Credibly Confidential Contracts

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Abstract

Confidential contracts are signed to protect the identity of contracting parties from disclosure. However, such confidentiality is not credible if outsiders can perfectly infer the identity of the contracting parties in equilibrium. A confidential contract is credibly confidential when an inactive player uninvolved in the contract holds a non-degenerate Bayesian belief on the identity of the agent in the contractual relationship. The main research questions are whether and through what channel the preference for credible confidentiality influences incentive provision within a contract and how confidentiality concerns affect the endogenous formation of contractual relationships. With a preference for confidentiality, an agent's participation is motivated by a confidentiality premium, which amplifies the conventional tradeoff between efficiency and risk premium. Confidentiality concerns thus distort incentives within a contractual relationship when the agent is risk-averse. Furthermore, the principal may deliberately contract with a less efficient agent with a higher equilibrium probability to reduce the confidentiality premium, leading to an inefficient match. Credible confidentiality provides an explanation for the distortion of incentive provision within a contractual relationship and an inefficient formation of contractual relationships even when the principal and the agents are rational and well-informed.

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1 Introduction

Privacy concerns have become an important and well-recognized aspect of decision-making, whether in protecting or disclosing personal identity, safeguarding corporate R&D secrets, or ensuring national security. Confidential contracts serve as a tool to maintain privacy by keeping the identities of the contracting parties undisclosed. These contracts are widely used in national defense procurement, memoranda of R&D cooperation among firms, or poaching for experts before the official transition. Despite their relevance, confidential contracts have received only limited attention in contract theory.[1]

Confidentiality on paper does not necessarily imply real confidentiality. For instance, consider a principal attempting to poach an agent from a rival company while keeping the contract confidential, at least before the agent makes the official move. If it is common knowledge that this pair would generate the highest surplus among all possible pairs, outsiders can correctly infer their contractual relationship in equilibrium despite its confidentiality. The contract is not "credibly" confidential. In this paper, I recognize credible confidentiality as an equilibrium outcome where any inactive player (an uninvolved third party) has a non-degenerate Bayesian belief on who signed the contract. Given preferences for confidentiality, I characterize the credibly confidential contract and investigate the endogenous formation of principal-agent relationships. Our main research questions are whether and through what channel the confidentiality concern influences incentives within a contract and under what conditions a less efficient principal-agent relationship would arise with a higher probability.

Suppose that the principal proposes a confidential contract to an agent among a fixed pool of agents. The contract is designed to provide an incentive for the agent to exert a certain level of productive effort, i.e., a standard contract with moral hazard. Conventionally, the contractual relationship involves the pair of principal and agent with the highest matching value. With complete information on the matching values, in equilibrium, the inactive players (the public) can make a correct Bayesian inference on the identity of the agent in the contractual relationship. If the agent values confidentiality, he anticipates a disutility of identity exposure and refrains from signing the conventional contract. To induce participation, the principal offers additional compensation in the optimal contract, termed the confidentiality premium.

[1]Secret contracts served as an assumption to justify and simplify secret negotiations within a vertical organization, e.g., Martimort (1996), Piccolo, Tarantino, and Ursino (2015), and Dequiedt and Martimort (2015). In these papers, the secrecy of contracts is not part of the main research question.

The confidentiality premium amplifies the conventional tradeoff between efficiency and risk premium if the agents are risk-averse, which further distorts productive efficiency. Intuitively, the confidentiality premium raises the transfer payment, implying a lower marginal utility of transfer. It then requires a steeper transfer schedule in the contract to implement the same level of effort, which is feasible at an even higher risk premium. The principal thus finds it optimal to implement a lower level of effort. The credibly confidential contract is subject to contractual inefficiency. If the agents are risk-neutral, the confidentiality premium is independent of productive efforts. The credibly confidential contract implements efficient production. However, the confidentiality premium may lead to an inefficient distribution of contractual relationships, even with risk-neutral agents.

The confidentiality premium implies a higher contracting cost for the principal when she contracts with the agent of the highest matching value with certainty. By randomizing to whom she proposes the contract in equilibrium, the principal reduces the agent's disutility of identity exposure and saves the confidentiality premium. This is at the expense of contracting with an agent of a lower matching value with a positive probability in equilibrium, i.e., the principal faces a tradeoff between organizational efficiency and confidentiality premium. When the surplus loss from contracting with an agent of a lower matching value is outweighed by the reduction of confidentiality premium, the principal deliberately contracts with an agent of a lower matching value with a higher probability. This holds when the agents are not too diverse in matching values or when the agent of a lower matching value has a sufficiently weaker disutility of identity exposure. An inefficient distribution of contractual relationships arises. The concern of credible confidentiality is proposed as a novel explanation for contracting with an agent of a lower matching value, even when it is common knowledge that a more valuable one is available.

The inefficient organization is solely driven by the agents' aversion to identity exposure. The principal's preference for confidentiality does not explain the inefficient organization. If the agents are neutral to identity exposure, a confidentiality premium is not required to induce participation. The principal no longer faces a tradeoff between organizational efficiency and confidentiality premium. Any randomization of contractual relationships results from the principal's intrinsic preference for confidentiality, which is independent of the agents' matching values.

■ **Related Literature and Contribution.** The paper focuses on how privacy concerns affect the optimal confidential contract and the equilibrium contractual relationship.[2] It contributes to the vast economic literature on privacy.[3] The literature has been most active in behavior-based price discrimination as in Fudenberg and Tirole (1998), Villas-Boas (2004), Acquisti and Varian (2005), and Conitzer, Taylor, and Wagman (2012), as well as in targeted advertising as in Bergemann and Bonatti (2015), de Cornière and de Nijs (2016), and papers cited therein. Another active strand of the literature considers trades of data that contain personal information, either among the sellers, as in Taylor (2004) and Calzolari and Pavan (2006), or with some information intermediaries, as in Bergemann and Bonatti (2015) and Kastl, Pagnozzi, and Piccolo (2018). In these papers, privacy is treated as the technology to track or untrack the consumers' personal information on previous actions and choices. They study the endogenous decisions to disclose, to conceal, or to trade such information, as well as how these decisions interplay with the pricing and advertising strategies. In this paper, the information kept in the confidential contract is treated as given, and there is no way to explicitly disclose or transmit such information. Instead, the identities of contracting parties are inferred through equilibrium actions. I emphasize the equilibrium distortion of incentives and contractual relationships in order to maintain credible confidentiality.

With a similar idea that actions change perception and incentives, Daughety and Reinganum (2010) viewed privacy as the unobservability of actions to provide public goods, which also signals the value of public goods and affects the agent's social approval. They studied a different research question on whether there is a privacy-waiver equilibrium when maintaining privacy crowds out the possibility of signaling. Closest in the concept of privacy, Gradwohl and Smorodinsky (2017) also regard privacy as the belief of inactive players. They study conditions under which the equilibrium has full pooling in actions of all types of players when the players are anonymity-seeking or identification-averse. By anonymity seeking, the player's utility maximizing level of privacy is the prior belief. By identification aversion, the player's utility minimizing level of privacy is full disclosure of his type. The main research question is how privacy concerns affect the players' equilibrium actions in a perception game. The model of preference for confidentiality in this paper has special cases resembling these two preferences for privacy. The main modeling differences rely on two aspects. First, the types of agents (their matching values with the principal) are commonly known.

[2] It builds on contract theory with hidden actions pioneered by Mirrlees (1999, completed in 1975), Holmström (1979), and Grossman and Hart (1983). Please refer to a lecture by Holmström (2017) for the theory and insights over the decades of research.

[3] Please refer to Acquisti, Taylor, and Wagman (2016) for a comprehensive survey on the Economics of privacy.

Second, the principal can offer an incentive contract with a non-degenerate probability to an agent out of many. It is the identity of the contracting party instead of their type that is subject to confidentiality concerns. This allows me to pin down the distortion of contracts and the distribution of contractual relationships purely due to the aversion to identity exposure without real informational effects.

The implication of inefficient contractual relationships also contributes to the literature on contracting with search frictions, e.g., Demougin and Helm (2011), Moen and Rosén (2011), and Starmans (2024). In these papers, inefficient contractual relationships are attributed to search or informational frictions. I propose an alternative explanation for inefficient contractual relationships due to the desire to credibly conceal contracting identity, even if all players are well-informed of their matching values. Preference for confidentiality or aversion to identity exposure is empirically difficult to identify. Nevertheless, there were some efforts in lab experiments to study whether subjects behave differently when they are aware that they are perfectly anonymous to the experimenters or not. The evidence was mixed. Cox and Deck (2005) investigated reciprocal behaviors in trust games given double or single anonymity between the subjects and the experimenters and found significantly different behavior only for the second mover. In a lab-in-the-field experiment, List, Berrens, Bohara, and Kerkvliet (2006) found evidence that voting behaviors are different when subjects know that their votes are not perfectly observable by the experimenters. Barmettler, Fehr, and Zehnder (2012) found no significant evidence that pro-social behaviors depend on anonymity to the experimenter, while Vorlaufer (2019) found that pro-social behaviors are less likely and anti-social behaviors are more likely when the subjects are identifiable by an ID number than when they are strictly anonymous.

2 The Contracting Model

A principal owns a project that requires an agent's professional skill to complete. She is to sign a confidential contract with one and only one agent from a pool of n agents with relevant skills. The identity of the agent who signs the contract, as well as the content of the contract, are confidential (at least in the near future) to others but verifiable to the benevolent, secret-keeping judicial system. Demand for confidentiality can be found, for example, in national defense procurement, memoranda of R&D cooperation among firms, employment contracts with personnel who have access to highly classified future business plans, poaching for experts before official announcements, etc.

Jointly with the principal, the agent with identity $i \in N = \{1, 2, ..., n\}$ is able to generate commonly known matching value $v_i > 0$ for the project, $v_i \neq v_j$ for all $i \neq j$.[4] The identity i includes some traits of the agents, e.g., the field of research, gender, sexual orientation, etc., some of which the agents prefer to remain private, and some related to the principal's project so that she prefers to remain in secrecy. The matching value v_i is the differentiated ability of the agent or an indication of how relevant the agent's human capital or technology is to the principal's project. No assumption is made on whether there is a causation between the agent's identity i and his matching value v_i. Some traits of an agent may be related to the matching value, while others are not.

If a contractual relationship is formed, the agent exerts unobservable productive effort $e \in [0, \overline{e}]$ at a constant marginal cost $c > 0$, with $\overline{e} \in (0, \infty)$. Productive effort e generates one unit of contractible output (success) with probability $q(e|v_i)$, zero units of output (failure) otherwise. The probability $q(e|v_i)$ is increasing and concave in the effort, with $q(0|v_i) = 0$, $\lim_{e \to \overline{e}} q(e|v_i) \leq 1$, $\lim_{e \to 0} q'(e|v_i) > c$, and $\lim_{e \to \overline{e}} q'(e|v_i) < c$ so that the efficient level of effort is an interior solution; it has $q(e|v_i) \geq q(e|v_j)$ and $q'(e|v_i) \geq q'(e|v_j)$ for any $v_i > v_j$, with equality only at the limits. Transfer payments made to the agent contingent on the realization of outputs are contractible. The principal commits to pay $t_1$when the agent successfully generates one unit of output, t_0 otherwise. Transfer $t \in \{t_0, t_1\}$ gives the agent utility of transfer $u(t)$, which has $u'(t) \geq 0$, with equality at zero transfer, and $u''(t) \leq 0$.

Confidentiality is defined as the anonymity of who has signed the contract. The identity of the agent who signs the contract with the principal is confidential. Both the principal and the agent intrinsically value this confidentiality; otherwise, they would not have the incentive to sign a confidential contract in the first place. For instance, the principal may value the agent's anonymity because his field of specialty is highly related to the content of the project, and disclosure of which to competitors may result in detrimental outcomes. The agent values his anonymity as well. This possibly comes from peer pressure, e.g., accepting a job offer from a principal who has expressed discrimination against his peer, unfriendly gestures out of envy from other agents, or simply his aversion to being the center of attention. In this paper, I do not dig into the motivation for signing a confidential contract. Instead, I emphasize how contractual and organizational efficiency are affected by the preference for confidentiality.

Denote μ_i as the common Bayesian updated belief of some inactive players[5] that

[4]The assumption of commonly known matching value allows us to clearly distinguish confidentiality and credible confidentiality as an equilibrium outcome. As will be shown later, the benchmark confidential contract is not credibly confidential.

[5]They can be viewed as the general public, including other agents and the rival firms external to

the principal contracts with agent i. The contract is said to be credibly confidential if the Bayesian updated belief is non-degenerate for some agents, and it is not credibly confidential if the Bayesian updated belief is degenerate. When it is believed that the principal contracts with agent i with probability μ_i, agent i has a quadratic disutility of identity exposure $d(\mu_i|\eta_i, \alpha_i) = \eta_i \cdot (\mu_i - \alpha_i)^2$ and the principal (with index 0) has an aggregate disutility of identity exposure $d(\mu|\eta_0, \alpha_0) = \sum_{i \in N} \eta_0 \cdot (\mu_i - \alpha_0)^2$. The parameter η_k measures player k's disutility of being correctly perceived as having signed the contract, normalizing the disutility when not signing the contract to zero.[6] The parameter $\alpha_k \in [0, 1]$ measures the most preferred level of credible confidentiality for player k, which characterizes the player's preference for confidentiality. If α_i corresponds to the prior distribution of the agents' identities, the agents in this model are anonymity-seeking by the definition of Gradwohl and Smorodinsky (2017). For another example, $\alpha_i = 0$ represents the identification-averse agents by the definition of Gradwohl and Smorodinsky (2017). The principal's aggregate disutility from identity exposure incorporates the assumption that the agents differ only in matching value from the principal's perspective. The principal's preference for confidentiality is independent of the agents' identities except through the equilibrium probability of contracting.[7]

The timeline of the model is summarized as the following. The principal approaches agent i with probability p_i and proposes a contract $\mathbb{C}_i = \{t_{1i}, t_{0i}\}$ implementing effort e_i. The agent can accept or reject the contract. If the contract is rejected, the principal runs out of resources to contract with another agent, and both the principal and the agent earn zero reservation payoff. If the contract is accepted, the principal and the agent form a contractual relationship (or an organization, interchangeably used in this paper). The agent exerts effort, followed by the realization of output. Payment is made according to the contract specification.

this contractual relationship. I borrow the term from the literature studying the player's perception concern, e.g., Gradwohl and Smorodinsky (2017).

[6] It can also be regarded as measuring the difference in player k's disutility of being correctly perceived as having signed the contract and his disutility when not having signed the contract. I will focus on a positive measure, which is intuitively consistent with the motive to sign a confidential contract. For instance, if an agent's disutility of identity exposure is the same whether he agrees to a contract or not, given a fixed belief of the inactive players, he would not particularly prefer a confidential contract. A negative measure indicates a relatively higher disutility of being correctly perceived as not signing the contract, which is briefly discussed in Section 4.

[7] We abstract from the idea that the principal has a different preference for confidentiality when contracting with different agents. This is briefly discussed in Section 4.

3 Optimal Contract and Organization

We apply the perfect Bayesian equilibrium for analysis throughout. The equilibrium consists of the principal's probability of proposing a contract to each agent, a set of optimal contracts to each agent who receives a proposal with a positive probability, and the Bayes-consistent beliefs of the inactive players regarding the equilibrium probability distribution over the contractual relationship. In equilibrium, the inactive players believe that with probability $\mu_i = p_i$, the principal forms a contractual relationship with agent i. Contracting with agent i, the principal's expected profit is $\pi(e_i, t_{1i}, t_{0i}|v_i) = q(e_i|v_i) \cdot (1 - t_{1i}) - (1 - q(e_i|v_i)) \cdot t_{0i}$. Averse to identity exposure, the principal's expected payoff given the inactive players' consistent belief is $\Pi(e, t_1, t_0, p) = \sum_{i \in N} p_i \cdot \pi(e_i, t_{1i}, t_{0i}|v_i) - d(p|\eta_0, \alpha_0)$, where (e, t_1, t_0, p) are profiles of $(e_i, t_{1i}, t_{0i}, p_i)$ for $i \in N$. Agent i's expected payoff in the contractual relationship given the inactive players' consistent belief is $U(e_i, t_{1i}, t_{0i}|v_i) - d(p_i|\eta_i, \alpha_i) = q(e_i|v_i) \cdot u(t_{1i}) + (1 - q(e_i|v_i)) \cdot u(t_{0i}) - c \cdot e_i - \eta_i \cdot (p_i - \alpha_i)^2$.

Agent i has the incentive to accept the contract $\mathbb{C}_i = \{t_{1i}, t_{0i}\}$ and to exert effort e_i if the following individual rationality[8] and incentive compatibility constraints are satisfied,

$$U(e_i, t_{1i}, t_{0i}|v_i) - d(p_i|\eta_i, \alpha_i) \geq 0 \qquad (IR_i)$$

and

$$e_i \in \arg\max_a U(a, t_{1i}, t_{0i}|v_i) - d(p_i|\eta_i, \alpha_i) \qquad (IC_i).$$

The principal chooses the probability to propose a contract to each agent, the transfer payment specified in the contract proposed to each agent, and the implemented effort from each agent that

$$\max_{e, t_1, t_0, p} \Pi(e, t_1, t_0, p)$$

subject to (IR_i) and (IC_i) for $i \in I = \{j \mid j \in N \wedge p_j > 0\}$, and that $\sum_i p_i \leq 1$.

■ **Benchmark.** Without the confidentiality concern ($\eta_k = 0$ for all $k \in N \cup \{0\}$), the model corresponds to the standard contract theory with hidden action. The organization is efficient in the sense that the principal contracts with the agent of the

[8] The disutility of identity exposure is interpreted as a loss when being correctly perceived as having signed the contract, which can be avoided simply by not signing the contract. An alternative modeling choice is to assume that the agent's disutility of identity exposure is present as long as he stays in the pool of agents, whether he signs the contract or not, yet it is higher when he actually signs it. This alternative modeling has an ex-ante participation constraint, as discussed in Section 4. The current individual rationality can be treated as a reduced form of this ex-ante participation constraint.

highest matching value $v_a = \max_i v_i$. The inactive players believe that with probability $\mu_a = 1$ agent a signed the contract, even if the contract is confidential to the inactive players. The optimal contract $\overline{\mathbb{C}}_a = \{\bar{t}_{1a}, \bar{t}_{0a}\}$ implements efficient effort $\bar{e}_a \in \arg\max_e q(e|v_a) - c \cdot e$ with an expected transfer equal to the cost of effort $q(\bar{e}_a|v_a) \cdot \bar{t}_{1a} + (1 - q(\bar{e}_a|v_a)) \cdot \bar{t}_{0a} = c \cdot \bar{e}_a$ if the agent is risk-neutral; it implements the second-best effort $\tilde{e}_a < \bar{e}_a$ if the agent is risk-averse due to a standard tradeoff of risk premium and efficiency. With the confidentiality concern, the standard contract is at the cost of $\eta_0 \cdot (1 - \alpha_0)^2 + (n-1) \cdot \eta_0 \cdot (0 - \alpha_0)^2$ to the principal and at the cost of $\eta_a \cdot (1 - \alpha_a)^2$ to agent a. The benchmark contract is infeasible due to violation of individual rationality if agent a is averse to identity exposure, captured by $\eta_a > 0$ and $\alpha_a < 1$. These are assumed for the rest of this paper.

3.1 Contractual Efficiency

An agent i suffers from a disutility of identity exposure when he is believed, with a positive probability of $p_i > 0$, to form a contractual relationship with the principal in equilibrium. To motivate participation under this concern of identity exposure, the incentive feasible contract exhibits a higher expected utility of transfer than the cost of effort, as if a confidentiality premium is conceded to the agent regardless of the realized output. The confidentiality premium provides an incentive to form a contractual relationship. Whether it affects the implemented effort depends on the agent's risk preference.

Proposition 1. *Contracting with a risk-neutral agent i, the optimal contract $\mathbb{C}_i^* = \{t_{1i}^*, t_{0i}^*\}$ implements efficient effort $e_i^* = \bar{e}_i$ with a confidentiality premium $m^* = \eta_i \cdot (p_i - \alpha_i)^2 > 0$. Contracting with a risk-averse agent i, the optimal contract $\mathbb{C}_i^* = \{t_{1i}^*, t_{0i}^*\}$ further distorts the implemented effort from the second-best $e_i^* < \tilde{e}_i$ if the absolute risk aversion is not sharply decreasing in transfer.*

Proof. Appendix A.1. □

With a risk-neutral agent, the confidentiality premium is only an additional source of transfer to induce participation. It is independent of the productive output and the incentives once the contract is signed. Therefore, the optimal confidential contract implements efficient effort from the risk-neutral agent who receives an offer with a positive probability. With a risk-averse agent, on the other hand, the confidentiality premium amplifies the tradeoff between risk premium and efficiency. Intuitively, a higher transfer incorporating the confidentiality premium implies a lower marginal utility of transfer. It thus requires a steeper transfer schedule (a larger difference between transfers conditional on outputs, $t_{1i} - t_{0i}$) to provide incentives, which leads to an even higher risk premium. The optimal effort is further distorted downwards from the second-best. The agent's aversion to identity exposure has a negative impact on contractual efficiency through his risk aversion.

3.2 Organizational Efficiency

The confidentiality concern affects not only the optimal transfers and effort within a contractual relationship but also the formation of contractual relationships, captured by the equilibrium probability to contract with each agent. To focus on the effect of the confidentiality concern on the equilibrium formation of contractual relationships, assume that agents are risk-neutral.

Anticipating the optimal contracts in Proposition 1, the principal contracts with agent i with probability p_i^* that

$$\max_p \sum_{i \in N} \left[p_i \cdot \left(\underbrace{q(e_i^*|v_i) - c \cdot e_i^*}_{\text{contractual surplus}} - \underbrace{\eta_i \cdot (p_i - \alpha_i)^2}_{\text{confidentiality premium}} \right) - \underbrace{\eta_0 \cdot (p_i - \alpha_0)^2}_{\text{disutility of exposure}} \right]$$

subject to $\sum_i p_i \leq 1$, with $p = (p_1, p_2, ..., p_n)$. Denote $\lambda \geq 0$ as the Lagrange multiplier to the constraint.

The likelihood of contracting with agent i exhibits a tradeoff between surplus of the contractual relationship (captured by $q(e_i^*|v_i) - c \cdot e_i^*$) and the disutility of identity exposure, the latter in the form of confidentiality premium to the agent (captured by $\eta_i \cdot (p_i - \alpha_i)^2$) and the principal's disutility of identity exposure (captured by $\eta_0 \cdot (p_i - \alpha_0)^2$). The principal is more likely to contract with agent i with whom the contractual surplus is higher, with whom the confidentiality premium to induce participation is lower, and such that the principal herself is at a lower disutility of identity exposure. To reduce the confidentiality premium and the principal's own disutility of identity exposure, the principal may trade off organizational efficiency by contracting with an agent who does not have the maximum matching value with a positive probability.[9]

Lemma 1. *For any agent i to whom the principal proposes the contract with probability $p_i^* > 0$, $q(e_i^*|v_i) - c \cdot e_i^* - (\eta_i \cdot (p_i^* - \alpha_i)^2 + p_i^* \cdot \eta_i \cdot 2 \cdot (p_i^* - \alpha_i)) - \eta_0 \cdot 2 \cdot (p_i^* - \alpha_0) = \lambda^*$.*

[9]Koch and Peyrache (2008) also studied the implementation of mixed strategies in a principal-agent relationship. They focus on mixed strategy in efforts that creates a career concern and reduces explicit payments, whereas I focus on mixed strategy in the formation of contractual relationship to reduce the confidentiality premium.

For any agent $-i$ to whom the principal proposes the contract with probability zero, $q(e^*_{-i}|v_{-i}) - c \cdot e^*_{-i} - \eta_{-i} \cdot \alpha^2_{-i} + 2 \cdot \eta_0 \cdot \alpha_0 < \lambda^*$.

Proof. Appendix A.2. □

Agents to whom the principal proposes the contract with a positive probability have the same rank of surplus-confidentiality. The surplus within the contractual relationship net of the marginal confidentiality premium and the principal's marginal disutility of identity exposure is the same among agents who receive a contract proposal with a positive probability. An agent who receives the contract proposal with zero probability either generates a lower surplus had he participated in the contractual relationship or is so averse to identity exposure that it would take a large confidentiality premium to induce participation.

Among the agents to whom the principal proposes the contract with a positive probability, it is possible that the concern of identity exposure outweighs the contractual surplus so that the principal contracts with an agent of a lower matching value with a higher probability. To see this, suppose that among all agents who receive a contract proposal with a positive probability, agent h has the highest matching value, v_h, and agent l has a matching value of $v_l < v_h$. Denote $s(v_i) \equiv q(e^*_i|v_i) - c \cdot e^*_i$ as the maximum surplus in a contractual relationship with agent i. Contracting with agent l with a higher probability, the principal is subject to an efficiency loss of $s(v_h) - s(v_l)$. Denote $\Delta(\alpha_h, \alpha_l, p^*_h) \equiv \eta_h \cdot (p^*_h - \alpha_h) \cdot (3 \cdot p^*_h - \alpha_h) - \eta_l \cdot (p^*_h - \alpha_l) \cdot (3 \cdot p^*_h - \alpha_l)$ as the difference in the marginal expected confidentiality premium between agent h and agent l, had the principal proposed a contract to each agent with the same probability p^*_h. Contracting with agent l with a higher probability, the principal benefits from a reduced expected confidentiality premium $\Delta(\alpha_h, \alpha_l, p^*_h)$. It is more likely for the principal to contract with an agent of a lower matching value if the surplus loss falls short of the reduced marginal expected confidentiality premium, i.e., $p^*_l > p^*_h$ for $v_l < v_h$ if and only if $s(v_h) - s(v_l) < \Delta(\alpha_h, \alpha_l, p^*_h)$.

Definition. For explanatory ease, we say that the organization is inefficient if the principal contracts with an agent of a lower matching value with a higher equilibrium probability, i.e., $p^*_h < p^*_l$ when $v_h > v_l$.

Proposition 2. *An inefficient organization occurs if and only if $s(v_h) - s(v_l) < \Delta(\alpha_h, \alpha_l, p^*_h)$, given which the equilibrium organization satisfies one of the following three scenarios.*

1. *If the agent of a lower matching value is less averse to identity exposure in the sense that $\eta_l < \eta_h$, the inefficient organization has a sufficiently skewed equilibrium distribution of contractual relationships, with either $p_h^* > \max\{\alpha_h, \alpha_l\}$ or $p_h^* < \min\{\frac{\alpha_h}{3}, \frac{\alpha_l}{3}\}$.*

2. *If the agent of a lower matching value is more averse to identity exposure in the sense that $\eta_l > \eta_h$, the inefficient organization has an insufficiently skewed equilibrium distribution of contractual relationships, with $p_h^* \in \big(\max\{\frac{\alpha_h}{3}, \frac{\alpha_l}{3}\}, \min\{\alpha_h, \alpha_l\}\big)$.*

3. *If the preferred confidentiality has $\alpha_h > \alpha_l$, the inefficient organization has an equilibrium distribution of contractual relationship with $p_h^* \in \big(\frac{\alpha_l}{3}, \min\{\frac{\alpha_h}{3}, \alpha_l\}\big)$; if $\alpha_h < \alpha_l$, it has $p_h^* \in \big(\max\{\frac{\alpha_l}{3}, \alpha_h\}, \alpha_l\big)$.*

Proof. Appendix A.2. □

Proposition 2 lists three scenarios in which the principal reduces the expected confidentiality premium at the expense of organizational efficiency. In the first scenario, the expected confidentiality premium is increasing in the probability of contracting for both agents, given a sufficiently skewed distribution of contractual relationships. If the agent of a lower matching value is less averse to identity exposure, the principal can reduce the expected confidentiality premium by contracting with him at a higher probability, trading off the chance to contract with the agent of a higher matching value. In the second scenario, the expected confidentiality premium is decreasing in the probability of contracting for both agents, given an insufficiently skewed distribution of contractual relationships. The principal can reduce the expected confidentiality premium by implementing an inefficient organization if the agent of a lower matching value is more averse to identity exposure. In the third scenario, the expected confidentiality premium is increasing in the probability of contracting for the agent of a higher matching value while decreasing for the agent of a lower matching value. It is optimal for the principal to contract with the latter with a higher probability, regardless of his disutility of identity exposure.[10]

Neither $s(v_h) - s(v_l)$ nor $\Delta(\alpha_h, \alpha_l, p_h^*)$ in Proposition 2 directly depends on the principal's preference for confidentiality (η_0). The principal's disutility of identity exposure is irrelevant at the margin when the marginal expected confidentiality premium is evaluated at the same probability of contracting. The dominant elements in

[10]We neglect the discussion on the opposite scenario with a decreasing (increasing) expected confidentiality premium in the probability of contracting with the more (less) efficient agent. Organizational inefficiency is absent in this case.

$\Delta(\alpha_h, \alpha_l, p_h^*)$ are the agents' confidentiality concerns. Therefore, when the agents do not have any preference for confidentiality, inefficient organizations do not occur.

Corollary 1. *The inefficient organization is driven solely by the agents' aversion to identity exposure. It is never optimal for the principal to contract with an agent of a lower matching value with a higher probability when the agents have zero disutility of identity exposure.*

Proof. Appendix A.2. □

Intuitively, if the agents are not averse to identity exposure, there is no tradeoff between organizational efficiency and confidentiality premium. The probability of contracting exhibits a tradeoff only between organizational efficiency and the principal's disutility of identity exposure. At any probability of contracting, the latter is identical across agents. Therefore, the principal contracts with an agent of a higher matching value with a higher probability, i.e., $p_h^* > p_l^*$ for $v_h > v_l$. An inefficient organization does not arise.

■ **Simple Example.** Consider a two-agent model with agent h and agent l such that $v_h > v_l$. Let $q(e|v_i) = \sqrt{v_i \cdot e}$, where $e \in [0, 1]$ and $v_i \in (0, 1]$. The surplus in the contractual relationship is thus $s(v_i) = \frac{v_i}{4 \cdot c}$. Suppose that both agents prefer to be completely off the radar, defined as $\alpha_i = 0$ for both i, and that the principal is not averse to identity exposure, $\eta_0 = 0$, to focus on the tradeoff between organizational efficiency and confidentiality premium. The organization is inefficient with $p_h^* < p_l^*$ if and only if $\frac{v_h - v_l}{3 \cdot c} < \eta_h - \eta_l$. This holds when the difference in surplus in the contractual relationship is insufficiently large, yet the difference in confidentiality premium is sufficiently large. The principal thus trades off organizational efficiency to reduce the confidentiality premium when signing a credibly confidential contract.

4 Discussion: Scope of the Model

The current model is constructed to focus on how confidentiality concerns affect the optimal contract and the distribution of contractual relationships. More fruitful implications can be derived by relaxing some of the premises.

■ **Endogenous Pool of Agents**[11]

The pool of agents who have the relevant ability to participate in the principal's project is assumed to be fixed. However, it can be an outcome realized from the endogenous choices of the principal and the agent in several ways. If we consider this pool as the principal's talent pool or her list of subcontractors before contracting, the principal can exclude agents with high disutility of identity exposure from the pool to reduce the expected confidentiality premium given complete information on such disutility. If the agents are anonymity-seeking with $\alpha_i = \frac{1}{n}$ for any i, the principal may strategically increase the number of agents in the pool and randomize her contract proposal over a larger subset of the agents. The principal's choice of n in either of the scenarios exhibits a tradeoff between confidentiality premium and subsequent contracting efficiency. Additional implications on the size of the labor or subcontractor market can be derived from this relaxation, but the fundamental tradeoff remains.

Alternatively, the principal can implement the size of the agent pool. In the current paper, given the fixed pool of agents, the individual rationality constraint does not incorporate the agent's willingness to stay in the pool. If the agent can freely join or exit the pool, the feasible contract must take the agent's ex-ante individual rationality into account, while (IR_i) in Section 3 is an interim individual rationality conditional on staying within the agent pool. Denote $\hat{d}(\mu_i|\hat{\eta}_i, \alpha_i)$ as the disutility of identity exposure when agent i is included in the agent pool but does not receive an offer. Agent i's expected disutility of identity exposure is therefore $p_i \cdot d(p_i|\eta_i, \alpha_i) + (1-p_i) \cdot \hat{d}(p_i|\hat{\eta}_i, \alpha_i)$ before the principal proposes a contract with a positive probability p_i. The contracting problem is subject to an additional participation constraint

$$p_i \cdot [U(e_i, t_{1i}, t_{0i}|v_i) - d(p_i|\eta_i, \alpha_i)] - (1 - p_i) \cdot \hat{d}(p_i|\hat{\eta}_i, \alpha_i) \geq 0$$

to induce the agent to stay in the pool. Given binding (IR_i) in Section 3, this constraint is clearly violated for any $\hat{d}(p_i|\hat{\eta}_i, \alpha_i) > 0$, implying that an additional premium is required to induce the agent to stay in the pool of potential contracting partners. The tradeoff between contractual efficiency and confidentiality premium will lean towards the latter.

[11] I am grateful to an anonymous referee who raised this interesting point.

■ Risk-Neutral Agents with Limited Liability

We have shown in Proposition 1 that the confidentiality concern amplifies the tradeoff between contractual efficiency and risk premium. The natural question would be whether it also amplifies the tradeoff between efficiency and limited liability rent in a similar manner.

The standard contract with a risk-neutral agent protected by limited liability is such that the binding limited liability constraint gives the agent additional rent, which results in slacking individual rationality. Given the equilibrium distribution of contractual relationships, if the agents have sufficiently mild confidentiality concerns, a slight disutility of identity exposure does not violate individual rationality. The standard contract is still optimal. On the opposite extreme, the optimal contract in Proposition 1 satisfies limited liability if the confidentiality premium is sufficiently high. This happens when the agents have sufficiently strong confidentiality concerns. The confidentiality premium outweighs the required limited liability rent, making the latter irrelevant.

Proposition 3. *A sufficiently strong confidentiality concern mitigates the tradeoff between efficiency and limited liability rent. Effort is restored to its efficient level.*

Proof. A detailed derivation can be found in Appendix A.4. □

■ Attention Seeker

To focus on credibly confidential contracts, I assumed that the agents are averse to identity exposure. The fundamental idea that the perception of inactive players affects the optimal contract can apply to the opposite scenario with attention-loving agents, i.e., when $\eta_i < 0$ and $\alpha_i = 0$ for each agent i. With other assumptions remaining the same, the reasoning behind Proposition 1 stands. An agent who receives a contract offer with a positive probability enjoys additional utility of attention, so he is willing to accept a contract with a lower expected transfer. For a risk-neutral agent, the utility of attention is independent of incentives once the contract is signed. The optimal contract implements efficient effort at a lower expected transfer payment. For a risk-averse agent, however, a lower transfer in response to the positive utility of attention implies a higher marginal utility of transfer. It requires a flatter transfer schedule to provide incentives, which relaxes the tradeoff between efficiency and risk premium. The optimal effort is restored upwards from the second-best. The agent's love of attention improves contractual efficiency.

In terms of organizational efficiency, the principal's contracting problem is convex in p_i when $\eta_i < 0$. The equilibrium distribution of contractual relationships is, therefore, degenerate. The principal is willing to contract with an agent who does not have the highest matching value if he is sufficiently attention-loving (captured by a sufficiently high $|\eta_i|$) and if the surplus in this relationship does not differ too much from the most efficient relationship (e.g., $s(v_h) - s(v_l)$ is sufficiently small).

■ **Heterogeneous Preferences for Confidentiality across Agents**

The assumption that the principal's preferred level of confidentiality, α_0, is the same across agents is to capture her intrinsic preference for confidentiality that is independent of the agents' identities. It can be relaxed to include the possibility that it is especially costly for the principal to be inferred as a contracting partner with a specific agent, e.g., an agent with a serious criminal record. The optimal contract given $p_i > 0$ does not directly depend on the principal's preference for confidentiality, so Proposition 1 holds qualitatively. The equilibrium distribution of contractual relationships not only reflects the tradeoff between contractual surplus and the confidentiality premium in Section 3.2 but also involves an additional consideration of the principal's heterogeneous preference for confidentiality across agents. Given an additively separable disutility, this additional consideration has no qualitative effects on the tradeoff between contractual surplus and the confidentiality premium. However, Corollary 1 no longer holds, and the principal's preference for confidentiality can partially explain an inefficient organization.

5 Conclusion

Confidentiality of contract is recognized as an equilibrium belief. With preferences for such credible confidentiality, the optimal contract includes a confidentiality premium to induce participation. This does not crowd out productive effort in a given contractual relationship with a risk-neutral agent but amplifies the risk-efficiency tradeoff with a risk-averse agent, which further distorts productive effort. Even with risk neutrality without contractual distortion, the confidentiality concern is at the expense of organizational efficiency under some conditions. The principal may optimally contract with an agent of a lower matching value at a higher probability if the organizational surplus loss is smaller in magnitude than the reduction of the expected confidentiality premium.

To focus on how the preference for confidentiality affects the optimal contract, I assumed a commonly known matching value for each agent. What is left for future research is the optimal credibly confidential contract when the agent's matching value is privately known to the contractual relationship. If the distributions of the agents' values do not have overlapping supports, the "link" between the agent's identity and his matching value is common knowledge. The result of this paper persists. The more interesting extension is where the distributions of the agents' matching values have overlapping supports so that there is asymmetric information on the link between the agent's identity and his matching value. In addition, such asymmetrically known link between identity and matching value may be a policy outcome of privacy protection. How the privacy protection policies affect credibly confidential contracts is worth investigating.

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A Appendix: Proofs

The principal's contracting problem

$$\max_{e,t_1,t_0,p} \sum_{i\in N} p_i \cdot (q(e_i|v_i)\cdot(1-t_{1i}) - (1-q(e_i|v_i))t_{0i}) - \sum_{i\in N}\eta_0\cdot(p_i-\alpha_0)^2$$

subject to

$$q(e_i|v_i)\cdot u(t_{1i}) + (1-q(e_i|v_i))\cdot u(t_{0i}) - c\cdot e_i - \eta_i\cdot(p_i-\alpha_i)^2 \geq 0 \qquad (IR_i),$$

$$e_i \in \arg\max_e q(e|v_i)\cdot u(t_{1i}) + (1-q(e|v_i))\cdot u(t_{0i}) - c\cdot e - \eta_i\cdot(p_i-\alpha_i)^2 \qquad (IC_i),$$

and

$$\sum_i p_i \leq 1.$$

A.1 Proof of Proposition 1

Disutility of identity exposure does not depend on the content of the contract, so the contract proposed to agent i with probability p_i, $\mathbb{C}_i^* = \{t_{1i}^*, t_{0i}^*\}$ implementing e_i^*, solves the reduced problem

$$\max_{e_i, t_{1i}, t_{0i}} q(e_i|v_i) \cdot (1 - t_{1i}) - (1 - q(e_i|v_i))t_{0i}$$

subject to

$$q(e_i|v_i) \cdot u(t_{1i}) + (1 - q(e_i|v_i)) \cdot u(t_{0i}) - c \cdot e_i - \eta_i \cdot (p_i - \alpha_i)^2 \geq 0 \qquad (IR_i)$$

and

$$e_i \in \arg\max_e q(e|v_i) \cdot u(t_{1i}) + (1 - q(e|v_i)) \cdot u(t_{0i}) - c \cdot e - \eta_i \cdot (p_i - \alpha_i)^2 \qquad (IC_i).$$

For any $t_{1i} > t_{0i}$, the incentive compatibility constraint (IC_i) can be replaced by the local incentive compatibility $q'(e_i|v_i) \cdot (u(t_{1i}) - u(t_{0i})) - c = 0$. Incentive compatibility only depends on the difference in transfer. The individual rationality constraint (IR_i) is binding. For any pair of transfer (t_{0i}, t_{1i}) such that (IR_i) is slacking, there is an alternative pair $(t'_{0i}, t'_{1i}) < (t_{0i}, t_{1i})$ that generates $u(t'_{0i}) = u(t_{0i}) - \varepsilon$ and $u(t'_{1i}) = u(t_{1i}) - \varepsilon$ such that $q(e_i|v_i) \cdot (u(t_{1i}) - \varepsilon) + (1 - q(e_i|v_i)) \cdot (u(t_{0i}) - \varepsilon) - c \cdot e_i - \eta_i \cdot (p_i - \alpha_i)^2 \geq 0$ and that local incentive compatibility is unaffected. The principal clearly prefers (t'_{0i}, t'_{1i}) to (t_{0i}, t_{1i}). By binding (IR_i) and local incentive compatibility, the optimal transfer schedule (t_{1i}^*, t_{0i}^*) to implement effort e_i^* has

$$\begin{cases} u(t_{0i}^*) &= c \cdot \left(e_i^* - \frac{q(e_i^*|v_i)}{q'(e_i^*|v_i)}\right) + \eta_i \cdot (p_i - \alpha_i)^2 \\ u(t_{1i}^*) &= c \cdot \left(e_i^* + \frac{(1 - q(e_i^*|v_i))}{q'(e_i^*|v_i)}\right) + \eta_i \cdot (p_i - \alpha_i)^2 \end{cases}.$$

With $q(e_i^*|v_i) > 0$ and $q'(e_i^*|v_i) > 0$ for any $e_i^* > 0$, the optimal transfer schedule satisfies $t_{1i}^* > t_{0i}^*$.

■ **Risk-Neutral Agent with $u(t) = t$.**

Binding (IR_i) implies that $q(e_i^*|v_i) \cdot t_{1i}^* + (1 - q(e_i^*|v_i)) \cdot t_{0i}^* - c \cdot e_i^* = \eta_i \cdot (p_i - \alpha_i)^2 > 0$. The excessive transfer beyond the cost of effort is to motivate agent i to participate when he is averse to identity exposure, defined as the confidentiality premium $m^* = q(e_i^*|v_i) \cdot t_{1i}^* + (1 - q(e_i^*|v_i)) \cdot t_{0i}^* - c \cdot e_i^* = \eta_i \cdot (p_i - \alpha_i)^2$.

With binding individual rationality, the effort e_i^* implemented by (t_{1i}^*, t_{0i}^*) solves

$$\max_e q(e|v_i) - c \cdot e - \eta_i \cdot (p_i - \alpha_i)^2.$$

The expected transfer is a sum of the total cost of effort and confidentiality premium, with the latter being independent of effort choice. The contract thus implements the efficient level of effort $e_i^* = \bar{e}_i \in \arg\max_e q(e|v_i) - c \cdot e$.

■ **Risk-Averse Agent with $u''(t) < 0$.**

Denote $u_{0i}^* \equiv u(t_{0i}^*)$ and $u_{1i}^* \equiv u(t_{1i}^*)$. With binding individual rationality, the effort e_i^* implemented by (t_{1i}^*, t_{0i}^*) solves

$$\max_e q(e|v_i) - q(e|v_i) \cdot u^{-1}(u_{1i}^*) - (1 - q(e|v_i)) \cdot u^{-1}(u_{0i}^*).$$

The first-order optimality condition has $q'(e|v_i) = q'(e|v_i) \cdot (u^{-1}(u_{1i}^*) - u^{-1}(u_{0i}^*)) + q(e|v_i) \cdot \frac{1}{u'(t_{1i}^*)} \cdot \frac{\partial u_{1i}^*}{\partial e} + (1 - q(e|v_i)) \cdot \frac{1}{u'(t_{0i}^*)} \cdot \frac{\partial u_{0i}^*}{\partial e}$, which can be rearranged to $q'(e|v_i) = q'(e|v_i) \cdot (u^{-1}(u_{1i}^*) - u^{-1}(u_{0i}^*)) + \left(\frac{1}{u'(t_{1i}^*)} - \frac{1}{u'(t_{0i}^*)}\right) \cdot \left(\frac{-q(e|v_i) \cdot (1-q(e|v_i)) \cdot q''(e|v_i) \cdot c}{(q'(e|v_i))^2}\right)$. At $\eta_i = 0$, the solution corresponds to the second-best effort in a standard contracting problem with a risk-averse agent. The difference in transfers $u^{-1}(u_{1i}^*) - u^{-1}(u_{0i}^*)$ is increasing in the disutility of identity exposure as $\frac{\partial(u^{-1}(u_{1i}^*) - u^{-1}(u_{0i}^*))}{\partial d(\mu_i|\eta_i, \alpha_i)} = \frac{1}{u'(t_{1i}^*)} - \frac{1}{u'(t_{0i}^*)} > 0$, given a strictly concave utility of transfer and $t_{1i}^* > t_{0i}^*$. The difference in inverse marginal utilities $\frac{1}{u'(t_{1i}^*)} - \frac{1}{u'(t_{0i}^*)}$ are also increasing in the disutility of identity exposure if $\frac{\partial(u'(t_{1i}^*)^{-1} - u'(t_{0i}^*)^{-1})}{\partial d(\mu_i|\eta_i, \alpha_i)} = -\frac{u''(t_{1i}^*)}{(u'(t_{1i}^*))^3} + \frac{u''(t_{0i}^*)}{(u'(t_{0i}^*))^3} > 0$, which holds if the absolute risk aversion is not sharply decreasing in transfer. Therefore, the right-hand-side of the first-order condition is increasing in $d(\mu_i|\eta_i, \alpha_i)$. The marginal contractual cost of effort for the principal is increasing in the disutility of identity exposure. The optimal effort to implement is further distorted downwards from the second-best.

A.2 Proof of Lemma 1, Proposition 2, and Corollary 1

Anticipating the optimal contracts proposed with probability $p = (p_1, p_2, ..., p_n)$ in Proposition 1, the principal contracts with agent i with probability p_i^* that

$$\max_p \sum_{i \in N} \left[p_i \cdot \left(q(e_i^*|v_i) - c \cdot e_i^* - \eta_i \cdot (p_i - \alpha_i)^2\right) - \eta_0 \cdot (p_i - \alpha_0)^2\right]$$

subject to $\sum_i p_i \leq 1$. Denote λ as the Lagrange multiplier to this constraint and λ^* as its equilibrium measure.

By the first-order optimality conditions, $q(e_i^*|v_i) - c \cdot e_i^* - \eta_i \cdot (p_i - \alpha_i)^2 - p_i \cdot \eta_i \cdot 2 \cdot (p_i - \alpha_i) - \eta_0 \cdot 2 \cdot (p_i - \alpha_0) - \lambda^* \leq 0$, $p_i \cdot [q(e_i^*|v_i) - c \cdot e_i^* - \eta_i \cdot (p_i - \alpha_i)^2 - p_i \cdot \eta_i \cdot 2 \cdot (p_i - \alpha_i) - \eta_0 \cdot 2 \cdot (p_i - \alpha_0) - \lambda^*] = 0$, and $(1 - \sum_i p_i) \cdot \lambda^* = 0$. By the second order conditions, $-\eta_i \cdot (3 \cdot p_i - 2 \cdot \alpha_i) - \eta_0 < 0$ if $\eta_0 > 2 \cdot \eta_i \cdot \alpha_i$ for all p_i or $p_i > \frac{2}{3}\alpha_i - \frac{1}{3} \cdot \frac{\eta_0}{\eta_i}$. For any agent i to whom the principal proposes a contract with a positive probability $p_i^* > 0$, it satisfies $q(e_i^*|v_i) - c \cdot e_i^* - \eta_i \cdot (p_i^* - \alpha_i)^2 - p_i^* \cdot \eta_i \cdot 2 \cdot (p_i^* - \alpha_i) - \eta_0 \cdot 2 \cdot (p_i^* - \alpha_0) = \lambda^*$. It is optimal to propose a contract to agent $-i$ with probability $p_{-i}^* = 0$ if $q(e_{-i}^*|v_{-i}) - c \cdot e_{-i}^* - \eta_{-i} \cdot \alpha_{-i}^2 + \eta_0 \cdot 2 \cdot \alpha_0 < \lambda^*$.

Denote the surplus in the contractual relationship with agent i as $s(v_i) \equiv q(e_i^*|v_i) - c \cdot e_i^*$. Suppose that among all agents to whom the principal proposes a contract with a positive probability, agent h has the highest matching value. Any other agent $l \neq h$ with $l > 0$ has $v_l < v_h$. In equilibrium, $(p_h^*, p_l^*) > (0, 0)$ satisfies $s(v_h) - \eta_h \cdot (p_h^* - \alpha_h)^2 - p_h^* \cdot \eta_h \cdot 2 \cdot (p_h^* - \alpha_h) - \eta_0 \cdot 2 \cdot (p_h^* - \alpha_0) = s(v_l) - \eta_l \cdot (p_l^* - \alpha_l)^2 - p_l^* \cdot \eta_l \cdot 2 \cdot (p_l^* - \alpha_l) - \eta_0 \cdot 2 \cdot (p_l^* - \alpha_0)$ from the optimality conditions in Lemma 1, which can be rearranged to $s(v_h) - s(v_l) - \eta_0 \cdot 2 \cdot (p_h^* - p_l^*) = \eta_h \cdot (p_h^* - \alpha_h) \cdot (3 \cdot p_h^* - \alpha_h) - \eta_l \cdot (p_l^* - \alpha_l) \cdot (3 \cdot p_l^* - \alpha_l)$. The left-hand side of this equation is the difference in surplus and the difference in the principal's disutility of identity exposure, while the right-hand side is the difference in the marginal confidentiality premium.

To see conditions under which the equilibrium has $p_l^* > p_h^*$, evaluate each side of the equation at $p_l = p_h^*$. It is more likely for the principal to contract with agent l who has a lower matching value if and only if $s(v_h) - s(v_l) < \eta_h \cdot (p_h^* - \alpha_h) \cdot (3 \cdot p_h^* - \alpha_h) - \eta_l \cdot (p_h^* - \alpha_l) \cdot (3 \cdot p_h^* - \alpha_l)$. The right-hand side of this inequality is the difference in marginal expected confidentiality premium if the principal proposes a contract to agent h and agent l with the same probability p_h^*, denoted as $\Delta(\alpha_h, \alpha_l, p_h^*) \equiv \eta_h \cdot (p_h^* - \alpha_h) \cdot (3 \cdot p_h^* - \alpha_h) - \eta_l \cdot (p_h^* - \alpha_l) \cdot (3 \cdot p_h^* - \alpha_l)$. If $s(v_h) - s(v_l) < \Delta(\alpha_h, \alpha_l, p_h^*)$, $q(e_l^*|v_l) - c \cdot e_l^* - \eta_l \cdot (p_h^* - \alpha_l)^2 - p_h^* \cdot \eta_l \cdot 2 \cdot (p_h^* - \alpha_l) - \eta_0 \cdot 2 \cdot (p_h^* - \alpha_0) > \lambda^*$, the principal has incentive to raise p_l^* above p_h^*. If $p_l^* > p_h^*$, by the optimality conditions, $q(e_l^*|v_l) - c \cdot e_l^* - \eta_l \cdot (p_h^* - \alpha_l)^2 - p_h^* \cdot \eta_l \cdot 2 \cdot (p_h^* - \alpha_l) - \eta_0 \cdot 2 \cdot (p_h^* - \alpha_0) > \lambda^* = q(e_h^*|v_h) - c \cdot e_h^* - \eta_h \cdot (p_h^* - \alpha_h)^2 - p_h^* \cdot \eta_h \cdot 2 \cdot (p_h^* - \alpha_h) - \eta_0 \cdot 2 \cdot (p_h^* - \alpha_0)$, which can be rearranged to $s(v_h) - s(v_l) < \Delta(\alpha_h, \alpha_l, p_h^*)$.

Given $s(v_h) > s(v_l)$, $s(v_h) - s(v_l) < \Delta(\alpha_h, \alpha_l, p_h^*)$ only if $\Delta(\alpha_h, \alpha_l, p_h^*) > 0$. Several cases are possible for $\Delta(\alpha_h, \alpha_l, p_h^*) > 0$: i) $p_h^* > \max\{\alpha_h, \alpha_l\}$ or $p_h^* < \min\{\frac{\alpha_h}{3}, \frac{\alpha_l}{3}\}$, and $\eta_l < \eta_h$, ii) $p_h^* \in \left(\max\{\frac{\alpha_h}{3}, \frac{\alpha_l}{3}\}, \min\{\alpha_h, \alpha_l\}\right)$, and $\eta_l > \eta_h$, iii) $\alpha_h > \alpha_l$ and $p_h^* \in \left(\frac{\alpha_l}{3}, \min\{\frac{\alpha_h}{3}, \alpha_l\}\right)$, or $\alpha_h < \alpha_l$ and $p_h^* \in \left(\max\{\frac{\alpha_l}{3}, \alpha_h\}, \alpha_l\right)$. To conclude, it is more likely for the principal to contract with agent l, who has a lower matching value, if only if the surplus loss from contracting with agent l is lower than the reduced contracting cost in the form of marginal confidentiality premium ($s(v_h) - s(v_l) < \Delta(\alpha_h, \alpha_l, p_h^*)$), which occurs only if one of the above three scenarios hold.

In the special scenario where only the principal cares about identity exposure, $\eta_0 > 0 = \eta_i$ for all agent i, optimality conditions in Lemma 1 implies $s(v_h) - s(v_l) - \eta_0 \cdot 2 \cdot (p_h^* - p_l^*) = 0$. Therefore, $p_h^* > p_l^*$ for any $v_h > v_l$.

A.3 Example

Let $q(e|v_i) = \sqrt{v_i \cdot e}$, where $e \in [0,1]$ and $v_i \in (0,1]$. The efficient level of effort is $e_i^* \in \arg\max_e \sqrt{v_i \cdot e} - c \cdot e = \left(\frac{\sqrt{v_i}}{2 \cdot c}\right)^2$. The maximum surplus in the contractual relationship with agent i is thus $s(v_i) = \frac{v_i}{4 \cdot c}$. By Proposition 1, the efficient level of effort is implemented within a contractual relationship. We focus on the equilibrium distribution of contractual relationships.

If the agents prefer being completely off the radar, i.e., $\alpha = 0$, and the principal is not averse to identity exposure, i.e., $\eta_0 = 0$, only case i) in Proposition 2 applies, and the optimality conditions in Lemma 1 have

$$\begin{cases} \frac{v_h}{12 \cdot c} &= \eta_h \cdot p_h^2 + \lambda \\ \frac{v_l}{12 \cdot c} &= \eta_l \cdot p_l^2 + \lambda \\ 1 &= p_h + p_l \end{cases}, \text{ or rearranged to } \begin{cases} \frac{v_h - v_l}{12 \cdot c} &= \eta_h \cdot p_h^2 - \eta_l \cdot p_l^2 \\ 1 &= p_h + p_l \end{cases}.$$

Plugging the second equation into the first, we find

$$\begin{cases} \frac{v_h - v_l}{12 \cdot c} &= (\eta_h - \eta_l) \cdot p_h^2 + (2 \cdot p_h - 1) \cdot \eta_l \\ \frac{v_h - v_l}{12 \cdot c} &= (\eta_h - \eta_l) \cdot p_l^2 - (2 \cdot p_l - 1) \cdot \eta_h \end{cases}.$$

If $\eta_h < \eta_l$, the optimality conditions hold only at $p_h^* > \frac{1}{2} > p_l^*$. Inefficient organization occurs only if $\eta_h > \eta_l$. Both equality hold at $p_h = p_l = \frac{1}{2}$ if and only if $\frac{v_h - v_l}{12 \cdot c} = \frac{\eta_h - \eta_l}{4}$. If $\frac{v_h - v_l}{12 \cdot c} > \frac{\eta_h - \eta_l}{4} > 0$, the optimality conditions hold at $p_h^* > \frac{1}{2} > p_l^*$. If $0 < \frac{v_h - v_l}{12 \cdot c} < \frac{\eta_h - \eta_l}{4}$, the optimality conditions hold at $p_h^* < \frac{1}{2} < p_l^*$. The equilibrium distribution of contractual relationships is inefficient if and only if $\frac{v_h - v_l}{3 \cdot c} < \eta_h - \eta_l$.

A.4 Risk-Neutrality with Limited Liability

Suppose that the agents are risk-neutral with limited liability in the sense that the ex-post payoff from the contract (excluding the disutility of identity exposure) must not be negative. The contract proposed to agent i with probability p_i, $\mathbb{C}_i^{ll} = \{t_{1i}^{ll}, t_{0i}^{ll}\}$ implementing e_i^{ll}, solves the reduced problem

$$\max_{e_i, t_{1i}, t_{0i}} q(e_i|v_i) \cdot (1 - t_{1i}) - (1 - q(e_i|v_i))t_{0i}$$

subject to

$$q(e_i|v_i) \cdot t_{1i} + (1 - q(e_i|v_i)) \cdot t_{0i} - c \cdot e_i - \eta_i \cdot (p_i - \alpha_i)^2 \geq 0 \qquad (IR_i),$$

$$e_i \in \arg\max_e q(e|v_i) \cdot t_{1i} + (1 - q(e|v_i)) \cdot t_{0i} - c \cdot e - \eta_i \cdot (p_i - \alpha_i)^2 \qquad (IC_i),$$

and

$$t_{ji} - c \cdot e \geq 0 \quad \text{for } j = 1, 0 \qquad (LL_j).$$

With $\eta_i = 0$, the problem corresponds to the standard contracting model with limited liability. (LL_0) is binding and (IR_i) is strictly satisfied. Binding limited liability and local incentive compatibility jointly imply $t_{0i}^{ll} = c \cdot e_i^{ll}$ and $t_{1i}^{ll} - t_{0i}^{ll} = \frac{c}{q'(e_i^{ll}|v_i)}$. The principal implements $e_i^{ll} \in \arg\max_e q(e|v_i) - c \cdot e - \frac{q(e|v_i) \cdot c}{q'(e_i^{ll}|v_i)}$.

With a sufficiently low disutility of identity exposure $\eta_i \leq \underline{\eta} \stackrel{\text{def}}{=} \frac{q(e_i^{ll}|v_i)}{q'(e_i^{ll}|v_i)} \cdot \frac{c}{(p_i - \alpha_i)^2}$, the above contract does not violate (IR_i). A minor confidentiality concern does not affect the contract and the induced effort. With $\eta_i > \underline{\eta}$, the above contract violates (IR_i), so the optimal contract satisfies binding (IR_i). With a sufficiently high disutility of identity exposure $\eta_i \geq \overline{\eta} \stackrel{\text{def}}{=} \frac{q(e_i^*|v_i)}{q'(e_i^*|v_i)} \cdot \frac{c}{(p_i - \alpha_i)^2}$, where e_i^* is the solution to Proposition 1, limited liability constraints are strictly satisfied. The optimal contract is the same as that in Section 3 with risk neutrality. The productive effort is restored to the efficient level. As $e_i^* > e_i^{ll}$ and $q(e_i|v_i)$ being increasing and concave, it is straightforward that $\overline{\eta} > \underline{\eta}$. For intermediate disutility of identity exposure, the optimal contract and the implemented effort solve binding (IR_i), local incentive compatibility, and (LL_0).