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Rent-seeking versus productive activities in a multi-task experiment ☆

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A B S T R A C T

Incentive instruments like asset ownership and performance pay often have to strike a balance between the productive incentives and the rent-seeking incentives they provide. Standard theory predicts that these instruments become less attractive when the effectiveness of rent-seeking activities increases. In contrast, theories that emphasize the importance of reciprocity suggest that this relationship may go the other way around. In this paper we test these predictions by means of a laboratory experiment. By and large our findings confirm standard theory. Incentive instruments typically become less attractive when the scope for rent-seeking activities increases. However, reciprocity motivations do seem to mitigate the adverse effects of rent-seeking opportunities to a considerable extent.

1. Introduction

Asset ownership and performance pay are typically seen as means to motivate hard work. A potential disadvantage of such high-powered incentive instruments is that they may also stimulate unproductive activities. Take, for instance, performance pay. To motivate workers to put in effort, an organization may want to pay them on the basis of observed performance. In many cases, however, the organization's objective is not contractible and/or an undistorted performance measure is unavailable. Using a distorted performance measure will provide workers with incentives to "game" the system, meaning that they will optimize with respect to the actual performance measure rather than the intended (but non-contractible) objective (cf. Holmstrom and Milgrom, 1991; Baker, 1992).

Another example concerns asset ownership. Baker and Hubbard (2004) consider the relation between a truck driver and a dispatcher in which the driver makes two non-contractible decisions: (i) how much effort to expend in productive activities, namely driving in ways that better preserve truck value and (ii) how much effort to expend in rent-seeking activities, like looking for alternative hauls that improve the driver's bargaining position. If the driver owns the truck, he has stronger incentives for both types of activities. Hence, truck ownership of the driver is only optimal if the additional productive incentives outweigh the extra rent-seeking incentives. In line with this, Baker and Hubbard find that when productive activities become better contractible through the introduction of on-board computers, ownership shifts from drivers to dispatchers.

These examples show that incentive instruments may imply a trade-off between productive incentives and rent-seeking incentives. Standard theory predicts that an instrument becomes less attractive as incentive device if the effectiveness of rent-seeking activities increases. Experimental evidence, however, suggests that this need not necessarily be the case. Many

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laboratory experiments have namely shown that reciprocity acts as an informal mechanism that stimulates productive effort/investments (Chapter 2 in Camerer, 2003 gives an overview).

Choosing an effort/investment level above the individually rational one may be seen as kind behavior, which is rewarded with a larger than predicted return. This in turn makes it worthwhile to choose effort/investment above what standard theory predicts. The presence of rent-seeking opportunities could strengthen this mechanism. In particular, observing that a party does not engage in rent-seeking although it has ample opportunities to do so, may convince the other party that she/he is really fair and thus deserves a larger reward. And the more effective rent-seeking activities are, the better a signal of good intentions this under-utilization of rent-seeking possibilities becomes. This in turn may make it (even) more attractive to engage in productive activities.[1] This paper reports an experiment designed to test this hypothesis.

Our experiment basically extends the trust game of Berg et al. (1995) with a second investment opportunity. In the first stage of the game a seller chooses two investment levels, a productive one and an unproductive one. In the second stage a buyer then decides how much money to transfer back to the seller, where back-transfers should be in between a minimum amount M and the overall surplus S (with $M<S$). Unproductive investments only affect M and do not affect S. Productive investments increase S and may also increase M. Within this setup we explore how the actual investments are affected when the sensitivity of the lower bound M to the two types of investments is varied.

This is one of the first experiments that considers unproductive investments within a multi-tasking environment. Harbring and Irlenbusch (2005) and Harbring et al. (2007) test the prediction of tournament theory that a larger prize spread not only induces more productive effort, but also more destructive sabotage activities. In contrast to our setup, these experiments do not include a subsequent transfer stage. The game ends after the effort decisions have been made. Hence there is no role for the informal reciprocity mechanism as discussed above.

Fehr and Schmidt (2004) conduct a two-task principal-agent experiment in which the tasks are complements. Efficiency requires an even allocation of effort over the two tasks. However, although both effort levels are observable to the principal, only effort level e_1 in task one can be contracted upon. In the experiment the principal first chooses between a piece rate contract on e_1 and a bonus contract in which only a non-contractible bonus is promised. Subsequently the agent chooses effort levels e_1 and e_2 (which are perfectly observed by the principal). Finally, under the bonus contract the principal decides after observing e_1 and e_2 whether to pay (part of) the promised bonus. Standard theory predicts that the piece rate contract is chosen and that effort is allocated highly asymmetrically. The findings contradict these predictions. The bonus contract is chosen in 80% of the cases, effort allocation is much more even under the bonus contract, and the bonus contract strictly Pareto dominates the piece rate contract. Unlike Fehr and Schmidt's experiment, in our setting one type of effort constitutes a pure social waste. Moreover, we also consider the interplay between explicit and implicit incentives, by varying the degree to which good explicit incentive contracts are available. Our focus is on how these variations affect observed rent-seeking behavior.

The remainder of this paper is organized as follows. In the next section, we discuss a simple (reduced form) model on which our experiment is based. This section also derives both the standard equilibrium predictions and some alternative predictions based on a formal theory of (intention-based) reciprocity. Section 3 describes our experimental design, while Section 4 discusses the results. The final section summarizes and concludes.

2. Theory

2.1. Basic setup of the model

We first present the simple game on which our experiment is based, together with the standard equilibrium predictions. After that we discuss how this game can be interpreted as a reduced form model of asset ownership and performance pay as incentive devices. The next subsection derives predictions based on intention-based reciprocity.

Consider a relationship between a male seller and a female buyer. Both parties are assumed to be risk neutral. The order of play is as follows:

1. The seller chooses investment levels p and u, with $0 \le p \le \overline{p}$ and $0 \le u \le \overline{u}$. Costs of investment are equal to $C(p,u)=(p+u)^2$ and are immediately borne by the seller. Investment p creates a gross surplus of $R(p)=R+r\cdot p$.
2. The buyer decides how much of the gross surplus $R(p)$ goes to the seller. The maximum amount she can give to the seller equals $R(p)$, whereas the minimum amount she has to give to the seller equals:

$$w(p,u)=\pi\cdot R(p)+(1-\pi)\cdot Z(u)=\pi\cdot(R+r\cdot p)+(1-\pi)\cdot(Z+z\cdot u) \tag{1}$$

In this game p represents a *productive* investment, because it increases the gross surplus $R(p)$ up for division. Parameter $r \ge 0$ gives the constant marginal return to p. u is an *unproductive* investment, as it does not affect $R(p)$ but only increases the minimum amount $w(p,u)$ the seller can secure for himself. Parameter $z \ge 0$ reflects the (gross) marginal returns to this type of investment. The minimum amount $w(p,u)$ is a weighted combination of the value of productive activities $R(p)$ and the value of

[1] Experimental studies by Fehr and Rockenbach (2003) and Fehr and List (2004) indeed find that simply having opportunities to behave unkindly but not using them may be efficiency enhancing. In a similar vein Falk and Kosfeld (2006) obtain experimental evidence for the existence of "hidden costs of control".

Table 1
Equilibrium investment levels.

Condition	p^*	u^*
$(1-\pi)z > \pi r$	0	$\frac{(1-\pi)z}{2}$
$\pi r > (1-\pi)z$	$\frac{\pi r}{2}$	0

Remark: The efficient investment levels equal $p_{eff} = \frac{r}{2}$ and u_{eff}=0.

rent-seeking activities $Z(u)$, where we assume that $R(p) \geq Z(u)\ \forall p,u \geq 0$ (i.e. $R(0) \geq Z(\overline{u})$). $\pi \in [0,1]$ is a weight parameter which value is exogenously given. In the next two subsections, we will show that π can be interpreted as the seller's relative bargaining power or as the performance measure's sensitivity to manipulation. Following Holmstrom and Milgrom (1991), p and u are perfect substitutes at the costs margin. They thus compete with each other for the same resources. Given these assumptions, the efficient investment levels are equal to $p_{eff} = r/2$ and u_{eff}=0.

Assuming that seller and buyer are interested in their own monetary payoffs only, the subgame perfect equilibrium predictions are as follows. In the second stage, the buyer gives the seller the minimum amount $w(p,u)$. Anticipating this, the seller chooses investment levels that maximize $w(p,u) - C(p,u)$. Table 1 characterizes these equilibrium investments (p^*,u^*). If $\pi < 1$, standard theory predicts underinvestment in the productive dimension and overinvestment in the unproductive dimension. Only when $\pi = 1$ the seller obtains efficient investment incentives.

Our main interest lies in how investment levels vary with changes in z and π (relative to r). From Table 1 the following comparative statics predictions are obtained:

Standard theory. *Productive investments p are (weakly) decreasing in z and (weakly) increasing in π, while unproductive investments u are (weakly) increasing in z and (weakly) decreasing in π.*

Intuitively these comparative statics can be understood as follows. When the (gross) marginal return z to the unproductive investment increases, higher levels of u become more attractive. Because the two types of investment compete for the same resources, productive investments then become less attractive. In a similar vein, the larger weight π is, the bigger the share of the gross surplus $R(p)$ the seller can secure for himself. This makes productive investments p more attractive and unproductive investments u less so.

2.1.1. Interpretation 1: asset ownership

A first interpretation of the model follows the property rights theory of the firm, see, e.g. Baker et al. (2002). This theory builds on the idea that asset ownership provides incentives to make relationship-specific investments when contracts are incomplete. Once a party makes a specific investment, the investment is at risk because the other party may force a renegotiation of the deal. Anticipating that she/he cannot capture the full return, the investor will invest less than the efficient level. Asset ownership may alleviate this so-called holdup problem, because owning a critical asset implies that the investor has more bargaining power and thus can obtain a larger share of the ex post surplus. At the same time, however, the investor also obtains incentives to increase the asset's value in alternative, but inefficient uses. Asset ownership thus has both benefits and costs.

Our experimental game can be interpreted as a holdup model in reduced form. After the seller has sunk his investments, buyer and seller bargain about the division of the ex post surplus $R(p)$ that materializes would they trade with each other. This surplus increases with the level of productive investments. In case bargaining ends in disagreement, the parties do not trade and both receive the value of their alternative trading opportunities. For the buyer the outside value is normalized to zero. The seller's alternative opportunity is to sell his product on the outside market and yields him $Z(u)$. Higher values of unproductive investment u improve the seller's outside opportunities and thereby his bargaining position. Irrespective of the actual investments made, separation is never efficient though (i.e. $R(p) \geq Z(u)\ \forall p,u \geq 0$).

Within the property rights literature it is typically assumed that the outcome of the bargaining equals the generalized Nash bargaining solution, see, e.g. Hart (1995). Here this implies that the seller obtains a share equal to $w(p,u)$ as given in (1), with weight $\pi \in [0,1]$ reflecting his bargaining power. One interpretation of parameter π is thus that it reflects the investor's bargaining power in a holdup context. Parameter z then measures the (outside) marginal returns to investments in alternative trading opportunities. Using this interpretation, the main comparative statics predictions are that the lower the seller's bargaining power (lower π) or the more effective rent-seeking activities are (higher z), the more resources are shifted towards rent-seeking.

Seller ownership corresponds with higher values of both z and π. The potential detrimental effects of ownership are represented by increases in z. These make unproductive investments more beneficial, which come at the expense of investments p to specialize in the relationship. Asset ownership may thus have adverse effects on the incentives to specialize (cf. Rajan and Zingales, 1998). Increases in bargaining power π represent the beneficial incentive effects of ownership. By owning the asset the seller also obtains stronger incentives to invest in its efficient use.

2.1.2. Interpretation 2: performance pay

A second interpretation results when the basic model is viewed in terms of a principal–agent relationship with observable, but non-verifiable actions of the agent (cf. MacLeod and Malcomson, 1989; Schmidt and Schnitzer, 1995). A principal (buyer) hires an agent (seller) to perform a project for her. The project's value to the principal $R(p)$ depends on the amount of productive effort p the agent exerts. Unfortunately, because of non-verifiability effort itself is non-contractible and also the undistorted performance measure $R(p)$ is unavailable. Explicit performance pay contracts can only be based on the distorted measure $w(p,u)$ given in (1). Here unproductive effort u represents the degree to which the agent "games" or manipulates the performance measure (cf. Baker, 2002; Holmstrom, 1999). For example, u gives the degree to which the agent shades on quality. Alternatively, following Milgrom (1988) and Milgrom and Roberts (1988), u can be interpreted as the level of influence activities an agent undertakes. Instead of focusing on productive activities in the current job, the agent may devote valuable time to building up credentials in order to enhance his future promotion possibilities.

Unlike in the previous subsection, an unambiguous interpretation of parameter z independent of π is less clear cut here. One possibility is that z reflects the stake the agent has in manipulating the performance measure or in influencing the principal (e.g. the private value of promotion; cf. Milgrom, 1988), another one that it reflects his ability to do so. Parameter π then gives the performance measure's sensitivity to manipulation c.q. the principal's susceptibility to influence activities. For instance, π reflects the relative weight credentials take in the principal's promotion decision (cf. Milgrom and Roberts, 1988). Irrespective of the precise interpretation, the important thing to note is that the larger z and the smaller π, the more $w(p,u)$ deviates from $R(p)$ and the more distorted the performance measure is. Only when z=0 or $\pi=1$ measure $w(p,u)$ is perfectly aligned.

2.2. Intention-based reciprocity

Based on existing experimental evidence it was suggested in the Introduction that having better rent-seeking opportunities (but not using them) may be efficiency enhancing. For our game this hypothesis can be formalized using the theory of intention-based reciprocity as developed by Rabin (1993) and further refined by Dufwenberg and Kirchsteiger (2004). For ease of exposition we assume that the seller is selfish and motivated by money maximization only. The buyer may be motivated by reciprocity though, implying that she is willing to sacrifice to reward (punish) the seller's good (bad) intentions. In particular, her utility function equals

$$U_B = m_B + Y_B \cdot \kappa \cdot \lambda$$

Here m_B denotes the buyer's monetary payoffs and the term $Y_B \cdot \kappa \cdot \lambda$ gives her reciprocity payoffs. Parameter $Y_B \geq 0$ reflects the buyer's reciprocal attitude. The larger Y_B, the more sensitive to reciprocity she is. Factor κ measures the buyer's kindness towards the seller. It is positive if the buyer is kind to the seller and negative if she is unkind to him. Kindness is measured with reference to the range of payoffs $[w(p,u),R(p)]$ the buyer could give the seller in principle. Factor λ gives the buyer's belief about how kind the seller is towards her. It is positive when the buyer believes the seller is kind to her, and negative when she thinks he is unkind. Dufwenberg and Kirchsteiger (2004) provide exact definitions of how κ and λ are calculated. Key of the model is that a reciprocal buyer has an incentive to match the sign of her own kindness κ with the sign of the perceived kindness λ of the seller.

Because the reciprocity payoffs depend on the players' beliefs, psychological game theory is needed to derive equilibrium predictions. Within this framework Dufwenberg and Kirchsteiger define and prove the existence of a sequential reciprocity equilibrium (SRE). This concept requires each player to maximize his utility given correct beliefs and also invokes a subgame perfection requirement. The formal equilibrium analysis is somewhat involved and therefore relegated to Appendix A. Proposition 1 below summarizes the main predictions.

Proposition 1. *Let $b(p,u)$ denote the bonus the buyer gives to the seller on top of $w(p,u)$. In (a sequential reciprocity) equilibrium it necessarily holds that*

$$b(p,u) = \max\left\{0, R(p) - w(p,u) - [R(0) - w(0,\overline{u})] - \frac{2}{Y_B}\right\} \tag{2}$$

Define $\overline{Y}(z,\pi) \equiv 2/(\frac{r^2}{4} + (1-\pi)z\overline{u} - [\pi r p^* + (1-\pi)zu^* - C(p^*,u^*)])$. The (generically) unique SRE-outcome is characterized by:

(a) $Y_B < \overline{Y}(z,\pi)$: *the seller chooses $(p,u)=(p^*,u^*)$ and the buyer responds with $b(p^*,u^*)=0$;*
(b) $Y_B > \overline{Y}(z,\pi)$: *the seller chooses $(p,u)=(p_{eff},u_{eff})$ and the buyer responds with $b(p_{eff},u_{eff}) = (1-\pi)[r^2/2 + z \cdot \overline{u}] - 2/Y_B > 0$.*

From this proposition a number of interesting observations follow. First, in case $b(p,u) > 0$ the equilibrium bonus payment can be rewritten as

$$b(p,u) = (1-\pi)[rp + z(\overline{u} - u)] - \frac{2}{Y_B} \tag{3}$$

Hence, the higher z and the lower π, the higher the bonus for a given investment combination (p,u) is. The intuition here is that when z is high and π is low, the seller has better opportunities to signal good intentions through his investment choices. First consider variations in z. By under-utilizing rent-seeking opportunities (i.e. by choosing $u < \overline{u}$), the seller reveals his kindness. The larger parameter z is, the stronger this signal of kindness is. The seller is therefore rewarded more for a given investment combination (p,u) when z is higher. A similar reasoning applies for changes in π. By choosing a high p and a low u the seller signals good intentions. But the larger parameter π is, the more profitable a high p and a low u are for the seller himself (cf. Table 1). The signaling value of these choices is thus much lower and the buyer reduces the bonus payment in response. This explains why $b(p,u)$ decreases with π.

Second, whenever a positive bonus is given, the seller's overall gross payoffs $w(p,u)+b(p,u)$ make him residual claimant of the gross surplus $R(p)$. This may give the seller the right (i.e. efficient) incentives to invest. For this to happen the buyer need to be sufficiently reciprocal (cf. case (b)). If not (case (a)), the equilibrium investments correspond to the ones obtained when the buyer is entirely selfish. The cutoff value $\overline{Y}(z,\pi)$ determines the scope for efficiency enhancing reciprocity. Corollary 1 establishes how this scope varies with z and π.

Corollary 1. *The cutoff value $\overline{Y}(z,\pi)$ is decreasing in z and increasing in π. Hence the larger z and the smaller π, the larger the scope for efficiency enhancing reciprocity is.*

The way in which investment levels vary with changes in z and π is governed by two different forces. When the buyer is insufficiently reciprocal (cf. case (a) in Proposition 1), the comparative statics as emphasized by standard theory pertain. A higher z and a lower π then make rent-seeking activities directly more attractive, providing incentives to shift resources from productive investments towards unproductive ones. At the same time, however, Corollary 1 reveals that the seller is more easily persuaded to invest efficiently when z is high and π is low. That is, increases in z and/or decreases in π also make it more likely that case (b) in Proposition 1 applies.[2] The reason for this is that the seller gets better opportunities to signal good intentions, leading to higher and well-aligned bonus payments. Overall comparative statics depend on which of the two forces is strongest. Without precise information about the buyer's reciprocal attitude Y_B no definite predictions can be made. The main point we want to make is that reciprocity motivations may potentially lead to comparative statics that are opposed to standard theory. This is summarized in the qualitative prediction below.

Reciprocity. *The scope for efficiency enhancing reciprocity is increasing in z and decreasing in π. Productive investments p may therefore increase with z and decrease with π, while unproductive investments u may decrease with z and increase with π.*

The purpose of our experiment is to test the above comparative statics prediction against the opposite prediction derived from standard theory.

3. Experimental design

The experiment is based on a 3 by 2 design. We consider three different values of $z \in \{0,4,8\}$ and two different values of $\pi \in \{0,\frac{1}{4}\}$. The other parameters are always: R=80, r=20 and Z=0. Investment levels p and u are restricted to integer values between 0 and 10 (hence $\overline{p} = \overline{u} = 10$). Transfer payments in the second stage also need to be integer values and in between $w(p,u)$ and $R(p)$. Table 2 provides an overview of the six different treatments we consider together with the predicted investment levels under standard theory.

As our experimental game extends the Berg et al. trust game, we decided to include the (virtually corresponding) standard case $z = \pi = 0$ for comparative purposes. The other values of z and π have been chosen such that they allow to test the comparative static predictions that follow from Table 1. Our choices ensure that both variations of z and π within conditions (i.e. for a given row in Table 1) are considered, as well as variations of z and π that reverse the ranking of marginal benefits of the two types of investments (i.e. leading to a jump from one row to the other in Table 1). In the former case subjects are expected to change their behavior in one investment dimension only, while in the latter case they are expected to switch from one type of investment to the other. Both the weak and the strong comparative statics predictions summarized in the "standard theory" hypothesis in Section 2.1 can thus be tested.[3]

It may seem that the value of $\pi = \frac{1}{4}$ is somewhat conservative. It must be kept in mind, however, that for higher values of π (and given values of r and z) the rent-seeking channel effectively becomes obsolete. This holds because then the private returns to productive investments of $\pi \cdot r$ always exceed the private returns of $(1-\pi) \cdot z$ to rent-seeking and the seller is unlikely to invest unproductively at all (in Proposition 1 we have $u^*=u_{eff}=0$ for $\pi \cdot r > (1-\pi) \cdot z$). The setting then essentially reduces to a single-task situation with productive investments only.[4] The lower values of π that we consider in our experiment are particularly relevant for multi-task situations where striking a balance between productive and rent-seeking

[2] Interpreted within a principal-agent context, these comparative statics thus predict that stronger explicit incentives (lower z and higher π) may crowd out implicit incentives based on an informal reciprocity mechanism. Baker et al. (1994) and Schmidt and Schnitzer (1995) obtain a similar prediction for a repeated game setting in which implicit incentives follow from reputational considerations.

[3] In treatments ($z = 0$, $\pi = \frac{1}{4}$) and ($z = 4$, $\pi = \frac{1}{4}$) the predicted productive investment level in the continuous model of Section 2 equals $2\frac{1}{2}$. In the experiment investment choices are discrete, however, and sellers should be indifferent between p^*=2 and 3. From this perspective our parameter choices are perhaps a bit unfortunate. Yet our main interest lies in testing the (unambiguous) comparative statics and less so in testing the exact point predictions.

[4] Sloof (2008) experimentally explores a holdup model in which the investor can only make productive investments. He finds (among other things) that investments increase significantly after a large increase in bargaining power of the investor (viz., from $\pi = 0$ to 1).

Table 2
Treatments and standard predictions.

	z=0	z=4	z=8
$\pi=0$	p^*=0, u^*=0	p^*=0, u^*=2	p^*=0, u^*=4
$\pi=\frac{1}{4}$	$p^*=2\frac{1}{2}$, $u^*=0$	$p^*=2\frac{1}{2}$, $u^*=0$	p^*=0, u^*=3

$C(p, u)$=$(p+u)^2$, $R(p)=80+20\cdot p$ and $Z(u)=z\cdot u$.

incentives is at play. Notice also that not π and $(1-\pi)$ but $\pi\cdot r$ and $(1-\pi)\cdot z$ are relevant in this reasoning. Hence the comparative statics predictions under the standard model remain the same when we double π and adjust z and r accordingly.

We ran six sessions. Three sessions considered the case $\pi=0$ and three other sessions the case $\pi=\frac{1}{4}$. All subjects within a session were confronted with all three values of z. Overall 120 subjects participated, with 20 participants per session. The subject pool consisted of the undergraduate student population of the University of Amsterdam. Most of them were students in economics. They earned on average 24.75 euros in slightly more than 1 h. Earnings varied considerably, ranging from a minimum of 10.30 euros to a maximum of 49.30 euros.

Each session contained 15 rounds, which were divided into three blocks of five rounds each. Subjects kept the same role (either seller or buyer) during all these rounds. The experiment used a strangers design. Buyers and sellers were anonymously paired and their matching varied over the rounds. Within each block of five rounds subjects could meet each other only once. Subjects were explicitly informed about this. Moreover, within a session we divided the subjects into two groups of 10 subjects. Matching of pairs only took place within these groups. This yielded six observations per treatment (i.e. per combination of π and z value, cf. Table 2) at the aggregate group level. The π-variable is varied *between* subjects; we have six groups of 10 subjects for each π. Because of the between subjects variation, the six group observations per π-value are independent. The z-variable is varied *within* subjects; each subject experiences the three values of $z\in\{0,4,8\}$. Given the within subjects variation, we have *matched* group observations along the z-dimension. In the statistical analyses we use Mann–Whitney ranksum tests for unpaired (independent) observations to test the effect of different π-values, and Wilcoxon signrank tests for paired (matched) observations to test for differences along the z-dimension.

Each block of five rounds considered one particular value of z. With three possible values for z, six potential orders exist. We designed the experiment such that for each level of π we had one matching group that was confronted with a particular order of z's. For example, for $\pi=0$ one matching group was confronted with the order (z=0, 4, 8) another one with (z=8, 0, 4), etc. With six matching groups per π-value, every order of z's was thus represented. In that way we controlled for order and learning effects.

The experiment was phrased neutrally. The seller was referred to as participant A, the buyer as participant B. Each round started with the seller choosing a column C (choice of p) and a row R (choice of u) in an 11 by 11 matrix. The cell so selected then reported in the upper left corner the minimum amount subject B had to return, in the upper right corner the maximum transfer, and below these two numbers the costs of this particular investment combination printed in red. Each block of five rounds used a different matrix, printed on papers of different colors (white, yellow, blue). To further avoid confusion, after each block we first collected the old matrix before handing out the new one.

From each block of five rounds we randomly selected one round that was actually paid. This was done after all 15 rounds were completed. One randomly selected subject threw a die three times to select the three payment rounds. Subjects learned which three rounds were selected and they obtained the number of points they had earned in these rounds. Because subjects can in principle receive negative payoffs from the experiment, we also paid them a relatively large initial endowment of 200 points.[5] The initial endowment also gives subjects a budget to finance their investments. The conversion rate was one euro for 15 points. Subjects were informed about the payment procedure at the start of the experiment. The rationale for paying only one round per block is that it further strengthens the one-shot nature of each interaction.

The experiment was computerized. Subjects started with on-screen instructions. Before the experiment started all subjects had to answer a number of control questions correctly. They also received a summary of the instructions on paper (see Appendix B for a direct translation). At the end of the experiment subjects filled out a short questionnaire (basically asking for some background characteristics like gender and type of study) and the earned experimental points were exchanged for money.

4. Results

The presentation of the empirical results is divided into three subsections. The first subsection deals with investment. The second subsection deals with back-transfers, bonuses and returns to investment. The third subsection connects investments to their returns.

[5] In practice none of subjects earned negative payoffs and only four subjects earned less than the initial endowment of 13.33 euros (as already noted, the lowest payment was 10.30 euros).

Table 3
Average investment levels p and u by treatment and tests of equality.

		z=0	z=4	z=8	0 versus 4	0 versus 8	4 versus 8
$\pi=0$	p	3.19 [0]	2.63 [0]	1.60 [0]	0.156	0.031	0.031
	u	0.09 [0]	0.86 [2]	2.82 [4]	0.031	0.031	0.031
$\pi=\frac{1}{4}$	p	3.33 [2 or 3]	3.24 [2 or 3]	1.75 [0]	0.844	0.031	0.031
	u	0.12 [0]	0.56 [0]	2.22 [3]	0.062	0.031	0.031
0 versus $\frac{1}{4}$	p	0.700	0.589	0.485			
0 versus $\frac{1}{4}$	u	0.818	0.132	0.240			

Remark: Investment levels predicted by standard theory in square brackets. The p-values are obtained from signrank tests (for differences in z) and ranksum tests (for differences in π) performed at the matching group level.

4.1. Investment

Table 3 presents average levels of productive investment (p) and unproductive investment (u) for each combination of z and π, together with the results from tests of differences in investment levels within rows (same π, different z) and columns (same z, different π). These tests are based on mean investment levels per matching group.[6] All p-values are based on two-tailed tests since for some comparisons there is no prediction of the direction of the difference. Table 3 can be summarized by the following three results.

Result 1. Average productive investments are above the levels predicted by standard theory and average unproductive investments are typically below their predicted levels.

Result 2. Average productive investments are (weakly) decreasing in z, whereas average unproductive investments are increasing in z.

Result 3. Average productive and unproductive investments do not vary significantly with the value of π.

First consider the treatment with $\pi=0$ and z=0. Here the game boils down to a variation of the standard trust game. With z equal to zero, unproductive investments receive no monetary reward and there is also no rationale for investments in u.[7] In order to choose a positive level of productive investment p, sellers need to trust that there is at least a positive probability that buyers reward the investment. Results from standard trust games typically show that investors do trust receivers to some extent (and that receivers reward the investment). This is also true in our setting. In the treatment with $\pi=z=0$ the average productive investment p equals 3.19 instead of the predicted 0.

Keeping weight π fixed at zero and increasing the (gross) marginal return z to unproductive investments from 0 to 4 (and subsequently to 8) changes sellers' incentives. There is now an alternative investment opportunity with a guaranteed unit return of 4 (8). The second row in Table 3 shows that sellers indeed start to invest positive amounts in u. These amounts, however, fall short of the predicted amounts, which are optimal given a choice of p=0. Due to the quadratic cost function $(p+u)^2$, positive amounts of u increase the cost of investments in p, thereby making it more expensive for the seller to trust the buyer. It is therefore not surprising to observe that p goes down as z increases (although the decline is not significant for the change of z from 0 to 4).

The middle panel of Table 3 shows a very similar pattern for the treatments with $\pi=\frac{1}{4}$, both in absolute levels as well as in the comparative statics in z. For the treatment with z=0 and $\pi=\frac{1}{4}$, the average investment levels are virtually identical to those in the treatment with $z=\pi=0$. Increases in z are again accompanied by higher levels of u and lower levels of p.

Standard theory predicts that productive investments (weakly) increase when π increases from 0 to $\frac{1}{4}$. The reason is that it raises the seller's return to p from 0 to 5. This prediction is not supported by the results. For each level of z, average productive investments p are constant in π. For z equal to 4 and 8 there tends to be a small decline in unproductive investments u when π increases. The differences are, however, insignificant.

The previous results deal with the average levels of p and u separately. Our next result relates to the observed combinations of productive and unproductive investments.

[6] Individuals as data-points are not independent (with the exception of their very first decision) because they interact with each other in their group; the statistical significance of such tests is therefore exaggerated. Yet aggregating to the group level ignores much information and the power of tests at this level is low. If tests at the group level are not statistically significant this may thus be caused by the low power of the test. We therefore also calculated the p-values of the tests at the individual level. If these are too large (above 0.10) as well, we can be more confident that there is really no impact. In only two out of the 18 tests reported in Table 3 it makes a difference if tested at the subject or at the group level.

[7] In only 5 out of 150 investment choices in this treatment, u exceeds zero. Two subjects chose positive u in the third period of this treatment; one subject in the first round, and one subject in the first and second rounds. The average total profits of these four sellers were substantially below the average total profits of all sellers (62 versus 158).

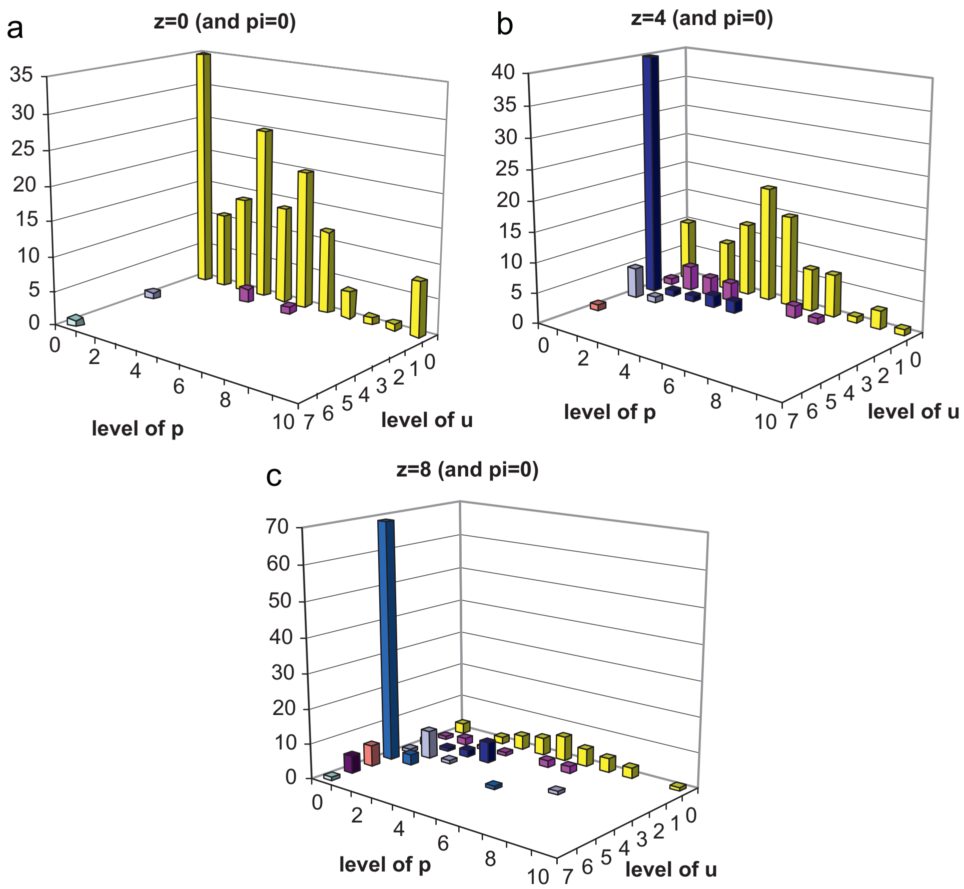

Fig. 1. Frequencies of p and u for $\pi = 0$ (n=150 in each treatment).

Result 4. In all treatments, the combination of p and u predicted by standard theory (i.e. (p^*, u^*) in Table 2), is the combination most frequently chosen.

This result follows from Figs. 1 and 2. These figures plot frequency distributions of combinations of p and u for each of the different treatments: Fig. 1 considers the three treatments with $\pi = 0$ and Fig. 2 the treatments with $\pi = \frac{1}{4}$. In each treatment the total number of observed investment choices equals 150. The combinations predicted by standard theory always correspond with the modal choices, with frequencies varying from 35 to 75. The figures also show that deviations from the standard predictions are typically in the direction of a larger p and (unless u=0 is predicted) a smaller u.

Overall, the actual comparative statics with respect to z (cf. Result 2) are in line with standard theory, but those with respect to π (cf. Result 3) are not. Reciprocity motivations may provide an explanation. As discussed in Section 2.2, an increase in π makes productive investments directly more attractive, because the seller can capture a larger part of the return on this investment. But a higher π at the same time decreases the scope for reciprocity, thereby potentially muting (productive) investment incentives. Our findings suggest that these two effects cancel out. Interestingly though, such complete crowding out is not observed with respect to variations in z. The next subsection explores whether the actual bonuses paid by buyers can explain this.

4.2. Back-transfers and bonuses

We now turn to the analysis of the back-transfers from buyers to sellers. Table 4 reports per treatment the mean values of various components of parties' payoffs. In square brackets are the predictions from standard theory. The minimum back-transfer equals $w(p,u)$. For the investment choices p^* and u^* predicted by standard theory, this expression increases in z and π. The rows with entry $w(p,u)$ show that this is also the case for the actual average minimum back transfers.

Standard theory predicts that buyers will not pay sellers more than the minimum back-transfer. The results in the rows labeled "Bonus" show that this prediction is not borne out by the data. When $\pi = 0$ the average bonus is between 16 and 30 and (weakly) decreases in z. For $\pi = \frac{1}{4}$ the average bonus is substantially lower and around 5, independent of z. Ranksum tests

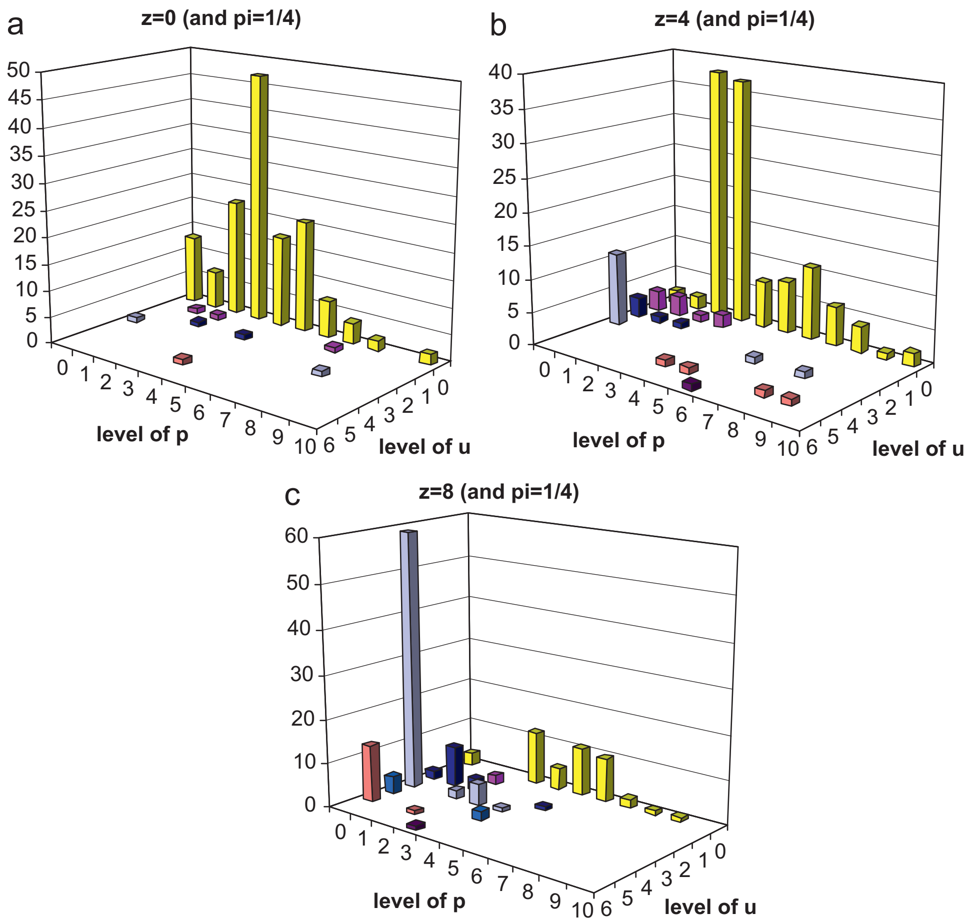

Fig. 2. Frequencies of p and u for $\pi=\frac{1}{4}$ (n=150 in each treatment).

(reported in Appendix C) reveal that bonuses decrease in π for any given level of z. We summarize these findings in the following result:

Result 5. The average bonus is positive and (a) weakly decreases with z for $\pi=0$, (b) is almost constant in z for $\pi=\frac{1}{4}$, and (c) decreases in π.

Table 4 also reports the average sum of the minimum back-transfer and the bonus (total transfer). Overall the test statistics reveal that the total transfer does not vary with z. However, total transfers do appear to increase in π (cf. Appendix C). This indicates that the overall effects of z and π on $w(p,u)$ dominate their effects on the bonus. Hence, the fact that in deviation from standard theoretical predictions buyers pay sellers a bonus, does not alter the predicted general pattern of the total transfers.

Because investors typically invest more in p and less in u than predicted (cf. Result 1), realized net total earnings exceed the predicted levels, especially when $\pi=0$ (cf. Table 4). And because buyers typically pay sellers some bonus, both parties appear to benefit from these deviations from standard theory. Both the buyers' earnings and joint earnings are (weakly) decreasing in z and constant in π. The former finding is in line with standard theory, the latter is not. The buyer was expected to earn less when π increases, whereas total earnings were predicted to increase. In line with standard theory, however, the seller benefits from having a higher π. He also benefits from a higher z. According to standard theory this ought to be the case because a higher z increases the (gross) return to the unproductive investment. With reciprocity motivations this could be the case if buyers pay a higher return to productive investments when z increases (cf. Corollary 1). We next investigate whether this latter mechanism operates.

Table 5 analyzes for each treatment how the bonus is related to the choices of p and u. Since bonuses cannot be negative and since we observe for each buyer five back-transfer decisions for each level of z, we estimate random effects tobit models. The table reports (for each treatment separately) the effects of changes in p and u on the expected value of the bonus the buyer wanted to pay to the seller.

The results in Table 5 clearly indicate that buyers do pay sellers a return on their productive investment. High levels of p increase the intended bonus. In all treatments, the estimates of the effects of p are significantly different from zero at the

Table 4
Average back-transfers, bonuses and earnings by treatment.

		z=0	z=4	z=8	0 versus 4	0 versus 8	4 versus 8
$\pi=0$	$w(p,u)$	0	3.4	22.6	0.031	0.031	0.031
		[0]	[8]	[32]			
	Bonus	30.2	26.8	16.7	0.562	0.031	0.094
		[0]	[0]	[0]			
	Transfer	30.2	30.2	39.3	1.000	0.156	0.219
		[0]	[8]	[32]			
	Earn. seller	12.1	13.8	17.5	0.563	0.094	0.844
		[0]	[4]	[16]			
	Earn. buyer	113.5	102.4	72.7	0.031	0.031	0.031
		[80]	[72]	[48]			
	Tot. earn.	125.6	116.2	90.2	0.094	0.031	0.031
		[80]	[76]	[64]			
$\pi=\frac{1}{4}$	$w(p,u)$	36.5	37.8	41.7	1.000	0.031	0.156
		[32.5]	[32.5]	[38]			
	Bonus	5.8	6.0	4.5	1.000	0.313	0.313
		[0]	[0]	[0]			
	Transfer	42.4	43.9	46.5	1.000	0.156	0.563
		[32.5]	[32.5]	[38]			
	Earn. seller	26.2	23.2	28.4	0.313	0.219	0.156
		[26.25]	[26.25]	[29]			
	Earn. buyer	104.1	100.9	68.4	0.844	0.031	0.031
		[97.5]	[97.5]	[42]			
	Tot. earn.	130.3	124.1	96.8	0.219	0.031	0.031
		[123.75]	[123.75]	[71]			

Remark: Standard theoretical predictions in square brackets. The *p*-values for differences in *z* are obtained from signrank tests performed at the matching group level.

Table 5
Effects of *p* and *u* on the bonus; random effects tobit estimates.

		z=0	z=4	z=8	LR-test (0=4=8)
$\pi=0$	*p*	10.13	11.26	8.29	0.114
		(0.77)	(0.97)	(1.38)	
	u	−5.29	0.32	−10.39	0.028
		(12.56)	(2.44)	(2.05)	
$\pi=\frac{1}{4}$	*p*	5.60	6.94	6.26	0.833
		(0.90)	(1.66)	(1.51)	
	u	−3.30	1.56	−0.95	0.078
		(4.21)	(2.53)	(2.23)	
LR-test ($0=\frac{1}{4}$)	*p*	0.026	0.004	0.616	
	u	0.799	0.745	0.005	

Remark: Standard errors appear in parentheses. The final column and bottom two rows present *p*-values from likelihood ratio tests on the equality of estimated coefficients (for *p* and *u* separately) across treatments.

5%-level. In contrast, in five out of six treatments the estimated effects of *u* are not significantly different from zero.[8] This suggests that buyers do not punish sellers for their, presumably unkind, choice of positive *u*. There is one exception: sellers who invest in *u* in the ($\pi=0, z=8$)-treatment are punished.

Result 6. The bonus depends positively on *p* and is (almost) independent of *u*.

We tested for equality of the effects of *p* and *u* on the (intended) bonus for different values of *z* and given values of π, see the final column in Table 5. It appears that bonus returns to *p* do not vary with *z*. Bonus returns to *u* are independent of *z* if $\pi=\frac{1}{4}$ and vary with *z* if $\pi=0$. The pattern in this last case is, however, not monotonic. By and large the bonus returns to *u* are independent of *z*. We also tested for equality of the effects of *p* and *u* on the bonus for different values of π while keeping *z* fixed. For *z*=0 and 4 returns on *p* are decreasing in π; for *z*=8 returns on *u* are increasing in π.

Result 7. The bonus returns on *p* and *u* are independent of *z*. The bonus returns on *p* are (weakly) decreasing in π and the bonus returns on *u* are (weakly) increasing in π.

[8] In all treatments the coefficients on *p* and *u* are always jointly significant and the random effects model is never rejected in favor of a pooled model.

Result 7 is partly consistent with the predictions based on intention-based reciprocity. From expression (3) for the predicted bonus under (sufficiently strong) reciprocity motivations it follows that the expected return to p in the bonus payment equals $20(1-\pi)$ (assuming that the bonus is positive). As explained there, the lower π the stronger a signal of kindness a given productive investment p is. A reciprocal buyer will therefore give a larger bonus in response. This is in line with what we observe, although the actual impact of changes in π is much smaller than predicted. Also in line with expression (3), the actual returns on p in the (intended) bonus are independent of z.

Under reciprocity motivations the expected return on u in the bonus equals $-z(1-\pi)\cdot u$. Note that this return is always negative. The seller is thus always punished for choosing high(er) values of u, but less so when π is high or z is low. We do indeed observe that bonus returns are weakly increasing in π. However, they do not vary with z, although reciprocity predicts a decreasing relationship whenever $\pi<1$. Apparently, buyers fail to recognize that a given investment level u is considered more unkind when z increases.

Together Results 5–7 reveal that bonus payments vary with p but are largely independent of u. Moreover, the bonus returns on p decrease with π and are independent of z. These findings provide a potential explanation for our earlier findings on investment levels. Because bonus returns are independent of z, variations in z only affect investment incentives through their impact on the minimum back transfer $w(p,u)$. This explains why actual productive investments decrease in z and actual unproductive investments increase in z, just like standard theory predicts. Variations in π trigger two opposing forces. An increase in π makes productive investments directly more attractive through its impact on $w(p,u)$. But a higher π also decreases the bonus returns to p, thereby mitigating productive investment incentives. This may explain why actual investment levels are independent of π. In the final subsection we connect actual investments and their overall returns.

The comparative statics with respect to π lend some support to the prediction that better explicit incentives may partially crowd out implicit incentives. When the performance measure becomes better aligned (π increases), the performance payment $w(p,u)$ provides stronger incentives to invest productively. At the same time, however, the impact of π on the non-contractible bonus payment reduces these incentives. Explicit incentives thus partially crowd out implicit incentives. This finding is in line with the results reported in Fehr and Schmidt (2007).

4.3. Investment and returns to investment

Standard theory predicts that sellers' net earnings are equal to $w(p,u)-(p+u)^2$. For given z and π, sellers' payoffs are thus a function of p, u, p^2, u^2 and $p\cdot u$. The same holds with respect to the reciprocity predictions (cf. expression (3)). For each treatment, we regressed sellers' actual payoffs on these five terms (and a constant). Results are presented in Table 6. In square brackets, this table also reports for each term the prediction from standard theory.[9]

We tested whether the estimated coefficients are jointly significantly different from their predicted values. For all six regressions we had to reject the hypothesis of no difference at the 1%-level. In spite of this, many of the separate coefficients are fairly close to the predicted values and not significantly different from these. The coefficients that are significantly different (at the 5%-level) from their predicted values are marked with an asterisk (*). The few significant differences found suggest that the returns to productive investments are somewhat larger and the returns to unproductive investment somewhat smaller than standard theory predicts. This provides a rationale for the deviations observed in Result 1.

To investigate this more carefully, the final two columns of Table 6 report the "optimum" levels of p and u for the seller, given the estimated payoff functions.[10] These columns also repeat from Table 3 the actual average investment levels (in curly brackets) and the investment levels predicted by standard theory (in square brackets). In most treatments deviations of actual investment levels from the theoretically predicted levels square well with the "optimum" levels. For instance, for $(\pi=0,z=0)$ theory predicts $p=u=0$, whereas "optimum" levels are $p^{opt}=4$ and $u^{opt}=0$. Actual investment in p is in the direction of 4 (3.19) while the actual u investment is basically zero. The main deviation is observed for treatment $(\pi=\frac{1}{4},z=8)$. Here the "optimum" levels coincide with the theoretically predicted levels ($p=0,u=3$), but actual investment patterns show positive (albeit small) investment in p.

Finally, looking how the "optimum" investment levels vary across treatments, the comparative statics in z are by and large in line with standard theory. Those with respect to π are not. According to standard theory, productive investments should weakly increase with π, whereas unproductive investments should weakly decrease. The "optimum" investment levels follow an opposite pattern. This confirms that increases in π trigger an opposing force in line with reciprocity motivations (cf. Section 4.2); the negative impact on implicit investment incentives provided by the bonus payment (more than) offsets the positive change in explicit incentives.

5. Conclusion

In this paper we explore, within a multi-task experiment, how incentives to engage in productive activities are affected when the (relative) marginal returns to unproductive rent-seeking activities increase. Standard theory predicts a negative

[9] From (1) and $R=80$ and $Z=0$, net payoffs can be rewritten as: $[80\pi]+\pi r\cdot p+(1-\pi)z\cdot u-p^2-u^2-2\cdot p\cdot u$. The predicted effects immediately follow from substituting the appropriate values of π and z.

[10] These levels were calculated by comparing the payoffs for all 121 possible (p,u)-combinations.

Table 6
Effects of p and u on sellers' net earnings and optimum investments.

	z	Coefficient estimates of effect on net earnings						Optimum investments	
		Const.	p	u	p^2	u^2	$p \cdot u$	p^{opt}	u^{opt}
$\pi=0$	0	1.80 (2.40) [0]	10.00* (3.49) [0]	5.12 (7.34) [0]	−1.19 (0.52) [−1]	−1.80 (1.05) [−1]	−6.31 (5.42) [−2]	4 {3.19} [0]	0 {0.09} [0]
	4	6.25 (4.68) [0]	4.31 (2.81) [0]	3.74 (3.62) [4]	−0.18* (0.38) [−1]	−1.09 (0.68) [−1]	−5.05 (2.18) [−2]	10 {2.63} [0]	0 {0.86} [2]
	8	−5.75 (6.54) [0]	18.32* (3.34) [0]	11.82 (2.85) [8]	−2.08* (0.29) [−1]	−1.51 (0.33) [−1]	−4.67* (0.82) [−2]	4 {1.60} [0]	0 {2.82} [4]
$\pi=\frac{1}{4}$	0	21.4 (1.63) [20]	5.46 (1.23) [5]	−0.67 (2.46) [0]	−0.79 (0.21) [−1]	−0.52 (0.62) [−1]	−2.78* (0.33) [−2]	3 {3.33} [2 or 3]	0 {0.12} [0]
	4	21.66 (3.91) [20]	5.54 (2.34) [5]	8.17 (3.18) [3]	−0.91 (0.27) [−1]	−3.51* (0.97) [−1]	0.03* (0.55) [−2]	3 {3.24} [2 or 3]	1 {0.56} [0]
	8	22.44 (4.40) [20]	1.07 (4.41) [5]	6.69 (1.96) [6]	0.10 (0.71) [−1]	−1.27 (0.22) [−1]	−1.69 (0.53) [−2]	0 {1.75} [0]	3 {2.22} [3]

Remark: Below the coefficients are the robust standard errors in parentheses and the effects predicted by standard theory in square brackets. Coefficients that differ significantly (at the 5%-level) from the predicted coefficients are marked with an *. p^{opt} and u^{opt} give the "optimum" investment levels, i.e. the combination of $p,u \in \{0,1,2,\ldots,10\}$ that gives the highest net payoff to the seller given estimated coefficients. Below p^{opt} and u^{opt} are average actual investment levels in curly brackets and theoretically predicted levels (based on standard theory) in square brackets.

relationship, whereas reciprocity considerations suggest that productive activities are unaffected or may even increase. The intuition behind this latter prediction is that better rent-seeking opportunities also improve opportunities to signal good intentions. This may strengthen an informal reciprocity mechanism under which productive activities are rewarded with a higher than predicted return.

Our findings reveal that subjects typically choose higher rent-seeking levels when the marginal returns to rent-seeking increase. The observed increases, however, are much smaller than standard theory predicts and often lack significance. Moreover, the investments in productive activities are typically higher than standard theory predicts and the investments in rent-seeking are usually lower. Reciprocity considerations thus seem to mitigate the adverse affects of rent-seeking opportunities. Yet they do not completely eliminate them. More generally, our results suggest that explicit incentive instruments like asset ownership and performance pay and implicit incentives based on reciprocity motivations, partially act as substitutes.

Appendix A. Derivation of reciprocity equilibria

In this appendix we formally prove Proposition 1 and Corollary 1. Following Dufwenberg and Kirchsteiger (2004) we assume that the buyer's utility is given by

$$U_B = m_B + Y_B \cdot \kappa \cdot \lambda \tag{A.1}$$

with m_B denoting the buyer's monetary payoffs and $Y_B \cdot \kappa \cdot \lambda$ her reciprocity payoffs. Within this latter term parameter $Y_B \geq 0$ captures the buyer's sensitivity towards reciprocity. Factor κ reflects the buyer's kindness towards the seller and λ the buyer's belief about how kind the seller is to her. We first derive these two factors, which differ for each of the possible investment choices (p,u) the buyer can be confronted with.

Like before, let $b(p,u) \geq 0$ denote the bonus the buyer gives to the seller after seller's choice (p,u). The buyer's kindness $\kappa(b(p,u),p,u)$ of choosing a particular bonus level $b(p,u)$ in response is formally defined as the difference between what the buyer (thinks she) actually gives to the seller by choosing $b(p,u)$ and the average of the minimum and the maximum monetary payoff that she (believes she) could give him in principle. We immediately obtain

$$\kappa(b(p,u),p,u) = w(p,u) - C(p,u) + b(p,u) - \frac{1}{2}[w(p,u) - C(p,u) + R(p) - C(p,u)] = b(p,u) - \frac{1}{2}[R(p) - w(p,u)] \tag{A.2}$$

Note that the buyer's kindness is monotonically increasing in the actual bonus paid. Moreover, a given bonus $b(p,u)$ is considered more kind the more the seller can already secure for himself.

Next we turn to λ, i.e. the perceived kindness of the seller. This factor is defined as the difference between what the buyer believes the seller believes he gives to the buyer by choosing (p,u), and the average of the minimum and the maximum payoff that the buyer believes the seller believes he could give to the buyer in principle. To calculate λ we thus need the buyer's second order beliefs about what the seller believes about her bonus payment. Let $b'(p,u)$ denote the seller's belief about the buyer's choice of bonus amount $b(p,u)$. Going one level up in the belief hierarchy, $b''(p,u)$ then gives the buyer's belief about $b'(p,u)$. The minimum and maximum amount the buyer believes that the seller believes he could give her then equals

$$k = \min_{p,u} R(p) - w(p,u) - b''(p,u)$$

$$K = \max_{p,u} R(p) - w(p,u) - b''(p,u) \tag{A.3}$$

With these expressions the believed kindness of a choice for (p,u) equals

$$\lambda(p,u) = R(p) - w(p,u) - b''(p,u) - \frac{1}{2}[k+K] \tag{A.4}$$

Expressions (A.1) through (A.4) characterize the buyer's utility.

We next state and prove three observations that are helpful in proving Proposition 1. Recall that $\overline{p}$ and $\overline{u}$ denote the maximum investment levels. Given the assumptions made in Section 2.1, the buyer's share $R(p)-w(p,u)$ then lies in between the minimum amount of $R(0)-w(0,\overline{u})$ and the maximum amount of $R(\overline{p})-w(\overline{p},0)$. Observation 2 below reveals that the higher $R(p)-w(p,u)$, the higher the perceived kindness of a choice for (p,u) is and the higher the corresponding bonus payment $b(p,u)$. In equilibrium investment combination $(0,\overline{u})$ is thus always perceived as the most unkind one and $(\overline{p},0)$ as the most kind choice (cf. Observation 3). There is an upper limit to perceived kindness though, and only when this upper bound is attained the buyer may give the seller a positive bonus in equilibrium (Observation 1).

Observation 1. In any SRE necessarily $\lambda(p,u) \le 1/Y_B$ and $\lambda(p,u) < 1/Y_B \Longrightarrow b(p,u) = 0$.

Proof. From the expression for the buyer's utility we obtain $\partial u_B/\partial b = -1 + Y_B \cdot \lambda(p,u)$. Suppose $\lambda(p,u) > 1/Y_B$. Then $\partial u_B/\partial b > 0$ and the buyer prefers to give the seller the largest possible bonus $b(p,u)$=$R(p)-w(p,u)$. In equilibrium beliefs are correct, so $b''(p,u) = b(p,u)$. With the expression derived for $\lambda(p,u)$ it then follows that $\lambda(p,u) = -\frac{1}{2}[k+K] \le 0$, a contradiction. Hence necessarily $\lambda(p,u) \le 1/Y_B$. For $\lambda(p,u) < 1/Y_B$ we obtain $\partial u_B/\partial b < 0$ and thus necessarily $b(p,u)$=0. □

Observation 2. Let (p_1,u_1) and (p_2,u_2) be such that $R(p_1)-w(p_1,u_1) > R(p_2)-w(p_2,u_2)$. Then in any SRE $b(p_1,u_1) \ge b(p_2,u_2)$ and $\lambda(p_1,u_1) \ge \lambda(p_2,u_2)$.

Proof. First suppose to the contrary that $b(p_1,u_1) < b(p_2,u_2)$. Then from expressions (A.3) and (A.4) we obtain under correct beliefs $b''(p,u) = b(p,u)$ that $\lambda(p_1,u_1) > \lambda(p_2,u_2)$. By Observation 1 this implies $\lambda(p_2,u_2) < 1/Y_B$ and thus $b(p_2,u_2)$=0. Because the bonus is necessarily non-negative this contradicts the supposition that $b(p_1,u_1) < b(p_2,u_2)$. Hence $b(p_1,u_1) \ge b(p_2,u_2)$ necessarily. Next, suppose $\lambda(p_1,u_1) < \lambda(p_2,u_2)$. Again by Observation 1 we have $b(p_1,u_1)$=0. Using $b(p_1,u_1) \ge b(p_2,u_2)$ we get that also $b(p_2,u_2)$=0. But for $b(p_1,u_1)$=$b(p_2,u_2)$=0 it necessarily holds that $\lambda(p_1,u_1) \ge \lambda(p_2,u_2)$ (cf. expression (A.4)), a contradiction. □

Observation 3. In any SRE necessarily $k = R(0)-w(0,\overline{u})$ and $K = R(\overline{p})-w(\overline{p},0)-b(\overline{p},0)$.

Proof. From Observation 2 follows that the seller's choice of $(p,u) = (0,\overline{u})$ which minimizes $R(p)-w(p,u)$ is considered most unkind. Because $\lambda(0,\overline{u}) \le 0$ we get $b(0,\overline{u}) = 0$ from Observation 1. In equilibrium beliefs are correct, so $b''(0,\overline{u}) = 0$ and we obtain $k = R(0)-w(0,\overline{u})$. Similarly, by Observation 2 a choice for $(p,u) = (\overline{p},0)$ is considered most kind. This immediately implies $K = R(\overline{p})-w(\overline{p},0)-b(\overline{p},0)$. □

Proof of Proposition 1. $R(p)-w(p,u)$ is maximized for $(p,u) = (\overline{p},0)$. From Observation 2 it follows that, if the SRE specifies a positive bonus for some (p,u), necessarily $b(\overline{p},0) > 0$. First suppose $b(\overline{p},0) = 0$. In that case $K = R(\overline{p})-w(\overline{p},0)$ from Observation 3. Together with $k = R(0)-w(0,\overline{u})$ it follows that $\lambda(\overline{p},0) = \frac{1}{2}[(R(\overline{p})-w(\overline{p},0))-(R(0)-w(0,\overline{u}))]$. To make $b(\overline{p},0) = 0$ indeed optimal it is required that $\lambda(\overline{p},0) \le 1/Y_B$ (cf. Observation 1), i.e. $(R(\overline{p})-w(\overline{p},0))-(R(0)-w(0,\overline{u}))-2/Y_B \le 0$. Next let $b(\overline{p},0) > 0$. From Observation 1 then necessarily $\lambda(\overline{p},0) = 1/Y_B$. With the expressions for k and K in Observation 3 we obtain $\lambda(\overline{p},0) = \frac{1}{2}[(R(\overline{p})-w(\overline{p},0))-(R(0)-w(0,\overline{u}))]-b(\overline{p},0)/2 = 1/Y_B$. This gives that $b(\overline{p},0) = [(R(\overline{p})-w(\overline{p},0))-(R(0)-w(0,\overline{u}))]-2/Y_B$. Using this bonus payment, Observation 3 yields that $K = R(0)-w(0,\overline{u})+2/Y_B = k+2/Y_B$. By plugging this value into equality (A.4) we obtain $\lambda(p,u) = R(p)-w(p,u)-b(p,u)-(R(0)-w(0,\overline{u}))-1/Y_B$ under correct beliefs about $b(p,u)$. From Observation 1 we have $\lambda(p,u) \le 1/Y_B$, so necessarily $b(p,u) \ge R(p)-w(p,u)-(R(0)-w(0,\overline{u}))-2/Y_B$. Now, whenever $b(p,u) > 0$ it must hold that $\lambda(p,u) = 1/Y_B$ (cf. Observation 1). In that case $b(p,u) = R(p)-w(p,u)-(R(0)-w(0,\overline{u}))-2/Y_B$. This yields expression (2) in the main text.

Given equilibrium bonus payment $b(p,u)$, the optimization problem for the seller becomes:

$$\max_{p,u} w(p,u)+b(p,u)-C(p,u) = \max_{p,u} w(p,u)+\max\left\{0, R(p)-w(p,u)-(R(0)-w(0,\overline{u}))-\frac{2}{Y_B}\right\}-C(p,u)$$

First observe that an investment combination for which the max-term is at its kink can never be optimal. This holds because for such investments the right derivative of the seller's payoffs with respect to p equals $r-\partial C/\partial p$, exceeding the left derivative equal to $\pi r - \partial C/\partial p$ whenever $\pi < 1$. (For $\pi = 1$ we have $w(p,u)=R(p)$ and an investment combination for which the max-term is at its kink does not exist.) Therefore, only two cases have to be considered.

First, assume that $b(p,u)=0$ for the seller's equilibrium investments. Then it immediately follows that $(p,u)=(p^*,u^*)$. For the assumption to hold it is required that $Y_B < 2/((1-\pi)rp^* + (1-\pi)z(\overline{u}-u^*))$. Next suppose $b(p,u) = R(p) - w(p,u) - (R(0) - w(0,\overline{u})) - 2/Y_B$ for the equilibrium investment levels. Then $(p,u) = (p_{eff}, u_{eff}) = (r/2, 0)$ and it is required that $Y_B > 2/((1-\pi)r^2/2 + (1-\pi)z\overline{u})$. Now when $2/((1-\pi)r^2/2 + (1-\pi)z\overline{u}) < Y_B < 2/((1-\pi)rp^* + (1-\pi)z(\overline{u}) - u^*)$ both candidates for the optimum exist. The seller's payoffs when choosing $(\frac{r}{2}, 0)$ equals $r^2/4 + \pi R + (1-\pi)(Z + z\overline{u}) - 2/Y_B$. A choice for investment combination (p^*,u^*) gives $w(p^*,u^*) - C(p^*,u^*)$. Comparing these two payoffs it immediately follows that when $Y_B > (<) \overline{Y}(z,\pi)$ the former is strictly larger (smaller). (When $Y_B = \overline{Y}(z,\pi)$ the seller is indifferent between investment combinations (p^*,u^*) and (p_{eff}, u_{eff}) and a continuum of equilibria exist.) From $[\pi rp^* + (1-\pi)zu^* - C(p^*,u^*)] \geq \pi^2 r^2/4$ it follows that $2/((1-\pi)r^2/2 + (1-\pi)z\overline{u}) < \overline{Y}(z,\pi) \leq 2/((1-\pi)rp^* + (1-\pi)z(\overline{u}-u^*))$. □

Proof of Corollary 1. We show that the denominator is increasing in z and decreasing in π. First observe that $M(z,\pi) \equiv [\pi rp^* + (1-\pi)zu^* - C(p^*,u^*)]$ just equals $w(p^*,u^*) - C(p^*,u^*) - [\pi R + (1-\pi)Z]$. Because (p^*,u^*) maximizes $w(p,u) - C(p,u)$, it also maximizes $[\pi rp + (1-\pi)zu - C(p,u)]$. By the envelope theorem then $\partial M/\partial z = (1-\pi)u^*$ and $\partial M/\partial \pi = rp^* - zu^*$. We obtain $\partial((1-\pi)z\overline{u} - M)/\partial z = (1-\pi)(\overline{u}-u^*) > 0$ and $\partial((1-\pi)z\overline{u} - M)/\partial \pi = -rp^* - z(\overline{u}-u^*) < 0$. □

Appendix B. Supplementary data

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.euroecorev.2010.09.007.

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