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Common agency with caring agents

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HIGHLIGHTS

- The paper considers two extensions to the standard common agency model.
- Extension 1: The agent's objective need not be increasing in contributions.
- Extension 2: The agent can (partially) reject contributions.
- Truthful equilibria are reconsidered in the new framework.
- The key properties of truthful equilibria are reaffirmed.

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ABSTRACT

This paper considers two extensions to the standard common agency model. First, the agent's objective need not be increasing in contributions. Second, the agent can (partially) reject contributions from the principals. Following these extensions, I generalize the concept of truthful equilibria and their key properties.

1. Introduction

Common agency was introduced by Bernheim and Whinston (1986) and was generalized by Dixit et al. (1997). This paper further extends the standard common agency setting by introducing two new features in the model discussed by Dixit et al. (1997): the agent's objective need not always be increasing in contributions and the agent can reject a contribution from a principal, either partially or in whole.

Following the literature, I concentrate on truthfulness. I consider a generalization of equilibria in truthful strategies, named quasitruthful equilibria, and obtain two main results. First, quasitruthful equilibria are efficient. Second, the best response set of a principal always contains a quasitruthful strategy. These results support the use of quasitruthful equilibria in generalized common agency problems.

Let us now briefly discuss motivation for the two extensions considered here. Firstly, non increasing objectives can come up for many reasons. An example is a politician who does not want to be associated with certain contributors. Thus, he might not want to receive money from them. Another example is a corrupt official. Such an official might tend to avoid excessive bribes, if they increase the probability of getting caught. My main motivation though, is an agent who cares for the welfare of the principals. In this case, the agent faces a tradeoff. On the one hand, contributions have a direct positive effect on his objective and on the other hand an indirect negative effect through principals' utility. Therefore, the agent's objective might not be always increasing in contributions.[1]

Secondly, the rejection of contributions is intuitive, since otherwise the agent is forced to accept money that he does not want. Rejecting contributions is not an issue in the standard model, since

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[1] "Caring agents" often appear in papers discussing lobbying. Examples are: Grossman and Helpman (1994), Dixit et al. (1997) and Campante and Ferreira (2007), etc.

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the agent always likes receiving them. However, here, the agent dislikes certain contributions and consequently denies them.[2]

The rest of the paper consists of Section 2, that discusses general theory and Section 3 that considers an example with caring agents.

2. General theory

2.1. Basic setting

Consider n principals and one agent.

Principals' utility, is a function $u_i : A \times R_+ \to R$ such that $u_i = u_i(a, c_i - r_i)$. Here, $a \in A$ is a policy vector chosen by the agent, $c_i \in R_+$ is a contribution that principal i pays to the agent, $r_i \in [0, c_i]$ is a refund of contribution money that captures the possibility of (partial) contribution rejection and $c_i - r_i$ is the net contribution of i. Principals' utility functions are differentiable and strictly decreasing, with respect to net contributions.

The objective of the agent is a function $G : A \times R_+^n \to R$ such that $G = G(a, c-r)$, where $c = (c_1, c_2, \ldots, c_n)$ and $r = (r_1, r_2, \ldots, r_n)$. The agent's objective is continuous in net contributions but not necessarily increasing in them.

Contributions and refunds should lie within certain bounds. When they do so, we say that they are feasible.

For every $a \in A$ there exists a maximum contribution by each principal $\overline{c_i(a)} < +\infty$, which reflects the fact that contributions cannot exceed available resources. A contribution $c_i \in R_+$ is feasible relative to a policy choice $a \in A$, if $0 \le c_i \le \overline{c_i(a)}$. A refund $r_i \in R_+$ is feasible, given a feasible contribution c_i, if $r_i \in [0, c_i]$. Vectors $c = (c_1, c_2, \ldots, c_n)$ and $r = (r_1, r_2, \ldots, r_n)$ are feasible relative to $a \in A$ and c respectively, if all c_i and r_i are feasible relative to $a \in A$ and c_i respectively. A feasible contribution schedule is a function $c_i : A \to R$ such that $c_i(a) \in \left[0, \overline{c_i(a)}\right]$, $\forall a \in A$. Finally, we say that the triplet $(c(\cdot), a, r)$ is feasible, if $c(\cdot)$ is a vector of feasible contribution schedules, $a \in A$ and r is feasible for $c(a)$.

Except from differences specified above, principals and agent take part in the standard common agency game described in Dixit et al. (1997).

Now, we turn to some key definitions.

Definition 1 (*Best Response*).[3] A feasible contribution schedule $c_i(\cdot)$ belongs in the best response set of principal i to the feasible contribution functions of the other players $c_{-i}(\cdot)$, if there exists $(a', r') \in \arg\max_{\substack{a \in A \\ r\ feas.}} \{G(a, c_i(a) - r_i, c_{-i}(a) - r_{-i})\}$, such that there does not exist a feasible triplet $(c_i^*(\cdot), a^*, r^*)$, such that $u_i(a^*, c_i^*(a^*) - r_i^*) > u_i(a', c_i(a') - r_i')$ and $(a^*, r^*) \in \arg\max_{\substack{a \in A \\ r\ feas.}} \left\{G(a, c_i^*(a) - r_i, c_{-i}(a) - r_{-i})\right\}$.

In the definition above, c_{-i}, r_{-i} are the vectors of contributions and refunds of all principals except principal i and the abbreviation "*r feas.*" states that r must be feasible relative to the respective contributions.

Definition 2 (*Equilibrium*). A feasible triplet $(c^o(\cdot), a^o, r^o)$ is an equilibrium if:

(a) $(a^o, r^o) \in \arg\max_{\substack{a \in A \\ r\ feas.}} \{G(a, c^o(a) - r)\}$

(b) for all i, there does not exist a feasible contribution schedule $c_i^*(\cdot)$ and $(a^*, r^*) \in \arg\max_{\substack{a \in A \\ r\ feas.}} \left\{G(a, c_i^*(a) - r_i, c_{-i}^o(a) - r_{-i})\right\}$, such that $u_i(a^*, c_i^*(a^*) - r_i^*) > u_i(a^o, c_i^o(a^o) - r_i^o)$.

The maximization of the agent's objective reflects the fact that the agent decides both on policy a and refunds r. The second maximization, with respect to refunds, is an addition to the standard definitions of best response and equilibrium.

Definition 3 (*Quasitruthful Schedules*). A payment function $c_i^T(\cdot; u_i^*)$, is a quasitruthful contribution schedule relative to $u_i^* \in R$, if $c_i^T(a; u_i^*) = \min\left\{\overline{c_i(a)}, \max\left[0, \phi_i(a, u_i^*)\right]\right\}$ for all $a \in A$, and $\phi_i(a, u_i^*)$ is implicitly defined as the solution of $u_i^* = u_i(a, \phi_i)$ with respect to ϕ_i.

This is the standard definition of truthful contribution schedules. Yet in the case at hand, unqualified use of the term truthful is not appropriate. Truthful payments reflect the principals' preferences over the agent's possible actions. Thus, a truthful schedule must depend on both policy choice and refunds, in order to be true to its name. Since the contribution schedule defined above is a function of policy choice alone, I have decided to use the term quasitruthful instead of plain truthful.

Definition 4 (*Quasitruthful Equilibrium*). A quasitruthful equilibrium is an equilibrium in which each equilibrium payment function is quasitruthful, relative to the equilibrium utility of the respective principal.

The definition above implies that refunds are zero, in any quasitruthful equilibrium. In general, refunds need not appear in any equilibrium quasitruthful or not. This is so because in anticipation of a refund, principals can reduce their contributions accordingly.[4] In the special case of quasitruthful equilibria, principals adjust their contributions through an increase in the associated utility level.

2.2. Main results

Proposition 1. *The best response set of principal i to the contribution schedules $c_{-i}^o(\cdot)$ of the other principals, always contains a quasitruthful contribution schedule.*

Proof. See Appendix A.

Proposition 2 (*Efficiency*). *Assume $(c^o(\cdot), a^o, r^o = 0)$ is a quasitruthful equilibrium. Then, there does not exist a feasible pair (a^*, c^*) such that $u_i(a^*, c_i^*) \ge u_i(a^o, c_i^o(a^o))$ $\forall i$ and $G(\alpha^*, c^*) \ge G(a^o, c^o(a^o))$ with at least one strict inequality.*

Proof. See Appendix A.

Propositions 1, 2, generalize two well known properties of truthful equilibria.[5] Proving these properties relied so far, on an agent's objective that is increasing in contributions. However, in the current context this is not necessary, since the possibility for rejecting contributions is in essence equivalent to an increasing agent's objective. The two preliminary results in the beginning of Appendix A demonstrate this point.

3. Application[6]

Quasitruthful strategies are truthful strategies in a model with refunds. In order to better understand their function, let us discuss an example.

Consider two principals, with utility functions $u_i = e - a - c_i + b_i\sqrt{2a}$ and an agent with objective $G = \sum_{i=1}^{2}(c_i + bu_i)$, where $a \in [0, e]$ is the agent's action and $c_i \in [0, e - a]$ is the contribution of principal i. The parameters of the model satisfy: $e > 0, 2 > b > \sqrt{2}, \sqrt{e}/2 > b_2 > 2b_1 > 0$. Then, $\frac{\partial G}{\partial c_i} < 0$.

In such a case, if we disallow refunds, truthful strategies fail to grasp the motives of the principals. This point is manifested in two ways.

[2] Felli and Merlo (2006) and Martimort and Stole (2003) discuss a similar point.

[3] On the Definitions 1 and 2, see Ko (2011).

[4] A formal proof is available upon request.

[5] See Bernheim and Whinston (1986) and Dixit et al. (1997).

[6] Details on the results of this section are available upon request.