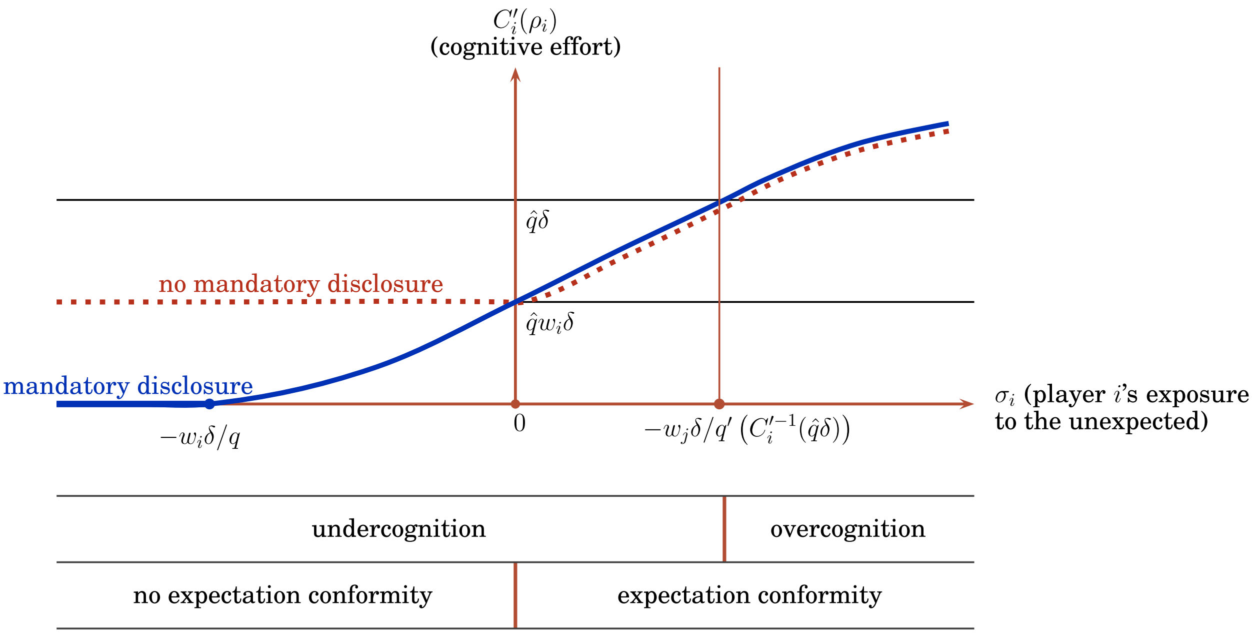

Figure 7: Comparative statics
[(1) Vary σ_i (e.g., by changing δ_i), keeping $w_i\delta$ constant; (2) ignore cognitive traps: C_i'' large enough.]

4 Two-sided cognition

4.1 Overcognition implies one-sided cognition

Note that condition (7), which specifies the conditions under which player i socially overinvests in cognition under unilateral information acquisition, is exactly the condition under which, under player i cognition, player j would not want to disclose that the state is $\widehat{\omega}$ if he knew it, and therefore would not want acquire information, however small the cost of doing so: see equation (4). The intuition for this result is that excess cognition by player i occurs when the private benefit of information exceeds the social benefit. Put differently, information, at the margin, reduces j's welfare; and so player j has no incentive to acquire this information, however cheap.

A simple corollary is that there can be overcognition only by the player who is relatively exposed to the unexpected (i.e., $\sigma_i > 0$), for example the buyer in the symmetric buyer-seller game.[12]

Proposition 4 (overcognition and two-sided cognition).
Whether disclosure is mandatory or not:
(i) Under one-sided cognition, player i engages in excess cognition if and only if (7) *is satisfied.*
(ii) Under two-sided cognition, player j does not want to engage in cognition, even when $C_j'(0) = 0$, *if and only if* (7) *is satisfied.*

4.2 Actual cognition by both players

Next, we look for an equilibrium in which both sides invest in cognition (and disclose, as the two co-vary), which as we saw requires that $w_i\delta + q'\sigma_i > 0$ for all i, where q' is the posterior belief that the state is ω conditional on none of the parties having discovered $\widehat{\omega}$. Assume that the search outcomes are independent. Such an equilibrium must satisfy:

Privately optimal cognition

For all i, under mandatory disclosure or if $\sigma_i \geq 0$: either $\rho_i = 0$ if $w_i\delta \leq q'\sigma_j$ or

$$C_i'(\rho_i) = \hat{q}(1-\rho_j)(w_i\delta - q'\sigma_j) \tag{8}$$

In the absence of mandatory disclosure and if $\sigma_i < 0$:

$$C_i'(\rho_i) = \hat{q}(1-\rho_j)w_i\delta. \tag{9}$$

Bayes rule

$$q' = \frac{q}{q + \hat{q}(1-\rho_i)(1-\rho_j)}. \tag{10}$$

[12] Condition (7) applied to the buyer takes the following form:
- in the absence of ex-post renegotiation: $1 < q'$, which is impossible, so that there is never overcognition;
- under ex-post renegotiation: $\alpha < q'(B - b)$, which is satisfied if the adjustment cost α is small enough. The buyer then engages in overcognition and the seller does not exert any cognitive effort at all.

Rewrite the first-order condition (8) as:

$$C_i'(\rho_i) = \hat{q}\left[(1-\rho_j)w_i\delta + (-\sigma_j)\frac{\hat{q}}{\dfrac{q}{1-\rho_j} + \hat{q}(1-\rho_i)}\right].$$

If $\sigma_j \leq 0$, player i's reaction curve (ρ_i as a function of ρ_j) is obviously downward-sloping. But strategic substitutability holds also if $\sigma_j > 0$: the derivative of the RHS with respect to ρ_j is $\hat{q}\left[-w_i\delta + \sigma_j\left(q'\right)^2\right] < 0$, from the active cognition condition.

We will assume that the functions C_i are sufficiently convex so that the reaction curves cross only once, defining a stable equilibrium.

Proposition 5 (actual two-sided cognition). *Assume independent searches and a stable equilibrium. Then, in the two-sided cognition region, cognitive efforts are locally strategic substitutes, reflecting the public good nature of information. Suppose that player i is relatively more exposed to the unexpected ($\sigma_i > 0$); then lifting the mandatory disclosure requirement increases j's cognition and reduces i's cognition.*

5 Concluding remarks

Cognition, broadly defined to include financial and human investments, attention, rehearsal and retrieval strategies, is at the core of informational asymmetries, and therefore frictions in contracting. This paper stressed the role of exposition to incompleteness as a unifying factor underlying the disclosure decision, expectation conformity as well as the normative consequences. In this respect, it is only a first pass at a much broader and richer set of questions.

A more satisfactory treatment would consider more general state spaces and more complex information structures and trades. It would also emphasize the need for a commonality of information to achieve efficient contracting.

Disclosure is a central topic in law and economics. We have formalized some of the relevant trade-offs and welfare recommendations. Clearly, applications abound, way beyond the framework developed here. A case in point is patenting (in or outside the context of standard setting), for which like in this paper search for prior art embodies both efficiency and rent seeking aspects. Disclosure rules have an important impact on the diligence to search, on the opposition process, or on what is included into a standard; but identifying the exact role and the policy implications requires developing a proper framework.

Finally, many contracts (such as laws, international agreements) involve more than two protagonists and their negotiation obey certain protocols which are likely to condition information acquisition. We leave these topics and the many other issues related to cognition-intensive contracting for future research.

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