Information gathering, disclosure and contracting in competitive markets.

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Abstract

The paper studies the determinants of agents' decisions to gather and disclose information competitive markets. In our set-up, information can be acquired by the agents *before or after* signing contracts and may have either operational or strategic value. Principals (intermediaries) compete by proposing contracts to the agents *before* the information gathering stages.

We characterize competitive equilibria under the assunption of proprietary information gathering technologies, and demonstrate that equilibrium contracts have very a simple shape in spite of the presence of asymmetric information. We show that the Pigouvian logic may be misleading in analyzing the effects of the contracting externalities imposed by private information gathering in competitive markets. In contrasts with the conventional wisdom and with most findings of the previous literature, we prove the following results: (I) Agents may acquire socially useless information (foreknowledge) in equilibrium, even if contractual proposals precede information gathering activities. This may happen whenever the signals available to the agents are not perfectly informative and not too costly. (II) If the operational value of information is sufficiently large in the sense of Blackwell, and the endowment and the investment's return are affiliated random variables, as it is usuallly the case in *production-funding* problems, private returns of information fall short of its social returns and pre-contractual access to information leads to under-acquisition under mild conditions. (III) If the operational value of information is large, and endowments are negatively correlated with the investment returns, as it often happens in *insurance-loss* reduction problems, precontractual access to information generally leads to over-acquisition of information. (IV) If the operational value and the cost of information are both low, in equilibrium agents often overinvest in information.

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Hirshleifer effect

Access to private pre-contracual information destroys trading opportunities and reduces welfare $\rightarrow$ private and social value of information generally do not coincide.

Example insurance in competitive markets : state contingent endowment is $(w_1 = 10, w_2 = 0)$, $p_s = 1/2 \quad and \; U(x) = \sqrt{x}$, $U(x^*) = 5$.

IF true state of nature revealed before the contracting stage, trading (insurance) opportunities in the insurance market vanish, agents must consume w_s in each state and lose welfare.

Received wisdom from large literature

· **Public disclosure of information with small social value reduce welfare** (*Hirshleifer, Green, Marshall, Morris-Shin, Schlee,Shavell*).

· **Access to precontractual information $\rightarrow$ overinvestment in information gathering** (*Hirshleifer, Shavell, Kremer Khalil Rochet, Morris-Shin, Bergeman-Valimaki***, *races to be first* and *cream skimming* literatures);

Assumptions : ex post efficient equilibria or information gathering **only** at the precontractual stge.

However, *no socially wasteful information* gathered *under optimal contracting in monopoly* (seminal contribution of Khalil-Kremer) if agents

- can choose whether to gather information *before of after* contracting, and
- have access to *only one*, *fully informative,* signal.

1 This paper

· Agents can acquire information (signals) either before or after contracting.

· Positive information may be voluntarily disclosed.

· Several signals with different informational content available, the more informative are more costly.

· Information may have social value. It may positively affect the expected returns of an investment or a loss reduction technology.

· Agents need to trade (with principals) in order to insure themselves or to fund investment activities.

· Principals compete by offering exclusive contracts

Main results 1

· Pure strategy equilibrium always exists with two stages contracting a la Rotschild-Stiglitz, where agents can acquire private information before contracting.

· *Equilibrium* configuration of offers precisely characterized

Two type of contracts offered :
contracts prescribing precontractual information
contracts perscribing not to gather precontractual information.

Agents accept the latter.

· Equilibrium contracts are "simple" in spite of access to asymmetric information.

For instance, in insurance applications they can be interpreted as standard contracts with deductible and maximal reimbursement.

Main results 2

Private versus social incentives to acquire information

· Agents always acquire information if the available signals not too informative and not "too expensive". This remains true *even if information has negative social value (no operational value).*

Hence

· Overinvestment in information gathering if social value of information is sufficiently low

If information has sufficient operational value

· Underinvestment in *production-funding* problems

· Overinvestment in loss-reduction insurance problems

Policy implications...

2 Theoretical point of the paper

One side of the coin (Hirshleifer and related literature):

Precontractual information gathering generates negative contractual externalities:

By purchasing precontractual information on the value of an asset I own I reduce the set of profitable trades that potential buyers can conclude with me.

Competition exacerbate the effects of this externality

Negative externality lead to *overinvest* in information if equilibria ex post efficient. However,

The other side of the coin (This paper):

· Principals anticipate how contracts affect incentives to gather precontractual information

· Principals design contracts to protect themselves against the bad effects of externalities

· *Protection effect* may dampen or enhance incentives to gather precontractual information

The paper

· consider the *externality and the protection effect together (interplay)*

· provide a characterization of the equilibrium based on super-submodularity of agents' payoffs functions

· show that the Pigouvian logic may be misleading in the analysis of informational externalities.

Set-up

Preferences and endowments Agents consume one good, their utility function $U(x)$ is strictly concave and twice differentiable. Principals are risk- neutral and maximize expected profit.

Finite number of individual states of the world, S, for each agent; w_s is the state s endowment, with $w_{s'} \geq w_s$ for $s' > s$; p_s is the probability of the individual state s.

Production Before uncertainty is resolved, but after information is gathered, agents can choose an action a, to be interpreted as an investment of units of the goods in a production or a loss-prevention technology.

$r(a, s)$ is the net returns of a; $r_a(a, s)$ may be increasing or decreasing in s.

Suggested interpretation :

$r_a(a, s)$ non decreasing in s in production problems: positive correlation with imperfectly transferable human capital);

$r_a(a, s)$ (often) non increasing in s in loss-reduction problems (with two states always true: the loss reduction tecnology is effective only in the bad state; otherwise, true when it is optimal to reduce the loss proportionally to its size).

Information gathering

information provides a better assessment the distribution of individual states of each agent.

Agents choose signals from the family $E = \{\eta_l\}_{\eta_l \in E}$. η_l is a random variable with finite support and conditional density $f_{\eta_l}(\sigma_n, s)$; F_{η_l} is the matrix of conditional probabilities.

Example η_l is a medical test σ_n is a possible result of the medical test

Signals ordered according to Blackwell sufficiency (Lehman order enough).

η_{l+1} more informative than η_l, η_0 completely uninformative
Agents can gather information before or after contracting.

The cost $c_\tau(\eta_l)$ of the signal η_l is decreasing in τ (earlier information is more costly) , and increasing in the informativeness (in l).

Simplifying assumption: at most one signal can be gathered (results extended in the paper).

TIMING

Contracts are offered in the initial stage, $\tau = 0$; .

Agents may gather and disclose information at $\tau = \tau_1$, or after contracting at $\tau = \tau_2$.

At $\tau = \bar{\tau}$, with $\tau_1 < \bar{\tau} < \tau_2$, each agent chooses one of the contracts offered.

Between τ_2 and $\tau = 1$, agents receive funds and invest (i.e. choose the action a); at $\tau = 1$, uncertainty is completely resolved and agents consume.

Information

The signal gathered by the agent, its realization, and the timing of information acquisition are private information.

IF ACQUIRED, information can be voluntarily disclosed.

An agent who has gathered the signal η_l and observed the realization σ_n can voluntarily disclose this information revealing both η_l and σ_n. (η_l and σ_n are hard - trasmissible - information)

However,

At the contracting stage $\tau = \bar{\tau}$, an agent cannot provide evidence that he has *not* gathered information before $\bar{\tau}$.

Actions and consumption choices are verifiable and contractible (exclusive contracts)

Information gathering plans

An *information gathering plan*, $\boldsymbol{\eta} = (\eta_1,\eta_2)$ specifies the signal η_l gathered at stage τ (either $\eta_1$or η_2) must be equal to zero.

Space of contracts

All contracts offered prescribe agents to disclose all the information they acquire either before or after contracting.

A contract $b = (\boldsymbol{\eta}, a_l(\sigma_n), \mathbf{z})$, specifies

· an information gathering plan, $\boldsymbol{\eta}$,

· an action $a_l(\sigma_n)$ and

· a vector of transfers z to the agent.

Transfers

For each contract such that $\boldsymbol{\eta} = \mathbf{0}$, $\mathbf{z} = (z(\sigma_0, 0), ...z(\sigma_0, S)) \in S+1$

$a_0(\sigma_0) \equiv$ action prescribed by the contract.
$z(\sigma_0, 0) \equiv$ (uncontingent) loan received at the investment stage
$z(\sigma_0, s) \equiv$ final period state transfer contingent on s.

For each contract such that $\boldsymbol{\eta} \neq \mathbf{0}$, $\mathbf{z} = (z(\sigma_n, s), ...z(\sigma_n, S)) \in (S \times N) + 1$

$a_l(\sigma_n) \equiv$ action prescribed by the contract contingent on σ_n and η_l
$z(\sigma_n, 0) \equiv$ loan received at the investment stage contingent on σ_n.
$z(\sigma_n, s) \equiv$ final period transfer contingent on s and σ_n

Feasible contracts satisfy $a(\boldsymbol{\sigma}) \leq w_0 + z(\boldsymbol{\sigma}, 0)$.

Payoffs
Agents (expected) utility payoff :

$$\sum_{n\in N} g(\sigma_n) \sum_{s\in S} p_{l^a}(s,\sigma_n) U(x(\sigma_n,s))$$

where,

$$x(s,\sigma_n) \;= w_s + r(s,a(\sigma_n)) - a + c_\tau(\eta^a) + z(0,\sigma_n) + z(s,\sigma_n)$$

Principals expected profit on b:

$$\Pi(b,\phi^a) = -[z(\sigma_n,0) + \sum_{n\in N} g(\sigma_n) \sum_{s\in S} p_{l^a}(s,\sigma_n) z(\sigma,s)]$$

Competitive equilibrium in first best economies

First best expected return from investment

$$r(\eta_l) = \sum_{n \in N} g(\sigma_n) \sum_{s \in S} p_l(s, \sigma_n) r(a^*(\sigma_n), s).$$

Operational value of $\eta_l = r(\eta_l) - r(\eta_0)$

$\Delta r_a(s) = r_a(s+1) - r_a(s)$

Result 1 For any pair of return functions $\hat{r}(a, s)$ and $\tilde{r}(a, s)$ such that $|\Delta\hat{r}(a, s)| > |\Delta\tilde{r}(a, s)|$, $\hat{r}(\eta_l) > \tilde{r}(\eta_l)$.

Result 2 In equilibrium, (i) **no precontractual information**, (ii) $a^*_\eta(\sigma_n)$ maximizes the operational value of information; (iii) agents do not gather any signal before contracting.

Value of strategic precontractual information may be positive out of equilibrium but is zero in equilibrium.

What goes wrong with precontractual asymmetric information ?

If extra costs of precontractual information low, *at the first best allocation* individually optimal to gather private information...first best allocation not incentive compatible.

Incentive compatibility

Example only one contract, $x = (...x(s,\sigma_0)...)$ offered, which prescribes not to gather information.

If the agent does not follow the contractual prescription, gather η_l before contracting and observes σ_n, obtains

$$V_n(x,w) = \sum_{s\in S,} p_l(s,\sigma_n) \max\left\{U(x(\sigma_0,s) - c_1(\eta_l)), U(w_s)\right\}$$

If $w_s - x(\sigma_0,s)$ larger than $c_1(\eta_l)$, $U(w_s) > U(x(\sigma_0,s) - c_1(\eta_l))$,
If x^* is the fair state-independent allocation and $c_1(\eta_l)$ sufficiently small, $V_n(x^*,w) > U(x^*)$.

In general,
Rational not to gather information if and only if

$$\sum_{s\in S,} p_0(s,\sigma_0)u(x(\sigma_0,s)) \geq \sum_{n\in N,} g(\sigma_n)V_n(x,w) \text{ for all } l$$

Incentive compatibility 2

A contract x prescribing to gather the signal η_l is incentive compatible if

$$E_l U(x) \geq \sum_{n \in N,} g(\sigma_n) \max_{x' \in \hat{X}(\sigma_n, \eta_l)} \{E_{l'}(x')\} \text{ for each } l' \in L(l)$$

where $\hat{X}(\sigma_n, \eta_l) = \tilde{X}_n(\sigma_n, \eta_l) \cup \tilde{X}_0(\sigma_n, \eta_l)$

$\tilde{X}_n(\sigma_n, \eta_l)$, set of allocations that the agent can obtain in the market by disclosing his information, with the set

$\tilde{X}_0(\sigma_n, \eta_l)$, set of allocations that he can obtain by pretending to be uninformed at the contracting stage.

Note whether a contract is or not incentive compatible depends on the *whole* set of contracts offered in the market

Define,

$$x_i(n,l) = \arg\max_{x \in \Pi(n,l)} E_{n,l} U(x)$$

$X^I \equiv \{..., x_i(n,l), ...\}$ set of interim efficient allocations preferred by each interim type (n,l):

$$x_i(n,l) = \arg\max_{x \in \Pi(n,l)} E_{n,l} U(x)$$

Unique competitive equilibrium

· All interim efficient contracts offered
· Best contract incentive compatible againts interim efficient contracts offered,
· Agents take the latter.

Equilibrium allocation and signal solve

$$\max_{x(\sigma_n,s),\ l \in \{0,1,...,L\}} E_l U(x) \tag{1}$$

$$s.t.\ \ x \in IC_{\eta_l}(\hat{X}) \cap \Pi_{\eta_l} \tag{2}$$

$$\hat{X} = \left\{x - \Delta c(\eta_l) \cup X^I\right\} \tag{3}$$

where
Π_{η_l} is the ex ante non negative profit constraint for $\eta = \eta_l$

$IC_{\eta_l}(\hat{X})$ is the set of incentive compatible allocations for $\eta = \eta_l$

Intuition, if part

· In equilibrium, contracts in X^I are offered even if they are not accepted.

· In equilibrium no principal can deviate since

- agents who decide to gather and disclose information are already obtaining the best possible deals
- agents who do not gather information information obtains the best possible deals given that intermediaries must deter them from becoming informed.

Intuition, only if part

· Competition leads principals to offer $x_i'(n,l) = (x_i(n,l) - \varepsilon$ whenever agents accept this contract if offered,

· Adding $x_i'(n,l)$ to the offer set X' induces precontractual information gathering if $x \notin IC_{\eta_l}(X' \cup x_i'(n,l))$

· But interim efficient contracts are the best possible deals for the informed agents Hence $IC_{\eta_l}(X') \subset IC_{\eta_l}(\hat{X} \cup x_i'(n,l))$ if $X^I \notin \hat{X}$

Equilibrium contracts

Proposition 1 *If agents are risk averse, and Δc sufficiently small, equilibrium allocations are such $x((\sigma_n, s) = \bar{x}$, with $\bar{x} > 0$ for any vector (σ_n, s) in which $z(\sigma_n, s) > 0$, . Moreover, there always exists an equilibrium contract satisfying the following properties (i) $x(\sigma_n, s) \geq x(\sigma_{n'}, s')$ for all pairs (σ_n, s) and (σ_n, s') such that $s \geq s'$; (ii) for all pairs (σ_n, η_l) such that $z(\sigma_n, s) < 0$, there exists at most two values $\tilde{x}$ and $\underline{x}$ with $\bar{x} > \tilde{x} \geq \underline{x}$ and a an individual state $\tilde{s}$ such that $x(\sigma_n, s) = \tilde{x}$ for all $s \geq \tilde{s}$ and $x(\sigma_n, s) = \underline{x}$ for all $s < \tilde{s}$. Finally, $\tilde{x} = \underline{x}$ whenever $\xi'(x) > -k$ with $0 < k < \bar{k}$, for some positive $\bar{k}$, or $\Delta c_\tau(\eta_l)$ sufficiently small.*

Intuition

insurance problem, two possible realizations of the signal, σ_1 and σ_2 η_l with $l > 1$ gathered in equilibrium.

Acquiring precontractual information same as buying an option giving the right to access interim efficient contracts under the good realization of the signal .

Consider an agent who acquires precontractual information (buy the option) before deciding whether to sign the insurance contract supporting $x(s, \sigma_2)$.

He GAINS for $\sigma = \sigma_2$, since $\sum_{s \in S} p_l(s, \sigma_2) U(x(s, \sigma_2)) < U(x_i(1, l))$

He LOOSES for $\sigma = \sigma_1$ since

$$\sum_{s \in S} p_l(s, \sigma_n) U(x(\sigma_n, 1)) > \max \left\{ \sum_{s \in S} p_l(s, \sigma_1) U(x(s, \sigma_2) - \Delta c), U(x_2(1, l)) \right\}$$

IC requires gains and losses to be equal.

Allocative distortions introduced in equilibrium in order to discourage precontractual acquisition by increasing losses and reducing gains

To minimize gains, consumption larger than in the first best for σ large. Moreover, consumption must be flat for good realization of σ.

To increase losses, consumption smaller than in the first best σ small, (and can entail some variability when risk aversion decreasing with wealth).

Aquisition of information with negative or small social value

Proposition 2 *Assume that autarky is not a first best allocation. There exists two strictly positive numbers, c_0 and r such that a signal $\eta_l \geq \eta_1$ is acquired in equilibrium by the agent whenever $c_0(\eta_1) < \bar{c}_0$ and $r(\eta_l) - c_2(\eta_l) > -r$. Moreover, the more informative is η_1 the larger is the value of $\bar{c}_0$. Finally, for η_1 sufficiently informative no information is gathered in equilibrium if $r(\eta_l) - c_2(\eta_l) > -r$.*

Proposition 3 *If $r_a(a, s) - r_a(a, s')$ sufficiently small for all s and s', η_1 is not perfectly informative, and $c(\eta_1)$ and Δc sufficiently small, agents overinvest in information gathering in equilibrium.*

Intuition

Equilibrium contract prescribes to gather some information, as this make easier easier to discourage precontractual information.

If Δc very small, best **IC** allocation under η_0 is very close to the autarky one.

However,

If η_1 is also quite uninformative, all interim efficient allocation $(\not h, 1)$ close to the first best.

Equilibrium expected utility must be larger or equal than utility achievable under precontractual information.

Hence, allocations very close to the first best **IC** under η_1.

Dimensionality problem If s only weakly correlated with σ, large distorsions of the first best allocation necessary to generate small reduction of the GAIN from precontractual acquisition under η_0. This is not true under η_1.

Acquisition of information with positive social value (results for production fundig problems)

Assume *MLRP*.

Lemma 4 *For all σ_n, $r_l(\sigma_{n'} \geq \sigma_n) > r_{l-1}(\sigma_{n'} \geq \sigma_n)$. Moreover, there exists a strictly positive vector $k \in \Re^S$ such that $r_l(\sigma_{n'} \geq \sigma_n) - r_{l-1}(\sigma \geq \sigma_n) \geq \sum k_s \left| r_a(a, s') - r_a(a, s) \right|$.*

Intuition in production-funding problems, better information increases the expected productivity conditional on $\sigma_{n'} \geq \sigma_n$, because returns and endowments are positively correlated and r has increasing differences.

Proposition 5 *Incentive sets associated to more informative signals are smalller if one of the following conditions is verified : (i)* $\Delta y(\eta_l)/\sup_{x\in F^*}|u''(x)/u'(x)| > k$; *(ii) there are only two subsets of signals conveying different information; (iii) signals' errors are normally distributed (more generally Blackwell matrices are symmetric)*

Intuition

Conditional on observing $\sigma_{n'} \geq \sigma_n$, agents' wealth is larger in expected terms under more informative signal . HENCE,

Under more informative signals, larger transfers in expected terms necessary to implement any allocation x entailing a any fixed consumption larger than the expected wealth in bad states.

However, larger transfers makes it more difficult to discourage precontractual information gathering.

Proposition 6 *Assume MLRP. Agents underinvest in equilibrium if one of the following conditions is verified : (i)* $\Delta y(\eta_l)/\sup_{x\in F^*}|u''(x)/u'(x)| > k$; *(ii) there are only two subsets of signals conveying different information; (iii) signals' errors are normally distridIuted*

Intuition

By reducing slighly the amount of information gathered with respect to the first best, the effect on expected wealth is second order, but less distorted allocations become incentive as the incentive set gets larger for larger l.