An Experimental Examination of Common Agency

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Introduction

Settings in which more than one principal attempts to influence the behavior of a single agent are common. One area in which these relationships are prevalent is in the interaction between economic and political actors. Lobbying, where the government actor is the common agent of private principals, and regulatory bureaucracy in which a firm may be regulated by several governmental agencies are examples of situations in which a model that includes common agency can augment the basic principal agent framework in a useful way. Dixit has developed a model that is intended to capture essential aspects of common agency as they are reflected in political economy. This paper presents the results of an experimental test of a simplified version of the Dixit model. The experimental test investigates the main result of that model which implies that incentives for the agent weaken under common agency.

The paper proceeds in the following way: Section 2 presents a simple model that generates clear hypotheses about the power of incentives when the number principals vary. This model differs from Dixit's by eliminating the stochastic component of the problem. The relation of this model to previous experimental work on agency theory is reviewed. Section 4 outlines the experimental protocol and Section 5 presents the experimental results.

2 A Common Agency Model

The exploration of common agency is tested experimentally as a repeated game in a linear contracting setting. The theoretical solution is presented below for a single round which, by backwards induction, is the same in all rounds of the game. First the solution is presented for the case of a single principal and a single agent who carries out two tasks.

2.1 Benchmark : The Single Principal Case

A contract, $\omega = (\alpha_1, \alpha_2, \beta)$ is chosen by the principal. The contract consists of incentive payments for each task, $\alpha_i \in \{\underline{\alpha}_i, \underline{\alpha}+1, ..., \overline{\alpha}_i - 1, \overline{\alpha}_i\}$ $i = 1,2$ which represent the marginal benefit of output for the agent for each task, and $\beta \in \{\underline{\beta}, \underline{\beta}+1, ..., \overline{\beta}-1, \overline{\beta}\}$ a fixed payment[1].

Next the agent decides whether to accept or reject the offered contract.

a) If the contract is rejected both parties receive their reservation payments of zero.

b) If the agent accepts the contract he chooses effort levels, $t_i \in \{0,..\overline{t}_i\}$ $i = 1,2$ and the output x_i is determined by $x_i = t_i$, $i = 1,2$.

Payoffs to the principal and agent, π_P and π_A, are the following.

a) If the contract is rejected, $\pi_P = \pi_A = 0$

b) If the contract is accepted,

$$\pi_P = (b - \alpha)' x - \beta$$

$$\pi_A = \alpha' x + \beta - t' C t .$$

[1] In the experimental implementation, $\underline{\alpha} = -\overline{\alpha}$, and $\underline{\beta} = -\overline{\beta}$. Negative and positive incentives and fixed fees are allowed.

The parameters include the principal's marginal benefit of output, $b' = [b_1 \quad b_2]$, and $C = \begin{bmatrix} c_{11} & 0 \\ 0 & c_{22} \end{bmatrix}$. The choice variables t, α are vectors of dimension 2 by 1, with β a scalar.

2.2 The Single Principal Solution

The equilibrium solution for the game is derived in two stages. First the equilibrium effort level of the agent is determined as a function of the incentive choices of the principal. The principal then chooses incentives given the first stage result. In stage one, the agent chooses an effort level to satisfy

$$t \equiv \arg\max_{t} \quad \pi_A \qquad 2.1$$

The solution $t^*(\alpha)$ defines a best reply function in response to any α offered by the principal. The participation constraint

$$\pi_A \geq 0 \qquad 2.2$$

must also be satisfied by the contract $\omega(\alpha, \beta)$.

Equations 3.1 and 3.2 act as constraints on the principal and so his problem is to

$$\max_{\alpha,\beta} \pi_P \text{ s.t. 2.1 and 2.2.}$$

In equilibrium, optimality requires that the participation constraint binds and so the entire surplus goes to the principal. The principal offers full incentives, $\alpha_i = b_i, \quad i = 1,2$ and then uses the fixed component, β , to extract the surplus from the agent. The equilibrium contract then is $\varpi = (\overline{\alpha_1}, \overline{\alpha_2}, -\alpha' x + t' C t)$, and the resulting payoffs are

$$\pi_P = bx - x'Cx$$

$$\pi_A = 0 .$$

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2.3 The Case of Two Principals

In the extension to two principals, benefits are distributed across the principals so that $b_1' = [b_{11} \quad b_{12}]$, and $b_2' = [b_{12} \quad b_{22}]$, with the first subscript referring to the principal, the second to the task. In the experimental implementation and in the solution that follows we restrict attention to the case where each principal benefits from one of the tasks exclusively. The marginal benefits are thus given by $b_1' = [b_{11} \quad 0]$, and $b_2' = [0 \quad b_{22}]$.

The sequencing of the game, is as in the single principal case, with each principal first creating a contract for the agent. Each principal can create incentives for both of the tasks.

Each principal selects from $\alpha_i^j \in \{\underline{\alpha}_{ij}, \underline{\alpha}_{ij} + 1, \ldots, \overline{\alpha}_{ij} - 1, \overline{\alpha}_{ij}\} \quad i, j = 1,2$.

The agent's solution to the first stage is given by

$$t_i * (\alpha_i) = \frac{\alpha_{ii} + \alpha_{ji}}{c_{ii}}, \, i, j = 1,2, \quad i \neq j$$

The opportunity for each principal to influence the agent's efforts related to the other principals task leads to a non-cooperative equilibrium in which aggregate incentives are reduced. Principal *i*'s problem given the rational behavior of the agent is to

$$\max_{\alpha_i} \quad (b_i - \alpha_i)' t * (\alpha_i).$$

The resulting equilibrium yields $\alpha_{ii} = \frac{2}{3} b_{ii}$, and $\alpha_{ij} = -\frac{1}{3} b_{jj}$. Aggregate incentives in the multiple principal setting are reduced from the single principal benchmark with

$\alpha_i^M = \frac{1}{3} b_{ii}$ where $\alpha_i^M = \alpha_{ii} + \alpha_{ji}, \quad i, j = 1,2, i \neq j$.

The solution yields a single equilibrium in incentives. The aggregate fixed fee is also uniquely defined but each principal's contribution to the aggregate fixed fee is not uniquely defined.

2.4 Discussion:

The game played in the experimental treatment presents the subjects with a simpler agency problem than is found in the model of moral hazard developed by Dixit. Since risk-sharing motivations are absent, the optimal action of the principal is to "sell the firm" at the price of the entire surplus. The simpler model however, obtains the same basic result as under moral hazard; incentives are weakened by the introduction of an additional principal.

3 Experimental Protocol

There has been limited exploration of the impact of multiple principals in the experimental literature[2]. Work in the single principal setting as well as in other

[2] Multiple principals were studied by Kirchsteiger and Prat, although not in a way that is directly relevant to the current research. These authors investigate the behavioral validity of Bernheim and Whinston's (1986b) truthful equilibrium in an environment with two principals, a single agent, and a single task. They find that the truthful equilibrium is rarely chosen and instead subjects appear to play a less efficient 'natural' equilibrium, which is computationally less complex.

proposer/responder settings such as the ultimatum game suggest what some of the relevant concerns may be in the extension to multiple principals.

Anderhub Gachter and Konigstein (AGK hereafter) create an environment with a single principal and single agent that is similar to that used in the present research. AGK use a linear contracting framework without random shocks in output. The equilibrium result is thus the same “sell the firm” equilibrium discussed above. The authors report that while incentive constraints were often recognized, participation constraints generally did not bind. In addition, agent effort choices were related to the sharing of the surplus, suggesting the existence of a ‘reciprocity-compatible’ constraint.

The reciprocity finding of AGK plays an important role in the current design. In order to analyze the impact of the multiple principals on reciprocity it is necessary to distinguish the behavioral impact of the multiple equilibria with respect to the fixed portion of the contract from the reciprocity concerns that relate to the agent. Both of these issues suggest that the agent may receive surplus in excess of the Nash equilibrium prediction, since the existence of the multiple equilibria suggest that a principal may be motivated to lower its share of the surplus to guard against the possibility that the reciprocity constraint is violated by the inequitable allocation of the fixed fee between principals[3]. In order to understand how the two effects interact, a treatment is implemented in which the reciprocity constraint is eliminated through the use of a computerized agent. In this case the contract would be rejected only if the principal’s jointly failed to provide the agent a non-negative return. Thus the experiment consists of a two by two factorial design with both one and two principals and a human and computerized agent. Table 1 outlines the predictions for incentives and surplus share in each of the cells.

Table 1: Theoretical predictions of the cells.

	Robotic Agent	Human Agent
Single Principal	Incentives: $\alpha = b$ Surplus Share: Satisfies participation constraint	Incentives: $\alpha = b$ Surplus Share: Satisfies reciprocity constraint:
Two Principals	Incentives: $\alpha = b/3$ Surplus Share: Coordination yields "noisy equilibrium." "Noise" goes to agent.	Incentives: $\alpha = b/3$ Surplus Share: Reciprocity constraint and "noisy" coordination constraint

Experimental results[4]:

The experiments reported here were conducted in April and May at the University of Maryland College Park. Subjects played the single and multiple principal contracting game outlined above with a computerized agent, programmed to respond optimally to the incentive, and to reject any contract in which its optimal response violated the participation constraint. The contrast between the single (SP) and two (TP) principal treatments was stark.

The results of the last three rounds of the contracting game are reported. First a simple measure of efficiency is presented. This measure is the amount of surplus created divided by the total possible surplus. In the single principal case, the efficiency was close to 1. With two principals efficiency was reduced to .56. This result, given the optimal

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[3] The equilibrium concept related to the fixed fee is a variant of the "noisy equilibrium" introduced by Mckelvey and Palfrey (1992) and applied by Goeree and Holt (2001). In the noisy equilibrium there is a positive probability of obtaining any of the equilibrium distributions of the surplus.

responses of the agent, was consistent with the lower powered incentives in the aggregate contract in the two principal treatment. The proportion of the surplus that remained with the agent is an indication of the coordination problems that arise in the TP treatment due to the multiple equilibria in the fixed fee. In the single principal case the agent received 2% of the surplus. In the multiple principal case 23% was left to the computerized agent. The measures are presented in Table 2 below.

Table 2: Mean and Standard Deviation of Performance Measures

Treatment	Efficiency	Share to Agent
SP	.996 (.0063575)	.022 (.007217
TP	.565 (.3564939)	.235 (.1216963)

These preliminary results are consistent with the predictions of the multiple principal theory with regards to the direction of the effects. The magnitude of the efficiency loss however is less than predicted, since the Nash equilibrium implies efficiency of 33%.

[4] This draft reports on the initial treatments with the computerized agent only.

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