Reciprocity in Dynamic Employment Relationships*

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This paper analyzes a dynamic relational contract for employees with reciprocal preferences. Developing a model of a long-term employment relationship, I show that generous upfront wages that activate the norm of reciprocity are more important when an employee is close to retirement. In earlier stages, direct incentives promising a bonus in exchange for effort are more effective. Then, a longer remaining time horizon increases the employer's commitment. Generally, direct and reciprocity-based incentives reinforce each other and should be used in combination. Moreover, I shed new light on the consequences of labor market competition for the importance of social preferences in the workplace.

Keywords: reciprocity, relational contracts, norms and social preferences

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1. Introduction

How to effectively motivate their employees is of utmost importance for firms, and many jobs involve some form of incentive pay. Alternatively, social preferences might induce employees to increase their effort in response to generous wages (Akerlof, 1982). A vast amount of evidence indicates that both, "standard" incentives as well as gift-exchange considerations, motivate employees (DellaVigna et al., 2019). However, there is less understanding of whether pay-for-performance and generous wages merely constitute two substitutable components of a firm's "incentive toolkit" (as studies within static settings indicate; see Englmaier and Leider, 2012a; DellaVigna et al., 2019), or whether more intricate interactions prevail – in particular considering the long-run nature of employment relationships and the inherent incompleteness of real-world labor contracts.

In this paper, I incorporate gift-exchange considerations into a model of informal *relational contracts*[1]. I show that generous wages which activate an employee's preferences for positive reciprocity can facilitate the use of informal pay-for-performance because they relax the employer's commitment problem. However, both means to provide incentives are dynamic substitutes over the course of an employee's career*:* In its early stages, promising a bonus in exchange for performance is more important because a longer remaining time horizon allows the employer to credibly promise a higher bonus. In later stages, generous wages assume a more significant role. Moreover, an employee's reciprocal preferences already shape the incentive system at the beginning of a career. Then, they affect the future surplus of the employment relationship which constrains the power of direct performance pay.

The idea that a relational contract can establish a norm to reciprocate goes back to Macneil (1980; 1983) who developed a norms-based approach to contracting, in which a relational contract is a manifestation of the norms supposed to govern the behavior of the involved parties (see MacLeod, 2007, for a formal characterization). This perception has been supported by recent evidence from Kessler and Leider (2012), Krupka et al. (2017), and MacLeod et al. (2020), who demonstrate that contracts – in particular informal "handshake agreements" – can generate inherent enforcement mechanisms by establishing norms that parties feel obliged to honor.[2] Moreover, norms calling for cooperative behavior have been found to respond to circumstances. For example, Kimbrough and Vostroknutov (2016) state that a small change in context can substantially alter the norms governing a situation, which consequently

[1] Relational contracts are self-enforcing informal agreements in which future quasi-rents determine the credibility of promises. They are used if individual contribution to firm value cannot be measured objectively; see Prendergast (1999), Gibbons and Henderson (2012), Malcomson (2012) Kampkötter and Sliwka (2016), or Frederiksen et al. (2017) for arguments on the importance of incentive schemes based on informal, "subjective" assessments of performance.

[2] Relatedly, Danilov and Sliwka (2017) show that contracts can signal the prevailing social norms in case of uncertainty and consequently induce more trustworthy behavior.

influences the extent of the prosociality of actions. Peysakhovich and Rand (2016) demonstrate that cooperation in anonymous one-shot games is shaped by the nature of previous games, in which cooperative equilibria either have been strongly supported or not been possible. Landmann and Vollan (2020) provide evidence for politicians becoming more pro-social after being elected.

I integrate these insights into a repeated principal–agent model.[3] The risk-neutral agent can exert costly effort which benefits the risk-neutral principal and is observable but not verifiable, hence formal, court-enforceable, contracts cannot be used to motivate the agent. Instead, both parties may form a self-enforcing relational contract which determines bonus payments the principal is supposed to make as a reward for the agent's effort. In addition, the relational contract specifies a *norm of reciprocity*, implying that a generous wage payment by the principal is supposed to be reciprocated by the agent via higher effort. The agent responds to this norm because he has preferences for reciprocity. These preferences are activated by non-discretionary wage components, by which I mean payments that are not paid as a reward for past effort. Thus, incentives can be provided (i) directly by promising a bonus to be made *after* the agent has exerted effort, and (ii) indirectly via the norm of reciprocity and paying a non-discretionary wage *before* the agent is exerting effort (i.e., using gift exchange as introduced by Akerlof, 1982). For the former, the principal uses "relational incentives"; for the latter, she uses "reciprocity-based incentives". This specification where only non-discretionary (and not all) wage payments activate the norm of reciprocity allows for a recursive structure of the optimization problem and a clear separation of both incentive tools.

Furthermore, building upon the aforementioned evidence for the endogeneity of norms, I let the agent's responsiveness to the norm of reciprocity be affected by the history of the employment relationship. More precisely, I assume that if the principal reneges on a promised bonus, not only does the relational contract break down, but also the agent's preferences for reciprocity toward the principal disappear. The history-dependence of the norm allows for the use of relational incentives *even though there is a predetermined last period*: Because the agent's preferences for reciprocity disappear once the principal reneges on a promised bonus and because the principal's profits in the last period of the game are higher with reciprocal preferences than without, her behavior in the penultimate period affects her profits in the last period. This interaction between relational and reciprocity-based incentives carries over to earlier periods and enables the principal to credibly promise an effort-based bonus. The maximum size of this bonus is determined by the so-called dynamic enforcement (DE) constraint, which states that a bonus must not exceed the difference between future discounted profits on and off the equilibrium

[3]In Section 2, I derive many of my results in a two-period model which I later extend to a longer time horizon.

path. Since *future* on-path profits increase in the extent of the agent's reciprocal preferences, the principal can also provide stronger relational incentives *today* if the agent is more reciprocal. This source of complementarity between relational incentives and the agent's reciprocal preferences is supported by an additional channel. The (DE) constraint in a given period is relaxed and more effort can be implemented if a non-discretionary wage is paid in this period, implying that reciprocity-based preferences are particularly valuable whenever the constraint binds. Therefore, relational and reciprocity-based incentives are complements and more effort is implemented with a combination of the two.

Both are dynamic substitutes, however, in the sense that relational incentives are gradually replaced by reciprocity-based incentives over time. The reason is that the (DE) constraint is "tighter" in later periods (having fewer remaining periods reduces the principal's future profits), which amplifies the benefits of reciprocity-based incentives as time passes. This implies that a profit-maximizing incentive scheme has the highest effort in the early stages of the employment relationship, where it remains until the (DE) constraint starts to bind. Then, the principal's reduced credibility effectively constrains her ability to pay a sufficiently high bonus. This gradually decreases effort, which in turn lets the principal respond with an increase in the non-discretionary fixed wage and place a higher weight on reciprocity-based incentives.

In a number of extensions, I derive further implications and explore the robustness of my results. In Section 3.2, I introduce a general reference wage that must be exceeded to activate the agent's preferences for reciprocity (as opposed to the main part where any positive wage serves this purpose). I argue that such a reference wage is shaped by the competitiveness of the labor market, but also by aspects such as the unemployment rate. Hence, I contribute to the discussion of how competition affects the relevance of social preferences and demonstrate that preferences for reciprocity can even become *more* important in a more competitive environment. The reason is that competition (by increasing the agent's reference wage) reduces the quasi-rents generated in the relationship, which tightens the (DE) constraint and thus diminishes the power of relational incentives. In Section 4.1, I let the agent's preferences for reciprocity not merely be triggered by non-discretionary, but by all realized payments (i.e., also by wages paid in response to past effort). Then, only upfront wages and no bonuses are used to compensate the agent. I consider asymmetric information on the agent's reciprocal preferences in Section 4.2. There, I assume that the agent might either be reciprocal (as in the previous analysis) or selfish (i.e., without any reciprocal preferences). I show that a "separating contract" is mostly played, where agents are supposed to exert high effort in the first period, which however is only exerted by the reciprocal type, whereas the selfish type shirks and is subsequently fired. Additional extensions can be found in Appendix A. There, I incorporate negative reciprocity, consider a reference wage that increases in previous wages (a pattern identified by Sliwka and Werner, 2017), and analyze the implications of reciprocity being triggered by the agent's material rent.

In Section 5, I state how my theoretical results relate to empirical observations. Finally, in Section 6, I discuss my assumptions regarding the modelling of relational contracts as well as reciprocity, and argue which implications can be derived for real-world incentive systems. All proofs can be found in Appendix C.

Related Literature

One of the most robust, thoroughly researched outcomes in behavioral economics is that individuals not only maximize their own material payoffs, but also take others' well-being into account when making decisions (DellaVigna, 2009). Many individuals seem to possess social preferences, where an important component is captured by preferences for intrinsic reciprocity. A vast amount of research since Fehr et al. (1993) and Fehr et al. (1998) has found experimental support for the existence of reciprocal preferences (see Camerer and Weber (2013) for an overview of experimental research, or DellaVigna and Pope (2018) and DellaVigna et al. (2019) for more recent evidence). Most of these contributions have been careful to rule out repeated interaction in order to isolate the effect of social preferences. However, to matter in the workplace, reciprocal preferences should not be marginalized by repeated game considerations. It is thus crucial to understand how repeated interaction affects the optimal provision of incentives for reciprocal individuals (Sobel, 2005). Some experimental studies have approached this question and disentangled the two motives for cooperation. Reuben and Suetens (2012) use an infinitely repeated prisoner's dilemma to assess the relative importance of strategic motives (i.e., driven by repeated interaction) and intrinsic reciprocity and find that cooperation is mostly driven by strategic concerns. Similarly, Dreber et al. (2014) observe that strategic motives seem to be more important than social preferences in an infinitely repeated prisoner's dilemma. Cabral et al. (2014) conduct an infinitely repeated veto game to distinguish between explanations of generous behavior. They find strategic motives to be the predominant motivation, but also present evidence for the importance of intrinsic reciprocity. Hence, experimental evidence suggests that repeated game incentives are an important mode to support cooperation even for individuals with reciprocal preferences. However, a sound understanding of how firms optimally design dynamic incentive schemes for reciprocal agents is still lacking. The present paper addresses this gap by providing a tractable theoretical framework that incorporates the norm of reciprocity into a relational contracting framework.

The theoretical literature on intrinsic reciprocity can be arranged along the lines of whether reciprocal behavior is merely triggered by outcomes or whether the counterpart's intentions matter as well. The classic gift exchange approach developed by Akerlof (1982) is an example of outcome-based reciprocity where firms can strategically use wages above the market-clearing level to induce their employees to work harder. Applying this idea to a moral hazard framework with reciprocal agents, Englmaier and Leider (2012a) show that generous compensation can not only be a substitute for performance-based pay, but may also increase profits. This is different from Rabin's (1993) assumption that the perceived kindness of an action should be the driving force to induce reciprocal behavior. Dufwenberg and Kirchsteiger (2004) apply this psychological game theory to extensive games. Segal and Sobel (2007) demonstrate how a player's preferences over strategies might be represented as a weighted average of the utility from outcomes of the individual and his opponents. Falk and Fischbacher (2006a) develop a theory incorporating both aspects, outcomes and intentions. They assume that an action is perceived as kind if the opponent has the option to treat someone less kind. They also discuss evidence that, while individuals respond to outcomes, those responses are considerably stronger if the choices are at the counterpart's discretion (see Falk et al., 2008; Fehr et al., 2009a; Camerer and Weber, 2013). Cox et al. (2007) and Cox et al. (2008) develop a theoretical framework based on neoclassical preference theory that can generate such results. I apply these ideas to a repeated game setting. Thereby, I adapt Abreu (1988), where histories in a repeated game are classified into events such as nasty or nice and then determine continuation play: Payments by the principal today correspond to events such as nasty or nice and also determine the agent's reciprocity parameter in the future.[4]

I also contribute to the literature on relational contracts. MacLeod and Malcomson (1989) derive relational contracts with observable effort, whereas Levin (2003) shows that those also take a rather simple form in the presence of asymmetric information. Malcomson (2013) delivers an extensive overview of the literature on relational contracts. Within this broader area, a few papers have investigated the implications of incorporating "behavioral" components into a relational contracting framework. Dur and Tichem (2015) incorporate social preferences into a model of relational contracts and show that altruism undermines the credibility of termination threats. Kragl and Schmid (2009) demonstrate that having a relational contract with inequity averse agents might reduce the principal's commitment problem, whereas Fahn and Zanarone (2021) explore how envious social comparisons among agents affect the trade-off between pay secrecy and transparency in a relational contracting setting. Fahn and Hakenes (2019) show

[4] I thank an anonymous referee for suggesting this link. Also see Bernheim and Rangel (2004) as an example for preferences responding to the environment.

that relational contracts in teams can yield better outcomes if individuals are present-biased than when they are time-consistent. More closely related, MacLeod (2007) assumes that upon agreeing to an agreement, a party experiences a utility loss from breaching the agreement. He shows that this assumption allows for the formation of relational contracts even in a setting with a predetermined last period. The present paper develops a tractable framework to incorporate intrinsic preferences for reciprocity into a relational contracting framework.

2. A Two-Period Model

I start with a simplified 2-period model to display the main mechanism and results of my approach and then derive a more general version. Note that all results derived in the 2-period version also hold in the general setting (see Appendix B).

There is one risk-neutral principal ("she") and one risk-neutral agent ("he"). At the beginning of every period $t \in \{1,2\}$, the principal makes an employment offer to the agent which specifies an upfront wage $w_t \geq 0$. If the agent accepts, he receives w_t and chooses an effort level $e_t \geq 0$, which is associated with effort costs $c(e) = e^3/3$. Effort generates an expected output e_t, which is subsequently consumed by the principal.[5] Afterwards, the principal can pay a discretionary bonus $b_t \geq 0$. If the agent rejects the offer, both consume their outside option utilities which are set to zero. Moreover, the principal and agent share a discount factor $\delta > 0$. For this example, I also allow for values of δ above 1 as a way to account for longer time horizons (which are explicitly analyzed later on).

Relational Contract & the Norm of Reciprocity Neither effort nor realized output is verifiable, however can be observed by both parties. Therefore, only relational but no formal incentive contracts are potentially feasible. A relational contract is a self-enforcing agreement and constitutes a subgame perfect equilibrium of the game. Informally speaking, principal and agent agree on the relational contract at the beginning of the game. It specifies the effort level the latter is supposed to exert in every period, and the compensation he is supposed to be paid in return (all contingent on the game's history). In addition to these "standard" components, the relational contract involves a *norm of reciprocity* which states how the agent is supposed to reciprocate against "non-discretionary" upfront wages, that is, wages that are not paid as a reward for past effort. For simplicity, I assume that only the bonus is used to "directly" reward the agent for his effort, thus any upfront wage is non-discretionary by construction (in

[5] Note that the distribution of the output is not relevant for my results since the principal is risk neutral and the agent's effort is observable (see below).

the general model, I provide a formal definition of "non-discretionary" and show that it is without loss of generality to only use the bonus for discretionary payments). This specification (compared to one in which all payments trigger reciprocal reactions) substantially simplifies the analysis because it implies that the profit-maximizing relational contract is sequentially optimal and the optimization problem has a recursive structure.

The agent's preferences in a period t are

$$u_t = b_t + w_t - c(e_t) + \eta_t w_t e_t.$$

The term $\eta_t \in [0, \infty)$ determines the agent's responsiveness to the norm of reciprocity and lets the principal's (expected) output enter the agent's utility.[6] Its value in a given period depends on the history via a *norm function*, which takes the following form: When the relational contract is agreed upon at the beginning of the game, the reciprocity parameter is activated, with $\eta_1 = \eta \geq 0$. The value η captures the agent's inherent preferences for positive reciprocity and might also be affected by the match-specific relationship between the principal and the agent. η_2 remains at η if and only if the principal has paid the bonus specified by the relational contract (see the general model for a formal definition). Otherwise, it drops to zero.

Note that η_2 does *not* drop to zero after a deviation by the agent (and if no bonus is paid in response), capturing the idea that the agent's general "goodwill" towards the principal depends on the latter's behavior, not on his own.

The principal maximizes her material payoffs,

$$\pi_t = e_t - b_t - w_t.$$

In the following, I characterize a subgame perfect equilibrium that maximizes the principal's (discounted) profit's at the beginning of the game, $\pi_1 + \delta \pi_2$.

2.1. The Provision of Incentives

Generally, the principal has two instruments to motivate the agent to exert effort, reciprocity-based incentives (paying an upfront wage) and relational incentives (promising a bonus in return for effort). In the second period, though, only the former is possible. There, $b_2 = 0$ because the principal has no incentive to make a payment after the agent has exerted effort. Assuming $\eta_2 = \eta$, the agent chooses

[6] In Section A.1 in Appendix A, I also consider negative reciprocity and thus negative values of η.

effort to maximize his per-period utility $u_2 = w_2 - e_2^3/3 + \eta w_2 e_2$, thus his effort equals

$$e_2 = \sqrt{\eta w_2}.$$

It follows that second-period profits are $\pi_2 = e_2 - w_2 = \sqrt{\eta w_2} - w_2$. For later use, note that the wage maximizing π_2 would be $w_2 = \eta/4$. Then, $e_2 = \eta/2$, resulting in profits $\pi_2 = \eta/4$ and a utility $u_2 = \eta/4 + \eta^3/12$.

In the first period, the principal can of course still use reciprocity-based incentives, and a wage w_1 would induce the agent to exert $\tilde{e}_1 = \sqrt{\eta w_1}$. In addition, the principal can "ask" for a higher effort e_1 and promise a bonus in return. Because effort is not verifiable, the principal needs an incentive to pay b_1, which she only has if reneging is sufficiently costly. In standard relational contracting models, no such bonus can be enforced within a finite time horizon because of a standard unraveling argument that can be applied once a predetermined last period exists: If the equilibrium outcome in the last period is unique, the same holds for all preceding periods. In my case, however, η_2 drops to zero once the reneges on the promised b_1, after which second-period profits are zero.[7] Therefore, the following dynamic enforcement (DE) constraint determines the maximum bonus the principal can credibly promise in the first period:

$$-b_1 + \delta \pi_2 \geq 0. \tag{DE}$$

Before going on, some remarks are in order. First, in "standard" repeated game models past history determines the current state of the relationship, which in turn leads to the decision to punish or cooperate (Abreu, 1988). Building upon ideas in Bernheim and Rangel (2004) and Falk and Fischbacher (2006b), I take into account that the state might also determine *preferences*. Second, my results do not rely on η dropping to zero after a deviation by the principal. Any reduction in η causes a difference between on- and off-path profits and thus allows for a positive bonus. However, a larger reduction in η increases the maximum feasible bonus because it yields a stronger punishment for the principal. If the norm of reciprocity could be designed to maximize potential cooperation (subject to the agent's personal characteristics which would limit the maximum η), it would involve a reduction of η to zero after a deviation by the principal (adapting Abreu (1988) to a setting with history-dependent preferences).[8]

Now, I turn to the agent's incentives to exert equilibrium effort e_1 given he is paid an upfront wage w_1 and promised a bonus b_1. Importantly, continuation utilities are not used to provide incentives, thus

[7] This mechanism resembles MacLeod (2007), where one party suffers if it breaches the contract; this allows for some cooperation in the last period, and consequently more cooperation in earlier periods.

[8] See Section A.1 in Appendix A for the possibility of an even negative value of η

u_2 is unaffected by e_1. The reason is that a wage reduction after a deviation would be at odds with w_2 being non-discretionary, which is a prerequisite for triggering the agent's reciprocity (see Lemma 11 in Appendix B for a formal proof).

This implies that the agent's incentive compatibility (IC) constraint, which states that exerting equilibrium effort e_1 must be optimal, is

$$-\frac{e_1^3}{3}+\eta w_1 e_1+b_1 \geq -\frac{\tilde{e}_1^3}{3}+\eta w_1 \tilde{e}_1. \tag{IC}$$

There, I take into account that, if the agent deviates, he will not choose zero effort but $\tilde{e}_1=\sqrt{\eta w_1}$. Note that $U_1 \geq 0$ must also hold but is implied by (IC) because payments are assumed to be non-negative and the right-hand side of (IC) cannot be smaller than zero. (IC) states that the bonus must cover the utility loss that the agent suffers from exerting an effort level above $\tilde{e}_1$, i.e., $b_1 \geq u_1(\tilde{e}_1)-u_1(e_1)$. Paying the bonus, however, has to be credible, thus the bonus is bounded above by (DE), $b_1 \leq \delta\pi_2$. These two conditions determine what can be achieved with relational incentives.

The original problem can be substantially simplified (see Lemma 11). First, because the agent is not motivated with future payoff streams, the equilibrium is sequentially optimal, hence the problem is equivalent to maximizing each π_t. This implies that $\pi_2=\eta/4$, the profits in a spot contract as derived above. Second, the (IC) constraint binds. If it did not bind, b_1 could be slightly reduced, which would increase profits and relax the (DE) constraint without violating the (IC) constraint. Thus, different than with reciprocity-based incentives, the agent does not receive a rent for relational incentives.

Taking these results into account, the remaining problem is to maximize

$$\pi_1=e_1-b_1-w_1=e_1-\left(\frac{e_1^3}{3}-\eta w_1 e_1+\frac{2}{3}\left(\sqrt{\eta w_1}\right)^3\right)-w_1,$$

subject to

$$\frac{e_1^3}{3}-\eta w_1 e_1 \leq \delta\frac{\eta}{4}-\frac{2}{3}\left(\sqrt{\eta w_1}\right)^3. \tag{DE}$$

2.2. Results

In the first period, the principal faces the following trade-off. Using relational incentives, i.e., (credibly) promising a bonus b_1, allows her to extract the full surplus; using reciprocity-based incentives, i.e., paying an upfront wage w_1, grants the agent a rent but reduces his effective effort costs. The optimal relational contract balances the costs and benefits of both means to provide incentives, taking into account that the (DE) constraint restricts the use of relational incentives. In the first step, I omit the (DE) constraint.

Lemma 1 *Assume the (DE) constraint is omitted. Then,* $w_1 > 0$ *for* $\eta > 1$*, whereas* $w_1 = 0$ *for* $\eta \leq 1$.

Lemma 1 implies that even without any restriction on relational incentives, the principal might still pay a positive upfront wage if η is sufficiently large. Then, the resulting effort cost reduction more than compensates for the rent the agent captures. In the following, I refer to the effort and wage levels for a non-binding (DE) constraint as the *first-best* levels

$$e^{FB} = \frac{1+\eta^2}{2\eta},\ w^{FB} = \frac{\left(\eta^2-1\right)^2}{4\eta^3} \text{if } \eta > 1$$
$$e^{FB} = 1,\ w^{FB} = 0 \text{if } \eta \leq 1.$$

Reciprocity-Based Incentives Complement Relational Incentives In the next step, I demonstrate how incorporating the (DE) constraint affects equilibrium effort and wage.

Lemma 2 *There exist values of the discount factor,* $\bar{\delta}(\eta)$*, such that first-best effort and wage levels satisfy (DE) if* $\delta \geq \bar{\delta}(\eta)$ *and violate it if* $\delta < \bar{\delta}(\eta)$*, with* $\bar{\delta}(\eta)$ *decreasing.*

If $\delta < \bar{\delta}(\eta)$*,* $e_1 < e^{FB}$*. Moreover,*

- *if* $\eta > 1$*,* $w_1 > w^{FB}$ *;*
- *if* $\eta < 1$*, there exists a* $\tilde{\eta} < 1$ *such that* $w_1 > 0$ *for* $\eta > \tilde{\eta}$*, whereas* $w_1 = 0$ *for* $\eta \leq \tilde{\eta}$.

In words, Lemma 2 states that first-best values can be implemented if the future is sufficiently valuable, an aspect that is the defining factor of standard relational contracting models. Here, this interaction is further shaped by the agent's preferences for reciprocity. Because π_2 increases in η, the critical discount factor above which the first best can be implemented decreases in η. Therefore, reciprocity-based incentives which are provided in the future *complement* the use of relational incentives today. A further source of complementarity arises if the (DE) constraint binds. Then, the first best cannot be implemented because of an insufficient future relationship value. In this case, a positive first-period upfront wage relaxes (DE) by decreasing the bonus that must be paid for implementing a given effort level. Therefore, if the (DE) constraint binds, w_1 is larger than when it does not bind.

Dynamics Now, I describe how the agent's effort as well as payoffs evolve.

Lemma 3 *$e_1 > e_2$ and $w_1 < w_2$; moreover, $\pi_1 > \pi_2$ and $u_1 < u_2$.*

In the second period, the principal cannot use a bonus which has a direct negative effect on effort. She responds by paying a higher upfront wage than in the first period. However, this does not fully compensate for the effort reduction caused by an absent bonus. This mechanism has more nuanced consequences – in that the incentive system gradually substitutes relational with reciprocity-based incentives towards the end of the agent's career – with a longer time horizon and is explored in Section 3.

The inability to use a bonus in the second period also reduces the principal's per-period profits. The agent, however, benefits because only reciprocity-based incentives come with a rent, and this rent increases in the paid wage.

Reciprocity Now, I explore how the size of η affects effort.

Lemma 4 *Efforts increases in η. In the first period, this effect is larger if (DE) binds.*

First, a higher reciprocity parameter η directly raises equilibrium effort e_t (and consequently profits) for a given wage $w_t > 0$ due to the reduction in effective effort costs. Second, there is an indirect effect. Because future profits also increase in η, the (DE) constraint in period 1 is relaxed, which further increases equilibrium effort in period 1 if (DE) binds. This interaction provides an additional source for the complementarity between relational and reciprocity-based incentives.

3. General Model

In Appendix B, I set up a general model with $T(\geq 2)$ periods, a general effort cost function $c(e_t)$, and expected output $e_t\theta$, where $\theta > 0$ is some productivity parameter. Moreover, I formally specify the agent's reciprocal behavior and allow for a general reference wage above which the agent reciprocates. Here, I give an overview about the results of such a model.

3.1. Main Results

Lemmas 1 and 2 are basically unchanged: If the (DE) constraint in a period t is omitted, $w_t > 0$ if η is above some threshold $\bar{\eta}$ (see Lemma 12 in Appendix B). Moreover (DE) holds for the respective first-best values if the future relationship value is sufficiently large. Otherwise, it binds and a positive

w_t relaxes the constraint. Therefore, if $\eta > \bar{\eta}$, wages are larger with a binding than with a non-binding (DE) constraint (and a cutoff $\tilde{\eta} < \bar{\eta}$ exists above which a positive wage is optimal if (DE) binds; see Lemma 13 in Appendix B).

However, the dynamics (corresponding to Lemma 3) are more nuanced. This is because the future surplus which affects the optimal mix of relational and reciprocity-based incentives not only relies on the size of η and δ, but also on the remaining time horizon which falls as time passes. Then, the remaining continuation profits go down and the (DE) constraint becomes "tighter" over time. This yields the following effort and compensation dynamics.

Proposition 1 *Equilibrium effort is weakly decreasing over time, i.e., $e_t \leq e_{t-1}$. Moreover, $e_t < e_{t-1}$ implies $e_{t+1} < e_t$, whereas $e_{t+1} = e_t$ implies $e_t = e_{t-1}$.*

The equilibrium upfront wage is weakly increasing over time and the bonus weakly decreasing, i.e., $w_t \geq w_{t-1}$ and $b_t \leq b_{t-1}$. Moreover, $w_t > w_{t-1}$ and $b_t < b_{t-1}$ imply $w_{t+1} > w_t$ and $b_{t+1} < b_t$, whereas $w_{t+1} = w_t$ and $b_{t+1} = b_t$ imply $w_{t+1} = w_t$ and $b_t = b_{t-1}$.

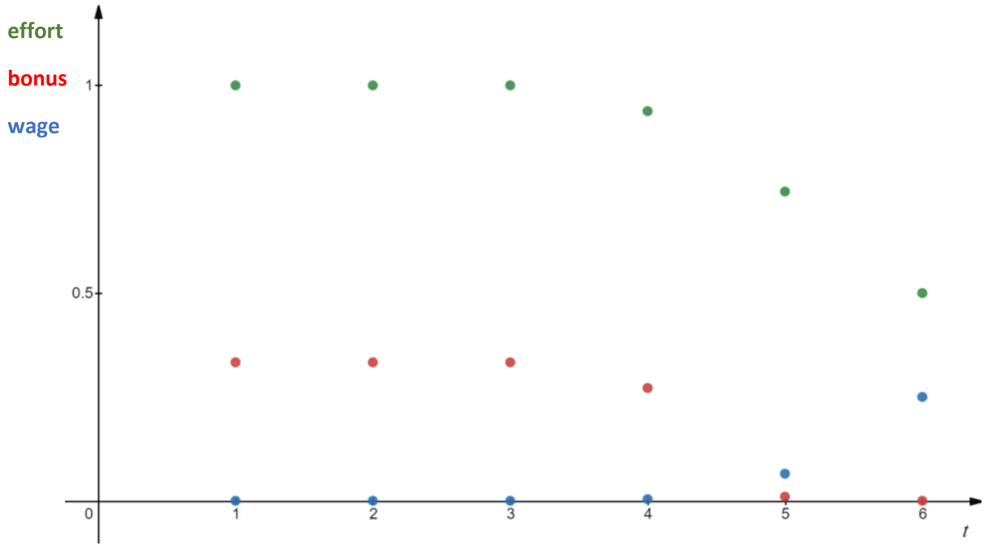
The agent's total compensation, $w_t + b_t$, might increase or decrease over time.

Proposition 1 indicates that effort and compensation are time-invariant in the early stages of the employment relationship, as long as the future is sufficiently valuable for the (DE) constraint not to bind. Once the end of the employment relationship is close and the (DE) constraint binds, effort and bonus profiles become downward-sloping and the wage profile upward-sloping. Then, the principal can no longer credibly promise her preferred bonus. On the one hand, this reduces equilibrium effort. On the other hand, the principal might respond with a wage increase that raises equilibrium effort due to the agent's preferences for reciprocity. The effort increase caused by a higher wage does not fully compensate for the effort reduction caused by the binding (DE) constraint, though, because the costs of implementing one additional unit of effort are now higher with reciprocity-based incentives than with relational incentives.

Hence, toward the end of an employment relationship, relational incentives are gradually replaced by reciprocity-based incentives (bonus $\downarrow$, wage $\uparrow$), with the substitution however being incomplete (effort $\downarrow$). The dynamics of the agent's total compensation, $w_t + b_t$, are not necessarily monotone and depend on the relative importance of relational and reciprocity-based incentives.

The following Figure 1 displays effort, wage, and bonus dynamics for the specific production function used at the beginning of this paper, i.e., where $\theta = 1$ and $c(e) = e^3/3$. Moreover, I assume $\eta = 1$, $T = 6$, and $\delta = 0.4$. Then, first-best levels can be implemented in periods $t \leq 3$, whereas the (DE) constraint binds from period 4 onwards.

Figure 1:



Payoffs With a longer time horizon, the principal's per-period profits also decrease over time (once (DE) binds), and the agent's per-period utilities increase. This result is again driven by the gradual replacement of relational with reciprocity-based incentives; because of the binding (IC) constraint, the agent only collects a rent with the latter.

Lemma 5 *The principal's per-period profits π_t are weakly decreasing over time, i.e., $\pi_t \leq \pi_{t-1}$. Moreover, $\pi_t < \pi_{t-1}$ implies $\pi_{t+1} < \pi_t$, whereas $\pi_{t+1} = \pi_t$ implies $\pi_t = \pi_{t-1}$.*

The agent's per-period utility u_t is weakly increasing over time, i.e., $u_t \geq u_{t-1}$. Moreover, $u_t > u_{t-1}$ implies $u_{t+1} > u_t$, whereas $u_{t+1} = u_t$ implies $u_t = u_{t-1}$.

Finally, equilibrium effort and profits increase with η (see Proposition 4 in Appendix B).

3.2. General Reference Wage

So far, I have assumed that the agent reciprocates to a positive non-discretionary wage. Now, the wage must instead exceed some reference wage $\overline{w} \geq 0$ – for the agent to reciprocate and to accept the principal's employment offer. Besides serving as a robustness check, this section can also yield insights into the role of labor market competition or aspects such as the unemployment rate or unemployment benefits. For example, I would expect $\overline{w}$ to be higher with more competition for workers (as in Schmidt, 2011), or to be lower with a higher unemployment rate.

For simplicity, I assume $\overline{w}$ to be constant and not vary over time. Then, the agent's period-t utility amounts to

$$u_t = w_t + b_t + \eta_t \left(w_t - \overline{w}\right) \theta e_t - c(e_t).$$

First, I characterize effort and wage in a spot reciprocity contract.

Lemma 6 *Effort in the profit-maximizing spot reciprocity contract is independent of $\overline{w}$; moreover,* $\partial w / \partial \overline{w} = 1$.

The principal responds to a higher $\overline{w}$ with an equivalent increase in w. It is optimal to keep incentives constant because the agent's reciprocal preferences are linear in $w - \overline{w}$. Therefore, a higher $\overline{w}$ only causes a redistribution of rents. To derive a profit-maximizing relational contract, I first characterize the agent's (IC) constraint for a general $\overline{w} \geq 0$,

$$b_t - c(e_t) + \eta \left(w_t - \overline{w}\right) e_t \theta \geq \eta \left(w_t - \overline{w}\right) \tilde{e}_t \theta - c(\tilde{e}_t). \tag{IC}$$

The outside wage $\overline{w}$ enters the agent's (IC) constraint only via the associated increase in the reference wage. This is different from a "standard" efficiency wage effect, where a better outside option of an employee directly reduces his incentives to work hard.

The principal's (DE) constraint still amounts to

$$-b_t + \delta \Pi_{t+1} \geq 0. \tag{DE}$$

The general structure of a profit-maximizing relational contract is as before, with constant wage and effort levels as long as (DE) is slack as well as upward-sloping wage and downward-sloping effort profiles once (DE) becomes binding. Still, $\overline{w}$ crucially affects the importance of reciprocity-based incentives, as described in Proposition 2.

Proposition 2 *A larger $\overline{w}$ tightens the (DE) constraint. If (DE) does not bind in period $t < T$, $\partial w_t / \partial \overline{w} = 1$ and $\partial e_t / \partial \overline{w} = 0$. If (DE) binds in period $t < T$, $\partial w_t / \partial \overline{w} > 1$ and $\partial e_t / \partial \overline{w} < 0$.*

Finally, the effort and compensation dynamics are as in Proposition 1.

As before, because the agent's reciprocal preferences are linear in $w - \overline{w}$, a larger value of $\overline{w}$ has no direct impact on the optimal provision of incentives. Therefore, the principal implements the same effort for all values of $\overline{w}$ if (DE) does not bind (i.e., in earlier periods of the employment relationship).

However, a higher value of $\overline{w}$ reduces the principal's future profits. This lets the (DE) constraint bind earlier, thus there are less periods of constant effort, bonus, and wage. Moreover, once the constraint binds, $\overline{w}$ restricts the principal's possibility of using relational incentives. As in the main analysis, she mitigates the necessary effort reduction by expanding reciprocity-based incentives and raising w_t beyond the increase induced by a larger $\overline{w}$. Hence, $\partial w_t / \partial \overline{w} > 1$ if (DE) binds and $w_t > \overline{w}$.

Presuming that a more competitive labor market increases $\overline{w}$,[9] this result relates to a number of theoretical and empirical contributions which have analyzed the effect of competition on the role of social preferences. If contracts are complete, competition has been found to drive out social preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Dufwenberg et al., 2011). With incomplete contracts (such as in the present setting), the situation is different, though (Fehr and Fischbacher, 2002; Schmidt, 2011). Schmidt (2011) analyzes how labor market competition might affect the utilization of fairness preferences by firms. Applying a static model, he shows that induced effort levels are the same for all degrees of competition and that only rents are shifted between firms and workers (as in my setting with a spot contract). I demonstrate that, if the dynamic nature of employment relationships is taken into account, the principal might actually make *more* use of reciprocity-based incentives in a more competitive labor market.

4. Extensions and Robustness

In the following, I analyze a number of extensions and the resulting implications for an optimal relational contract, again using the simplified setting with $T = 2$, $\theta = 1$, and $c(e) = e^3/3$.

4.1. Reciprocity Triggered by all Current Payments

Now, I let the agent's preferences for reciprocity be triggered by all realized current payments. Then, wages paid as a reward for previously exerted effort also induce the agent to reciprocate. This does not hold for the bonus, however, which is paid after effort has been exerted (this is changed in Section A.3 in AppendixA).

Whereas the agent's second-period effort still maximizes $u_2 = w_2 - c(e_2) + \eta w_2 e_2$ (hence $e_2 = \sqrt{\eta w_2}$), the principal does not maximize π_2 when selecting w_2. Therefore, the profit-maximizing equilibrium is not sequentially optimal anymore. Instead, w_2 is also a function of e_1 and set to maximize the principal's total discounted profit stream, Π_1. The agent's first-period effort must satisfy his (IC) constraint. Here,

[9] The extent of labor market competition will also affect the principal's outside option; my results hold as long as the effect on $\overline{w}$ is stronger.

I assume that once the agent deviates, $b_1 = 0$, and w_2 is set such that π_2 is myopically maximized (in which case $w_2 = \eta/4$, $e_2 = \eta/2$, and $u_2 = \eta/4 + \eta^3/12$). Therefore, if the agent deviates, he chooses $\tilde{e}_1$ to maximize $\tilde{u}_1 = w_1 - e_1^3/3 + \eta w_1 e_1$, and thus $\tilde{e}_1 = \sqrt{\eta w_1}$.

All this implies that the agent's (IC) constraint equals

$$
\begin{aligned}
&b_1 - \frac{e_1^3}{3} + \eta w_1 e_1 + \delta\left[w_2 + \frac{2\left(\sqrt{\eta w_2}\right)^3}{3}\right] \\
\geq &\frac{2\left(\sqrt{\eta w_1}\right)^3}{3} + \delta\left(\frac{\eta}{4} + \frac{\eta^3}{12}\right).
\end{aligned}
\tag{IC}
$$

The principal is only willing to make equilibrium payments if her (DE) constraint holds,

$$
-b_1 + \delta\left(e_2 - w_2\right) \geq 0. \tag{DE}
$$

Furthermore, η drops to zero if w_2 differs from the amount promised at the beginning of period 1. Then, the principal sets w_1, w_2, and b_1 to maximize $\Pi_1 = e_1 - w_1 - b_1 + \delta\left(e_2 - w_2\right)$, subject to (IC) and (DE), and taking into account that $e_2 = \sqrt{\eta w_2}$.

The structure of the optimal arrangement is similar to that in the main part, with two exceptions. First, it is optimal to set $b_1 = 0$.[10] Therefore, w_2 is *above* the level maximizing π_2 and bounded by the condition that second-period profits must be non-negative. This implies that the back-loading of upfront wages is more pronounced than before. Second, the principal's profits will be larger than those in the main model because the payments used to provide relational incentives also trigger reciprocal behavior, an aspect missing before.

4.2. Asymmetric Information

In this section, I explore the potential implications of asymmetric information on the agent's reciprocal inclinations. I assume that the agent can either be a "reciprocal" type with $\eta > 0$ (with probability $p \in (0, 1)$) or a "selfish" type with no reciprocal preferences (with probability $1 - p$). Moreover, the agent's type is his private information. Assuming that the principal can design the incentive scheme and does so in a profit-maximizing way, she chooses one of the following two options. First, the principal asks for a first-period effort level that only the reciprocal, but not the selfish agent is willing to exert. Then, the selfish agent collects the first-period wage, but is subsequently detected and fired (because he

[10] To the contrary, assume a profit-maximizing equilibrium has $b_1 > 0$. Then, a reduction in b_1 by a small $\varepsilon > 0$ together with an increase in w_2 by ε/δ does not affect (DE) and Π_1, but does relax (IC).

would exert no effort in the second period). I call this a "separation contract". Second, the effort request is sufficiently low that it satisfies the selfish type's (IC) constraint. In this case, the agent's effort choice cannot be used to screen agents and both types are also employed in the second period. Only then does the selfish agent – after collecting w_2 – shirk by exerting zero effort. I call this arrangement a "pooling contract".

I retain the setting of Section 4.1 where the norm of reciprocity is triggered by all realized payments. This simplifies the analysis of asymmetric information because, in a separation contract, the reciprocal agent takes into account that he will only remain employed if he exerts equilibrium effort in the first period. Therefore, only future wages are used to motivate the agent.

Now, I derive a Perfect Bayesian Equilibrium where *any* deviation by the agent lets the principal assign probability 1 to facing the selfish type. Then, a separation and a pooling contract are both feasible. The (IC) constraints, one for the selfish type (ICS), and one for the reciprocal type (ICR), already taking into account that $e_2 = \sqrt{\eta w_2}$, amount to

$$-\frac{e_1^3}{3} + \delta w_2 \geq 0 \tag{ICS}$$

$$-\frac{e_1^3}{3} + \eta w_1 e_1 + \delta \left[w_2 + \frac{2\left(\sqrt{\eta w_2}\right)^3}{3} \right]$$

$$\geq -\frac{\tilde{e}_1^3}{3} + \eta w_1 \tilde{e}_1, \tag{ICR}$$

with $\tilde{e}_1 = \sqrt{\eta w_1}$. Different from Section 4.1, a deviation from the equilibrium effort now results in a termination and henceforth zero off-path continuation utilities. For any effort level $e_1 \geq \tilde{e}_1$ (ICS) is tighter than (ICR) (this is shown in the proof to Proposition 3). Therefore, if the principal offered the profit-maximizing contract designed for a reciprocal type (which involves a binding (ICR) constraint), this would automatically result in a separation of types. Moreover, effort in a pooling contract will be determined by a binding (ICS) constraint.

Proposition 3 *In a profit-maximizing perfect Bayesian equilibrium at which any deviation from equilibrium effort induces the principal to assign probability 1 to facing a selfish type, a pooling contract is optimal if p is sufficiently small. If p is sufficiently large, a separating contract is optimal.*

Generally, the principal faces the following trade-off. First, with a pooling contract, the first-period effort is low (determined by a binding (ICS) constraint); however, it is exerted by both types. Then, only the reciprocal type exerts effort in the second period, whereas both are paid w_2. In this case, the principal's expected profits are $\Pi_1^P = e_1 - w_1 + \delta\,[p\,(\sqrt{w_2\eta} - w_2) - (1-p)w_2]$, and outcomes resemble those in the classical reputation literature (see Kreps et al., 1982; Mailath and Samuelson, 2006). Second, with a separating contract, the first-period effort is higher for a given w_2 (and determined by a binding (ICR) constraint), however only exerted by the reciprocal type. Then, both types are paid w_1, whereas the selfish type is fired and only the reciprocal type remains employed in the second period. In this case, the principal's expected profits are $\Pi_1^S = -w_1 + p\,[e_1 + \delta\,(\sqrt{w_2\eta} - w_2)]$. If p is sufficiently small, the principal prefers a pooling contract.

This pooling contract, however, relies on the assumption that the reciprocal type cannot reveal himself by choosing a higher effort level. But this restriction generally does not survive the Intuitive Criterion as a refinement of a perfect Bayesian equilibrium (Cho and Kreps, 1987). Assume that, in a pooling contract, an agent chooses an effort level slightly higher than equilibrium effort. Since the selfish type's (IC) constraint binds, whereas the reciprocal type's is slack, a deviation to a higher effort level should indicate that the principal in fact faces the reciprocal type. If the principal responds to this revelation by offering the profit-maximizing second-period wage for the reciprocal type, and if this gives the latter a higher utility than equilibrium play, an upward deviation by the reciprocal type indeed increases his utility. To support the relevance of this argument, in the proof to Proposition 3 I show that for low p and consequently a pooling contract,[11] $e_1 = \sqrt[3]{3\delta p^2\eta}$ and $w_2 = e_1^3/3\delta = p^2\eta$. If the reciprocal type deviates and chooses an effort level $e_1 + \varepsilon$, the principal will take this as a signal that she faces the reciprocal type and might instead offer $w_2 = \eta/4$ (the second-period wage that maximizes her profits with a reciprocal type; see the proof to Lemma 10). This wage also increases the reciprocal type's utility for $p < 1/2$.

Although a more general characterization of an optimal arrangement under asymmetric information is beyond the scope of this paper, this extension can provide a complementary explanations to experimental evidence indicating that cooperation in repeated interactions is larger than when individuals only interact once (see Section 5). A better understanding of optimal arrangements with asymmetric information about an agent's social preferences would probably require a setup tailored to its specific characteristics. Then, it would be worthwhile to incorporate a longer time horizon (to assess the timing of potential separations) as well as several types of reciprocal agents. With a longer time horizon, separations might happen early on because, with symmetric information, the agent's rent increases towards the end of his career due to a more extensive use of reciprocity-based incentives. Therefore, I would conjecture that a separation early on requires less information rents. However, this would rely on the direction of imitation temptations, but also on how separations take place. In the current setting with a selfish

[11] More precisely, for $p^2 \leq \left(\sqrt{2}\right)^3/3\delta\eta$.

agent, separation happens via effort choice, i.e., both types are offered the same first-period contract but the selfish type then chooses zero effort. Whether this also holds with two different types who both have a positive reciprocity parameter or whether those are optimally separated by offering them different contracts remains to be explored. Also, additional kinds of deviations have to be considered and beliefs assigned, for example if an agent does not choose the equilibrium effort of one type, but instead the respective $\tilde{e}$ (in particular if this type's (IC) constraint is binding). To conclude, a better understanding of optimal relational contracts for agents with social preferences under asymmetric information certainly is a worthwhile endeveor but left for future research.

5. Relation to Evidence

Having derived my main theoretical results, I now discuss a number of empirical observations that are consistent with an optimal relational contract for a reciprocal agent.

First, Boosey and Goerg (2018) find that relational and reciprocity-based incentives indeed are complements and that a relational contract with agents who are known to be reciprocal can be sustained with a finite time horizon. They conduct a lab experiment in which a manager and a worker interact for two periods. The worker can spend time completing a series of real effort tasks and is paid an upfront wage in every period. In addition, the principal may have the opportunity to pay a fixed bonus between the two periods, after the first period output has been observed. Boosey and Goerg (2018) observe that average output is considerably larger with this option than in those treatments in which the principal either cannot pay a bonus (in which case a positive effort is still observed, indicating that the participants have reciprocal preferences), or the bonus can be paid at the beginning or end of the game. Furthermore, Kölle et al. (2020) observe that cooperation of "pro-social" players in an infinitely repeated prisoner's dilemma is considerably more pronounced than of selfish players.

Second, Fahn et al. (2017) provide evidence for relational and reciprocity-based being dynamic substitutes. They attempt to test the predictions of a positive interaction between reciprocal preferences and equilibrium effort, and that this effect is stronger once relational incentives are gradually replaced by reciprocity-based incentives (i.e., in later periods when the (DE) constraint binds). Following Dohmen et al. (2009), Fahn et al. (2017) use data from the German Socio-Economic Panel (SOEP), an annual panel survey representative of the German population that contains a wide range of questions on the personal and socioeconomic situation as well as labor market status and income of respondents. In a number of years, it also contained questions designed to capture individual reciprocal inclinations. As a measure of (non-verifiable) effort, Dohmen et al. (2009) use overtime work, finding that individuals with stronger reciprocal inclinations are more likely to work overtime. Using the same data and approach as Dohmen et al. (2009), Fahn et al. (2017) show that the positive interaction between reciprocal inclinations and effort indeed is substantially stronger for older workers close to retirement.

My results on compensation dynamics can also be compared to Gibbons and Murphy (1992) who assess the relative importance of "direct" incentives (i.e., performance-based bonuses) and career concerns over the course of a manager's career. They find that direct incentives are particularly important for workers close to retirement, when potential promotion opportunities are less relevant. This is the opposite to my results, where direct incentives are more important at the beginning of a career. One difference between my setting and Gibbons and Murphy (1992) is that they allow for formal contracts based on a verifiable output measure (frictions arise because agents are risk averse), whereas in my setting the use of informal direct incentives relies on future profits generated by social preferences.

Third, consistent with the described effort dynamics, there is evidence that a worker's productivity decreases once he approaches retirement. Using US data, Haltiwanger et al. (1999) find that a firm's productivity is higher if it has a lower proportion of workers older than 55. Skirbekk (2004) reports that older workers generally have lower productivity and are overpaid relative to their productivity. Using Belgian data, Lallemand and Rycx (2009) show that having a high share of workers above 49 is harmful for a firm's productivity. Reduced effort in the last periods of an employment relationship has also been observed in many lab experiments (e.g., Brown et al., 2004; Fehr et al., 2009a), which I further discuss in the next Paragraph.

Fourth, the setting with asymmetric information can deliver a new explanation for the large amount of experimental evidence for higher cooperation in repeated than in one-shot interactions (even with a predefined last period). Whereas these outcomes are usually attributed to selfish types imitating those with social preferences (Fehr et al., 2009a), I provide a complementary story which takes into account that individuals with social preferences also behave strategically.[12] If the uninformed party can determine the incentive scheme, and in particular ask for a certain effort level, pooling equilibria at which a selfish type imitates a reciprocal type are much harder to maintain. Then, an early separation of types can be achieved by requiring an effort level that just satisfies the reciprocal type's (IC) constraint, with the remaining matches thereafter having a relational contract that produces outcomes resembling my main results (high effort in early periods, declining effort once the last period approaches). Such results have

[12]This is not assumed in most of the reputation literature (Kreps et al., 1982; Mailath and Samuelson, 2006), where "commitment" types automatically choose cooperative actions.

indeed been observed in the lab experiments conducted by Brown et al. (2004). They compare various settings, in particular one in which players (among whom one side assumes the role of firms and the other side represents workers) have the option to form long-term relationships or are randomly matched in each of the 15 rounds. Firms pay wages in every period and ask for effort from "their" workers, who subsequently select their effort levels. Brown et al. (2004) find that effort is significantly larger in the treatment with long-term relationships, where effort declines only in the last two periods. They present a theoretical explanation where some players have fairness preferences and where those without imitate the fair players early on, which mirrors the pooling contract in my setting. However, they observe many separations early on (70 percent in period 1, 65 percent in period 2) but few separations in later periods, which indicates that their outcomes rather resemble separating contracts.

6. Discussion & Conclusion

In this paper, I have developed a tractable framework to incorporate reciprocal preferences into a relational contracting model. I have demonstrated that relational and reciprocity-based incentives reinforce each other and should optimally be used in combination. At the beginning of an employee's career, relational incentives assume a larger role because a longer remaining time horizon increases a firm's commitment. Once the end of the career approaches, reciprocity-based incentives gradually become more important. Finally, I have provided a new perspective on the impact of competition on the relevance of social preferences in employment relationships, as well as on the consequences of asymmetric information about an individual's preferences for reciprocity.

To conclude, I want to discuss my paper's implications for real-world incentive systems and to what extent the trade-offs I have derived might apply. There, I first focus on my modelling of relational contracts, and second on the assumptions underlying the agent's preferences for reciprocity.

6.1. Modelling of Relational Contracts

Most jobs certainly involve aspects that are not verifiable and can only be evaluated "subjectively". However, for my setup (which is based on standard models of relational contracting) to be applicable, it is also important that the choice whether to compensate the agent as promised is made by the owner of the residual surplus. This certainly applies to the owners of a firm, so the question pertains whether the standard setting of relational contracts only relates to top managers for whom relational contracts indeed have been found to be relevant (Hayes and Schaefer, 2000; DeVaro et al., 2018). I would argue that relational contracts are also important at lower hierarchy levels where the individual contribution to firm value is difficult to verify. For example, assume that the principal corresponds to a middle manager who has some budget autonomy and whose own bonus is a share of her division's profits (which are a function of her subordinates' efforts, which itself are not verifiable on an individual level but in aggregate might generate a verifiable performance signal). Then, the middle manager's incentives when dealing with her subordinates can correspond to those in my model, in particular if her future career prospects also depend on her performance in previous positions. Then, paying a promised bonus reduces today's payoffs but maintains an employee's future goodwill.[13]

Indeed Gibbons and Henderson (2012) present cases of firms in which workers in lower tiers of the hierarchy are subject to relational contracts which resemble the ones in standard models. Lincoln Electric is a prominent example where a substantial part of the compensation of workers is based on hard-to-verify aspects such as reliability or dependability. But relational contracts are also used to encourage workers to make suggestions for improving work processes. Since Lincoln Electric does not rule out piece rate adjustments when fundamental methods change, workers who develop a process improvement might fear that piece rates are adjusted after a revelation. Therefore, they need to trust managers (who can benefit in the short run when reducing piece rates in response to a process innovation) to grant them their fair share of an increased productivity. Also Toyota's extraordinary success in the 1980s and 1990s was caused by its ability to continuously improve its production process. Workers were encouraged to identify inefficiencies and be creative in proposing solutions. Because such solutions could make workers redundant, they had to trust managers to implement improvements without reducing the workforce as a means to increase a department's short-run profits. Both cases indicate that also blue-collar workers might have relational contracts, and that their supervisors face trade-offs when assessing whether to compensate the workers as promised or reneging that are similar to my model – short-run savings versus long-run costs due to a reduction of the future willingness to cooperate.[14]

These examples share another aspect that is not included in my model of one principal and one agent. In reality, most people work in multi-worker firms that are able to replace workers and continue to exist when workers retire. Moreover, relationships might be multilateral (as in Levin, 2002). For example, if Lincoln Electric were to defect and change the piece rate in response to an innovative idea of one of

[13] Also note that the bonus in my model can be interpreted more widely as just an end-of-period payment; instead it can capture all kinds of promises for future rents, such as direct monetary payments, promotions, or an increased job security.

[14] Another example presented by Gibbons and Henderson (2012) involves white-collar employees in the pharmaceutical industry who are able to still work on research projects.

its workers, not only this worker but potentially also his colleagues would reduce cooperation once they found out about it.

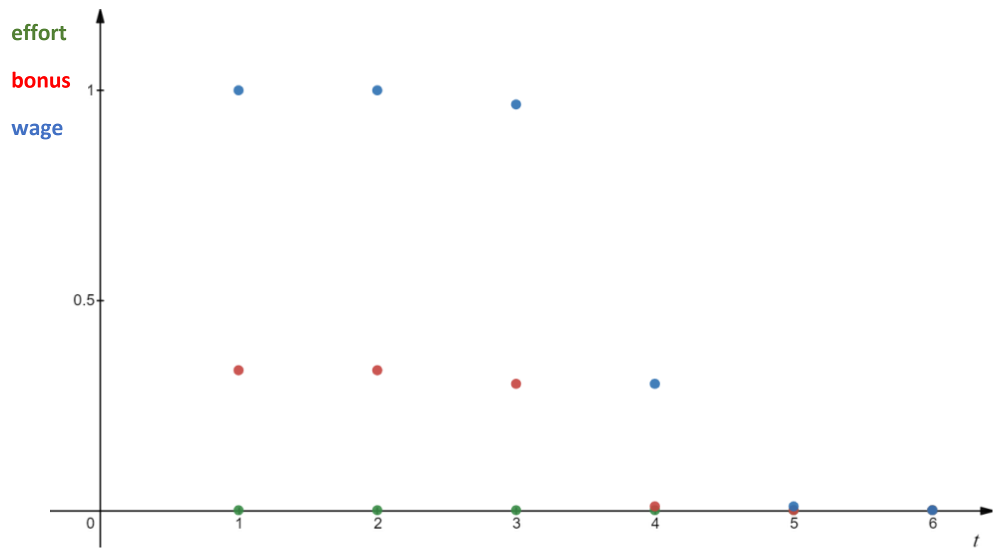
With multilateral punishments, career dynamics might be different than in my model because the principal's commitment would not necessarily be smaller in the later periods of an employment relationship. This, however, would require the complete detection of a firm's deviation in one relationship by other workers, which certainly is a too strong assumption for most real-world employment relationships. Observing a worker leaving might be due to the firm reneging on a promise, but could also happen for reasons that are exogenous to my model. In such a case, strategies to prevent deviation by the firm would have to be developed. These might involve on- and off-path punishments for the principal (as in Fahn and Klein, 2019). Such an outcome could relate to the literature on the consequences of downsizing, which has found that (mass) layoffs often reduce the productivity of survivors (Cascio, 1993; Heinz et al., 2020; Ahammer et al., 2022). There, Akerlof et al. (2021) find that these reactions are particularly pronounced if friends are affected, which is an indicator for some "indirect reciprocity" and might be caused by a decrease in η.

The exact consequences of allowing for multi-worker firms would depend on the environment, in particular how difficult it is to find a replacement, and to what extent other (prospective) employees can observe whether the principal reneges in a given relationship. My main insights would then continue to hold as long as frictions prevented full transparency and an easy replacement of workers.

6.2. Social Preferences in the Workplace

Although reciprocal preferences have been identified in real-world settings, its (total and marginal) impact on effort – in particular compared to pay-for-performance schemes – seems small (Al-Ubaydli et al., 2015; DellaVigna et al., 2019; Chen et al., 2021). For my model, these results could imply that η is positive but not too large for most individuals. A small η would indeed play a negligible role for the provision of incentives if effort or output was verifiable (which in my setting would correspond to a non-binding (DE) constraint). With non-verifiable effort measures and a finite-time horizon, though, a positive η is instrumental for motivating the agent to exert effort. Whereas a small η would indicate low effort towards the end of an employee's career, the complementarity between relational and reciprocity-based incentives causes a reinforcing effect which allows for high effort levels early on: In period $T-1$, the principal can credibly promise a small bonus because non-payment would result in a loss of π_T, and $\pi_{T-1} > \pi_T$. In period $T-2$, the feasible bonus is higher than in $T-1$ because non-payment would result in a loss of π_T and π_{T-1}, and so on. Therefore, I would argue that social preferences in the workplace are *particularly relevant* if effort is not verifiable. Then, even a small extent allows for substantial cooperation in situations where this would otherwise not be possible because of the ability to use relational incentives early on. To support this argument, I again present an example based on the previously used production function with $\theta = 1$ and $c(e) = e^3/3$. Moreover, I assume $\delta = 1$ and $T = 6$, and $\eta = 0.000001$ (Figure 2). Then, effort and wage in the last period are almost zero, the same holds for the second-to-last period 5. But already in period $t = 4$, a substantial amount of effort can be enforced, almost getting to the first-best in period $t = 3$ and finally landing there in period 2 and earlier. Although the quick increase of equilibrium effort also relies on the specific functional form (for $e < 1$, effort costs $e^3/3$ and consequently equilibrium bonuses are rather low), this example shows that substantial cooperation is possible also with agents whose η is very small.

Figure 2:



Note that this general result does not rely on reciprocity only being caused by non-discretionary payments but also holds if the agent reciprocates to all payments (Section 4.1), or if the effect of a gift deteriorates (Section A.2). Then, only the backloading of reciprocity-based incentives might be more pronounced.

Furthermore, given we presume that most individuals possess at least some preferences for reciprocity, it is important to know whether the giver's intentions are instrumental or whether individuals mostly care about distributions. I build on the gift exchange idea by Akerlof (1982) and assume that the principal can strategically utilize the norm of reciprocity. The agent understands the purpose of a gift received by the profit-maximizing principal but still reciprocates. Thus, (perceived) good intentions by the principal are not required. Initiated by Bolton et al. (1998), the question whether a reciprocal action is caused by a belief about the other's intention, or whether preferences over payoff allocations matter most, has received considerable attention. Bolton et al. (1998) find only little evidence for the role of intentions (in particular when it comes to positive reciprocal actions), instead distributional preferences are sufficient to explain reciprocal behavior.[15] Still, distributions do not seem to be the sole trigger of social preferences. Bolton and Ockenfels (2005) discover "reference dependence" of reciprocal preferences, in that available actions provide reference points against which carried-out actions are compared when assessing their appropriateness (also see Bewley, 1999; Fehr et al., 2009b, for evidence for reference dependence of social preferences). I incorporate this idea and let the agent's responsiveness to the norm of reciprocity, the value η_t, depend on whether realized behavior deviates from the reference functions determined by the relational contract.

Finally, the nature of reciprocal preferences could be important. As stated by Chen et al. (2021), as of now there is little field evidence on whether reciprocity takes the form of pure altruism (Becker, 1974: workers exert more effort if it has a higher value to their employer), a warm glow (Andreoni, 1989: whereas workers appreciate that their effort benefits their employer, the exact value is not relevant), or of gift-exchange (Akerlof, 1982: a higher wage translates into higher effort).

In my setting, extra generosity generates additional effort, and the agent works harder when this his effort is of higher value to the principal. The evidence for these assumptions is mixed, though. Whereas abundant laboratory evidence for a positive marginal link between wage and effort exists (see Fehr and Schmidt, 2006), Hennig-Schmidt et al. (2010) do not discover such an interaction in the field. However, they state that a higher wage might indeed increase effort if workers have information about the surplus their effort generates. In support for the latter, Englmaier and Leider (2012b) find that the size of the wage as well as the value of effort to the employer matter. DellaVigna et al. (2019) design a number of field experiments and observe that the value to one's employer does not seem to matter. Because variations in generosity only play a minor role as well, they conclude that the warm glow model (Andreoni, 1989) is suited best to describe behavior.

Thus, my assumptions that a higher wage and a higher value of effort to the principal let the agent work hard are only partially supported by evidence. Irrespectively, though, the core of my results remains valid, namely the general interaction between relational and reciprocity-based incentives. It is required that a "generous" wage generates some reciprocal reaction, and in particular that the employer's behavior in the relational contract, i.e., whether she keeps a given promise or not, affects the agent's reciprocal preferences. This link can materialize as in my main model, where a deviation by the principal reduces

[15] Also see Bolton et al. (2008) for evidence for strategic considerations in situations where other-regarding preferences affect behavior; and Malmendier and Schmidt (2017), who show that subjects reciprocate to gifts even though they apprehend that the giver is selfish and expects something in return.

the positive reciprocity parameter η; or as in Section 7 in Appendix A, where a deviation causes a negative reciprocal reaction by the agent. Then, future rents created by gift exchange provide incentives today. Different from efficiency-wage models where workers are motivated by future rents (Yellen, 1984; MacLeod et al., 1994), here it is the employer who is bound to lose future profits after breaking a promise made to the worker. Put differently, the prospect of using gift-exchange at the end of a worker's career allows for the use of "standard" incentives at its beginning.

Concluding, I would argue that my paper can provide one step towards a better understanding of the optimal use of a firm's incentive toolkit. Its major takeaway is that firms should mostly focus on keeping their promises in the early stages of employment relationships, and be generous later on. An important next step would involve an empirical assessment of how previous actions by firms determine employees' social preferences.

A. Appendix – Further Extensions

The following extensions are also analyzed in a setting with $T = 2$, $\theta = 1$, and $c(e) = e^3/3$.

A.1. Negative Reciprocity

I have abstracted from any potential "dark side" of reciprocal preferences in the sense that if an agent is granted a lower payment than expected, he wants to actively harm the principal. The potential consequences of negative reciprocity have been explored by, for example, Dufwenberg and Kirchsteiger (2004), Dohmen et al. (2009), and Netzer and Schmutzler (2014). In this section, I introduce negative reciprocity and show that it leads to the same results as in Section 2.2, even if η does not drop to zero after a deviation by the principal. Thus, as previously shown by Macleod (2003), the potential for organizational conflict can increase the efficiency of employment relationships in the face of contracting frictions. I use the approach introduced by Hart and Moore (2008), who assume that the terms of a contract provide reference points and determine a party's ex post performance. If someone receives less than they feel entitled to, they shade on performance, thereby causing a deadweight loss that has to be borne by the other party. I adapt the setting of Hart and Moore (2008) or Halonen-Akatwijuka and Hart (2020) to my environment and assume that the relational contract also determines the agent's reference point.

Therefore, the agent feels entitled to the equilibrium bonus $\hat{b}_1$. If he receives a lower bonus, his period-1 utility decreases by $\underline{\eta}\left(\hat{b}_1 - b_1\right)$, where $\underline{\eta} \geq 0$. Moreover, the agent can reduce this utility loss via shading (e.g., by sabotaging the principal), by an amount ρ at the agent's discretion. I assume that the agent still has to be employed by the principal to shade and the principal can fire the agent before making the choice whether to pay the bonus. Hence, she can escape the shading costs ρ but would then also sacrifice potential future profits.[16]

All this implies that the utility stream of the agent, conditional on not being fired, amounts to

$$\begin{aligned} U_1 = & b_1 + w_1 - c(e_1) + \eta w_1 e_1 - \max\left\{\left[\underline{\eta}\left(\hat{b}_1 - b_1\right) - \rho\right], 0\right\} \\ & + \delta\left(w_2 - c(e_2) + \eta w_2 e_2\right). \end{aligned}$$

[16]Thus, a bonus is still not feasible in the last period of the game.

The principal's payoff stream if she does not fire the agent before paying the bonus amounts to

$$\begin{aligned}\Pi_1 = & e_1 - w_1 - b_1 - \rho \\ & + \delta\left(e_2 - w_2\right).\end{aligned}$$

Since shading is not costly for the agent, it is optimal to set $\rho = \underline{\eta}\left(\hat{b}_1 - b_1\right)$ (for $b_1 \leq \hat{b}_1$). Furthermore, the second-period effort and wage equal $w_2 = \eta/4$ and $e_2 = \eta/2$, respectively; hence, the second-period profits are $\pi_2 = \eta/4$ (as in Section 2).

The principal faces two decisions. First, which bonus $b_1 \in \left[0, \hat{b}_1\right]$ to pay, and second whether to fire the agent. Concerning the first decision, if the principal decides to pay a bonus $b_1 \leq \hat{b}_1$ (and not to fire the agent), her profits amount to

$$\begin{aligned}\Pi_1 = & e_1 - w_1 + \left(\underline{\eta} - 1\right) b_1 - \underline{\eta}\hat{b}_1 \\ & + \delta\frac{\eta}{4}.\end{aligned}$$

This immediately reveals that $b_1 = 0$ is optimal for $\underline{\eta} < 1$, whereas $b_1 = \hat{b}_1$ for $\underline{\eta} \geq 1$. Since $b_1 = \hat{b}_1$ in equilibrium, $\underline{\eta} < 1$ also implies $\hat{b}_1 = b_1 = 0$, and that only reciprocity spot contracts are feasible.

Now assume $\underline{\eta} \geq 1$. Then, the principal sets $b_1 = \hat{b}_1$ if she does not fire the agent. She will terminate the relationship, however, if the bonus is larger than the period-2 profits, i.e., if $\hat{b}_1 > \delta\pi_2$.

The principal's optimization problem becomes maximizing $\pi_1 = e_1 - \hat{b}_1 - w_1$, subject to the agent's binding (IC) constraint, which yields $\hat{b}_1 = e_1^3/3 - \eta w_1 e_1 + 2/3\left(\sqrt{\eta w_1}\right)^3$, as well as subject to $\hat{b}_1 \leq \delta\pi_2$. The last condition is equivalent to the (DE) constraint, and thus the problem in this section is the same as the optimization problem in Section 2.2.

These results are collected in Lemma 7.

Lemma 7 *The profit-maximizing equilibrium with negative reciprocity, and a constant norm function* $\eta_t(h^{t-1}) = \eta \ \forall h^{t-1}$ *, has the following characteristics:*

- *If* $\underline{\eta} < 1$, $\hat{b}_1 = 0$. *Moreover,* $e_1 = e_2 = \eta/2$ *and* $w_1 = w_2 = \eta/4$.
- *If* $\underline{\eta} \geq 1$, $\hat{b}_1 > 0$, *and outcomes are as characterized in Section 2.2, with* $w_1 < w_2 = \eta/4$ *and* $e_1 > e_2 = \eta/2$.

A.2. Adjustment of the Reference Wage

Some evidence points toward a declining effect of gifts in long-term interactions. Gneezy and List (2006) conduct a field experiment in which they permanently increase the wages of recruited workers. Although workers respond with an immediate effort increase, this is only temporary, and effort falls to an amount only slightly above the initial level. Jayaraman et al. (2016) explore the effects of a mandated 30% wage increase for tea pluckers in India. They find that productivity substantially increases immediately after the wage raise. However, it starts falling again in the second month after the change and returns to its initial level after four months. Sliwka and Werner (2017) examine how reciprocal effort is affected by the timing of wage increases. They find that a permanent wage raise only temporarily increases effort and that the only way to permanently benefit from an individual's reciprocal behavior is to constantly raise wages.

This evidence suggests that individuals adapt to wage increases and update their reference wages.[17] In the following, I incorporate this evidence and assume that the agent starts with a reference wage of zero. In the second period, the first-period wage w_1 becomes the new reference wage. Hence, the agent's utilities are

$$u_1 = b_1 + w_1 - c(e_1) + \eta w_1 e_1$$
$$u_2 = b_2 + w_2 - c(e_2) + \max\{0, \eta (w_2 - w_1) e_2\}.$$

First, I compute the profit-maximizing spot reciprocity contract in the last period. Then, no bonus is paid, and – taking into account that setting $w_2 \geq w_1$ is optimal – effort maximizes $-e_2^3/3 + \eta (w_2 - w_1) e_2$. As shown in Lemma 6, effort is unaffected by the higher reference wage; hence, $e_2 = \eta/2$ and $w_2 = \eta/4 + w_1$.

The outcomes for an optimal relational contract are given in Lemma A.2.

Lemma 8 *Assume the second-period reference wage is equal to w_1. Then, $w_1 < w_2$. Moreover, the (DE) constraint might or might not bind.*

- *If it does not bind, $de_1/d\eta < de_2/d\eta$. Furthermore, there exists a $\overline{\eta} > 0$ such that the optimal wage is zero for $\eta \leq \overline{\eta}$. In this case, $e_1 > e_2$. For $\eta > \overline{\eta}$, setting a strictly positive wage is optimal, and e_1 can be smaller or larger than e_2.*

- *If it binds, there exists a $\tilde{\eta} > 0$ such that the optimal wage equals zero for $\eta \leq \tilde{\eta}$, whereas it is*

[17] Also see Eliaz and Spiegler (2018) who assume that the reference wage is a weighted average of past salaries.

strictly positive for $\eta \geq \tilde{\eta}$. In both cases, e_1 can be smaller or larger than e_2.

$\overline{\eta}$ can be smaller or larger than $\tilde{\eta}$, and both are larger than if the second-period reference wage equals zero independent of w_1.

The proof can be found in Appendix C.

The principal is reluctant to trigger the agent's reciprocal preferences in the first period. In particular, if δ is large, she wants to maintain this opportunity until later when relational contracts are no longer feasible. Therefore, the threshold for η above which a positive first-period wage is paid is larger than that in Section 2.2 – implying that the backloading of reciprocity-based incentives is more pronounced than with a constant reference wage. A higher w_1 also does not necessarily relax the (DE) constraint anymore (which implies that $\tilde{\eta}$ does not have to be smaller than $\overline{\eta}$). This is because a positive first-period wage has two effects on the tightness of the (DE) constraint. On the one hand, the necessary bonus to implement a certain effort level is reduced, which relaxes the constraint. On the other hand, future profits are reduced via the adjustment of the reference wage, which tightens the constraint.

A.3. Reciprocity Triggered by Rents

Finally, I explore the implications of reciprocity being triggered by the agent's material rent, in contrast to only by monetary payments. Thus, I assume that the agent's per-period utilities are

$$u_1 = (b_1 + w_1 - c(e_1))\,(1 + \eta e_1)$$
$$u_2 = (w_2 - c(e_2))\,(1 + \eta e_2)\,.$$

Importantly, when choosing his effort level, the agent also reciprocates on the equilibrium bonus of this period *before* it is paid. Hence, the principal is less inclined to pay a positive fixed wage in the first period. Only if a sufficiently tight (DE) constraint considerably restrains the bonus is w_1 positive.

Formally, effort in the second period is given by the agent's first order condition,

$$-e_2^2 - \frac{4}{3}e_2^3\eta + w_2\eta = 0.$$

This is taken into account by the principal who sets w_2 to maximize $\pi_2 = e_2 - w_2$.

In the first period, the principal's (DE) constraint still equals $-b_1 + \delta\pi_2 \geq 0$, whereas the agent's (IC) constraint becomes

$$\left(b_1 + w_1 - \frac{e_1^3}{3}\right)(1+\eta e_1) \geq \left(w_1 - \frac{\tilde{e}_1^3}{3}\right)(1+\eta \tilde{e}_1). \tag{IC}$$

Here, $\tilde{e}_1$ is characterized by $-\tilde{e}_1^2 - \frac{4}{3}\tilde{e}_1^3\eta + w_1\eta = 0$, and $e_1 > \tilde{e}_1$ if $b_1 > 0$.

Lemma 9 *Assume that the agent's preferences for reciprocity are triggered by his material rent. Then, the (DE) constraint binds given $T = 2$ and $\delta \leq 1$. Moreover, there exists a $\tilde{\eta} > 0$ such that the optimal wage equals zero for $\eta \leq \tilde{\eta}$, whereas it is strictly positive for $\eta \geq \tilde{\eta}$.*

In any case, $e_1 > e_2$ and $w_1 < w_2$.

The proof can be found in Appendix C.

With $T = 2$, second-period profits cannot be sufficiently large for a non-binding (DE) constraint given $\delta \leq 1$. However, in a more general setting with more than two periods, (DE) might indeed be slack. In this case, the proof to Lemma 9 reveals that paying a positive wage would not be optimal because the purpose of a positive wage – triggering the agent's reciprocal inclinations – can equivalently be achieved by a bonus, which additionally allows for higher effort via the use of relational incentives. With a binding (DE) constraint, the principal might pay a fixed wage in the first period, but only if η is large enough.

B. Appendix – General Model

Here, I introduce a more general version of the model and provide a formal definition of the nature of the agent's reciprocal preferences. As I have already provided the results for a positive reference wage above, I stick to the assumption that the agent reciprocates to any positive wage.

B.1. Setup

There is one risk-neutral principal ("she") and one risk-neutral agent ("he"). At the beginning of every period $t \in \{1,...,T\}$, with $2 \leq T < \infty$, the principal decides whether to make an employment offer to the agent or not ($d_t^P \in \{0,1\}$). In case an offer is made ($d_t^P = 1$), it specifies an upfront wage $w_t \in \mathbb{R}_+$. The agent's acceptance/rejection decision is described by $d_t^A \in \{0,1\}$. Upon acceptance ($d_t^A = 1$), the agent receives w_t and chooses an effort level $e_t \in \mathbb{R}_+$, which is associated with effort costs $c(e)$, with $c', c'', c''' > 0$ and $c(0) = 0$.[18] Effort generates an expected output $e_t\theta$, with $\theta > 0$, which is subsequently consumed by the principal (note that the linearity of output in effort is without loss of

[18] A positive third derivative is needed for an interior solution in Section B.3.

generality as long as output and effort cost are additively separable). Afterwards, the principal can pay a discretionary bonus $b_t \in \mathbb{R}_+$. If the principal refrains from making an offer ($d_t^P = 0$) or if the agent rejects an offer made by the principal ($d_t^A = 0$), both consume their outside option utilities which are set to zero. Moreover, the principal and agent share a discount factor $\delta \in (0,1]$.

B.2. Relational Contract, Preferences, and the Norm of Reciprocity

Because effort and output are only observable but not verifiable, no formal incentive contract can be used to motivate the agent. A relational contract is generally feasible, though, which is a self-enforcing agreement that constitutes a subgame perfect equilibrium of the game. In addition to the standard components of a game – players, information, action spaces, preferences, and equilibrium concept – I incorporate a norm function that activates the norm of reciprocity and maps the game's history into the agent's preferences. Before introducing this norm, I formally describe histories and feasible strategies.

Histories and feasible strategies The events in period t are denoted by $h_t = \left(d_t^P, w_t, d_t^A, e_t, b_t\right)$, with h_t being public information. A *history* of length $t-1$, h^{t-1} (for $t \geq 2$) collects the events up to, and including, time $t-1$, i.e. $h^{t-1} := (h_\tau)_{\tau=1}^{t-1}$. The set of histories of length $t-1$ is denoted by $\mathscr{H}^{t-1}$ (and $\mathscr{H}^0 = \{\emptyset\}$). I focus on pure strategies. For the agent, a pure strategy specifies what wage offers to accept in each period as a function of the previous history, and what level of effort to exert as a function of the previous history and current-period wages. Formally, it is a sequence of mappings $\left\{\sigma_t^A\right\}_{t=1}^T$ where, for each $t \leq T$, $\sigma_t^A = (d_t^A, e_t)$, and $d_t^A : \mathscr{H}^{t-1} \times \{0,1\} \times \mathbb{R}_+ \to \{0,1\}$, $(h^{t-1}, d_t^P, w_t) \mapsto d_t^A(h^{t-1}, d_t^P, w_t)$ and $e_t : \mathscr{H}^{t-1} \times \{0,1\} \times \mathbb{R}_+ \times \{0,1\} \to \mathbb{R}_+$, $(h^{t-1}, d_t^P, w_t, d_t) \mapsto e_t(h^{t-1}, d_t^P, w_t, d_t)$.

In each period, a pure strategy for the principal specifies her wage offer as a function of the previous history as well as the bonus payment as a function of the previous history, current-period wages and effort. Formally, it is a sequence of mappings $\left\{\sigma_t^P\right\}_{t=1}^T$, where, for each $t \leq T$, $\sigma_t^P = (d_t^P, w_t, b_t)$, and $d_t^P : \mathscr{H}^{t-1} \to \{0,1\}$, $(h^{t-1}) \mapsto d_t^P(h^{t-1})$, $w_t : \mathscr{H}^{t-1} \times \{0,1\} \to \mathbb{R}_+$, $(h^{t-1}, d_t^P) \mapsto w_t(h^{t-1})$, $b_t : \mathscr{H}^{t-1} \times \{0,1\} \times \mathbb{R}_+ \times \{0,1\} \times \mathbb{R}_+ \to \mathbb{R}_+$, $(h^{t-1}, d_t^P, w_t, d_t^A, e_t) \mapsto b_t(h^{t-1}, d_t^P, w_t, d_t^A, e_t)$.

Relational Contract and the Norm of Reciprocity The relational contract is agreed upon at the beginning of the game. It "activates" the norm of reciprocity and stipulates *reference functions* which specify history-dependent actions players are *supposed* to take. For the agent, the relational contract determines an acceptance function $\hat{d}_t^A(h^{t-1}, d_t^P, w_t)$ as well as an effort function $\hat{e}_t(h^{t-1}, d_t^P, w_t, d_t^A)$, with $\left(\hat{d}_t^A, \hat{e}_t\right) \in \sigma_t^A$. For the principal, the relational contract determines an offer function $\hat{d}_t^P(h^{t-1})$, a wage function $\hat{w}_t(h^{t-1}, d_t^P)$ and a bonus function $\hat{b}_t(h^{t-1}, w_t, d_t^A, e_t)$, with $\left(\hat{d}_t^P, \hat{w}_t, \hat{b}_t\right) \in \sigma_t^P$.

The *norm of reciprocity* states how the agent is supposed to reciprocate against "non-discretionary" upfront wages, that is, wages that are not paid as a reward for past effort. To incorporate this notion, the total wage $\hat{w}_t(h^{t-1}, d_t^P)$ is split into a discretionary part $\hat{w}_t^d(h^{t-1}, d_t^P)$ and a non-discretionary component, which is defined as $\hat{w}_t^{nd}\left(h^{t-1} \setminus \left\{e^{t-1}, d^{A,t-1}\right\}, d_t^P\right)$, where $e^{t-1} := (e_\tau)_{\tau=1}^{t-1}$ and $d^{A,t-1} := \left(d_\tau^A\right)_{\tau=1}^{t-1}$. Note that this specification does not rule out an indirect relationship between the agent's effort and w_t^{nd}, since the latter is a function of the principal's previous actions which itself are affected by the agent's behavior. Whereas the bonus and discretionary wage constitute the "direct" incentive system that grants payments as a reward for previously exerted effort, w_t^{nd} stipulates subsequent effort by the agent who adheres to the norm of reciprocity.

For the following, I follow the approach introduced by Abreu (1988) dividing histories into events corresponding to cooperate or cheat and adapt it to my setting. Therefore, I define the following sets of histories. First, $\mathscr{H}^{t,A^*}$ is the set of histories where the agent has not deviated, i.e., where the following holds for all all $\tau \leq t$:

$$\begin{aligned} d_\tau^A &= \hat{d}_\tau^{\,A}(h^{\tau-1}, d_\tau^P, w_\tau) \\ e_\tau &\geq \hat{e}_\tau(h^{\tau-1}, d_\tau^P, w_\tau, d_\tau^A). \end{aligned}$$

$\mathscr{H}^{t,A-cheat}$ is the set of histories including a deviation by the agent, hence where above conditions are violated for at least one $\tau \leq t$.

Second, $\mathscr{H}^{t,P^*}$ is the set of histories where the principal has not deviated in the subsequent dimensions, in that the following holds for all all $\tau \leq t$:

$$\begin{aligned} d_\tau^P &= \hat{d}_\tau^P(h^{\tau-1}) \\ b_\tau &\geq \hat{b}(h^{\tau-1}, d_\tau^P, w_\tau, d_\tau^A, e_\tau) \\ w_\tau &\geq \hat{w}^d(h^{\tau-1}, d_\tau^P). \end{aligned}$$

$\mathscr{H}^{t,P-cheat}$ is the set of histories including a deviation by the prinicpal, i.e., where above conditions are violated for at least one $\tau \leq t$. Importantly, $\mathscr{H}^{t,P-cheat}$ does *not* include deviations of $\hat{w}_t^{nd}(\cdot)$. Therefore, my approach differs from Abreu (1988) in that not all observable deviations from equilibrium actions trigger a punishment. Because of the definition of w_t^{nd}, the principal does not "cheat" if not paying its equilibrium amount.

Finally $\mathscr{H}^{t^*} \equiv \mathscr{H}^{t,P^*} \cup \mathscr{H}^{t,A^*}$ is the set of histories after which the relational contract does not specify a punishment.

The agent's utility function determines his responsiveness to the norm of reciprocity and – for period t – equals

$$u_t = d_t^A \left(b_t + w_t - c(e_t) + \eta_t w_t^{nd} e_t \theta \right).$$

The term $\eta_t \in [0, \infty)$ captures the agent's inherent preferences for positive reciprocity and lets the principal's output enter the agent's utility whenever $\eta > 0$ and $w_t^{nd} > 0$.[19]

The history-dependent *norm function* which determines η_t in every period "activates" the agent's reciprocity, with $\eta_1 = \eta \geq 0$. η_t remains at η unless $h^{t-1} \subseteq \mathscr{H}^{t-1,P-cheat}$. Otherwise, it drops to and remains at zero in all subsequent periods.[20] Therefore, in all periods $t \geq 2$,

$$\eta_t = \begin{cases} 0 & \textbf{if } h^{t-1} \subseteq \mathscr{H}^{t-1,P-cheat} \\ \eta & \textbf{otherwise.} \end{cases}$$

η_t does *not* drop to zero after a deviation by the agent (and if no bonus is paid in response). Hence, the agent's reciprocal inclinations towards the principal disappear once the latter refuses to make an offer she was supposed to make, or if she does not compensate the agent accordingly.

The principal only cares about her material payoffs,

$$\pi_t = d_t \left(e_t \theta - b_t - w_t \right).$$

A subgame perfect equilibrium determines equilibrium functions $d_t^P(h^{t-1})$, $w_t(h^{t-1}, d_t^P)$, $d_t^A(h^{t-1}, d_t^P, w_t)$, $e_t(h^{t-1}, d_t^P, w_t, d_t^A)$, and $b_t(h^{t-1}, d_t^P, w_t, d_t^A, e_t)$. In addition, for every history, I impose the consistency requirements $\hat{d}_t^P = d_t^P$, $\hat{w}_t = w_t$, $\hat{d}_t^A = d_t^A$, $\hat{e}_t = e_t$, and $\hat{b}_t = b_t$. The equilibrium concept is subgame perfect equilibrium, incorporating these consistency requirements as additional restrictions on equilibrium

[19]In a more general setting, the norm of reciprocity would be activated if w_t^{nd} exceeded some reference wage. Here, such a reference wage would equal zero; in Section 3.2, I consider positive reference wages.

Furthermore, one could argue that, if performance pay was very generous in relation to the agent's effort cost, it should be regarded as a gift. However, such a payment could be split into a part that compensates the agent for his effort costs and one that grants him a rent. Paying this rent up front (and anticipating that the agent exerts effort accordingly) would then be equivalent to paying a non-discretionary wage in my setting.

[20]Note that a drop to *zero* is not required. Any reduction of η after a deviation by the principal would yield similar results. Also note that this definition can equivalently be applied to settings in which the principal does not observe effort and output is not verifiable. Then, the bonus could be a function of output, and η_t would drop to zero if the principal reneged on paying it.

strategies.

In an equilibrium with $d_t^P = d_t^A = 1 \; \forall t$, the following recursive relationships hold in all periods $t \in \{1, ..., T\}$ for the principal's profits Π_t and the agent's utility U_t, where I set $\Pi_{T+1} = U_{T+1} = 0$:

$$\begin{aligned} \Pi_t &= e_t \theta - b_t - w_t + \delta \Pi_{t+1} \\ U_t &= b_t + w_t - c(e_t) + \eta_t w_t^{nd} e_t \theta + \delta U_{t+1}. \end{aligned}$$

In what follows, the objective is to characterize a subgame perfect equilibrium that maximizes the principal's profits at the beginning of the game, Π_1.

B.3. Reciprocity Spot Contract

Here, I derive a profit-maximizing spot contract for the case of a general cost function. As stated in the main part of the paper, such a contract will also be offered in the final period, T (this follows from Lemma 11 below). In a spot contract, $b = 0$, and the only means to incentivize the agent is a positive non-discretionary wage. Since $w = w^{nd}$, I omit the "*nd*" superscript in this section. Given w, and presuming he decides to work for the principal, the agent chooses effort to maximize his per-period utility $u = w - c(e) + \eta w e \theta$. This implies that the agent's effort is characterized by

$$-c'(e^*) + \eta w \theta = 0. \tag{1}$$

The principal sets w to maximize her expected per-period profits $\pi = e^* \theta - w$. Here, she has to take into account that accepting the contract must be optimal for the agent, hence $w - c(e) + \eta w e \theta \geq 0$ must hold. It is immediate that this is satisfied for any $w \geq 0$. Thus, the principal's problem is to

$$\max_w e\theta - w,$$

subject the non-negativity constraint $w \geq 0$, and that the agent chooses effort according to 1.

Lemma 10 *The profit-maximizing reciprocity spot contract has $w = c'(e)/\eta\theta$, where e is characterized by $\eta\theta^2 - c''(e) = 0$. Moreover, $\pi, u > 0$, and $de/d\eta, d\pi/d\eta > 0$.*

Proof: I maximize profits $\pi = e\theta - w$, taking into account that effort is characterized by $-c'(e) + \eta w \theta = 0$, and that the agent's (IR) constraint, $u = w - c(e) + \eta w e \theta \geq 0$, must be satisfied. Naturally, the latter holds for any $w \geq 0$ because the agent can always secure $u = w$ by choosing zero effort.

The principal's first order condition equals

$$\frac{d\pi}{dw} = \frac{de}{dw}\theta - 1 = 0,$$

where

$$\frac{de}{dw} = \frac{\eta\theta}{c''(e)}.$$

Hence, the optimal level of e is characterized by

$$\eta\theta^2 - c''(e) = 0,$$

and the wage amounts to

$$w = \frac{c'(e)}{\eta\theta}.$$

Therefore,

$$\frac{de}{d\eta} = \frac{\theta^2}{c'''(e)} > 0,$$
$$\frac{d\pi}{d\eta} = \frac{de}{d\eta}\theta - \frac{dw}{d\eta} = \frac{c'(e)}{\eta^2\theta} > 0.$$

■

Intuitively, a positive wage lets the agent partially internalize the principal's payoff, which is why he reciprocates and selects a positive effort level. Because this interaction is stronger for a more reciprocal agent, a higher η induces larger values of e and π.

B.4. Relational Contract

Now, I analyze how a relational contract is used to incentivize the agent. Two aspects are of particular interest, namely the enforceability of the relational contract and how the norm of reciprocity affects outcomes.

B.4.1. Preliminaries and Optimization Problem

The relational contract determines payment functions, and the promise to make these payments must be credible. This is captured by dynamic enforcement (DE) constraints for each period t, where with a slight abuse of notation I denote $\Pi_{t+1}(\mathscr{H}^{t,P^*})$ as continuation profits for histories $h^t \subseteq \mathscr{H}^{t,P^*}$, and so on:

$$-b_t + \delta \Pi_{t+1}(\mathscr{H}^{t,P^*}) \geq \delta \Pi_{t+1}(\mathscr{H}^{t,P-cheat}). \tag{DE}$$

Moreover, individual rationality (IR) constraints, $\Pi_t(\mathscr{H}^{t-1,P^*}) \geq 0$, must hold. Because $b_t \geq 0$, (IR) are implied by (DE) constraints and can hence be omitted. Generally, relational contracts require a (potentially) infinite time horizon because of a standard unraveling argument that can be applied once a predetermined last period exists: If the equilibrium outcome in the last period is unique, the same holds for all preceding periods. In my case, however, the norm function lets η_t drop to zero once the principal refuses to make a specified payment. Moreover, the "standard" grim trigger punishment is imposed afterward and relational contracts are no longer feasible (adapting Abreu (1988) to my setting, as laid out above). Thus, the principal's continuation profits are $\Pi_{t+1}(\mathscr{H}^{t,P-cheat}) = 0$ if a punishable deviation has occured in any $\tau \leq t$, and her behavior in period $t < T$ indeed affects her future profits. Hence, not only does the relational contract determine whether a given payment "activates" the agent's reciprocal preferences, but the latter are also a prerequisite for the relational contract to work.

In the next step, I explore the agent's incentives to exert equilibrium effort. Those are determined by a combination of reciprocity-based incentives (via a positive w_t^{nd}) and relational incentives (via b_t and w_t^d). Recall that my specification of the norm function implies that after a deviation by the agent, the reciprocity parameter remains at η. This indicates that the agent does not necessarily deviate to an effort level of zero. Moreover, since effort is public information, it is without loss to only specify a positive bonus $b_t \geq 0$ if the agent has exerted equilibrium effort and no bonus otherwise. Thus, the agent's (IC) constraint (which must hold in every period t) equals

$$\begin{aligned} &-c(e_t) + \eta_t w_t^{nd} e_t \theta + b_t + \delta U_{t+1}(\mathscr{H}^{t,A^*}) \\ \geq &-c(\tilde{e}_t) + \eta_t w_t^{nd} \tilde{e}_t \theta + \delta U_{t+1}(\mathscr{H}^{t,A-cheat}). \end{aligned} \tag{IC}$$

Note that, if the agent deviates, he will choose an effort level $\tilde{e}_t$ characterized by $-c'(\tilde{e}_t) + \eta w_t^{nd} \theta = 0$. $\tilde{e}_t$ is the effort the agent would select if he only responded to the norm of reciprocity. Relational incentives using subsequent discretionary payments are needed to motivate the agent to exert additional effort $e_t - \tilde{e}_t$.

An (IR) constraint $U_t(\mathscr{H}^{t-1,A^*}) \geq 0$ must also hold in every period but is implied by (IC) because payments are assumed to be non-negative and because the right-hand side of (IC) cannot be smaller than zero.

Concluding, the principal's problem is to maximize

$$\Pi_1 = \sum_{t=1}^{T} \delta^{t-1} \pi_t,$$

subject to a (DE) and (IC) constraint for every period t.

First, I derive a number of preliminary results, which simplify the problem and are collected in Lemma 11.

Lemma 11 *There exists a profit-maximizing equilibrium which has the following properties in all periods t:*

- $w_t = w_t^{nd}$
- *(IC) holds as an equality*
- $U_t(\mathscr{H}^{t-1,A^*}) = U_t(\mathscr{H}^{t-1,A-cheat})$
- *the equilibrium is sequentially optimal, hence the problem is equivalent to maximizing each π_t*

The proof can be found in Appendix C.

First, it is without loss of generality to only use bonus payments for the provision of relational incentives. Thus, $w_t = w_t^{nd}$ from now on, and all upfront wages are non-discretionary.

Second, the (IC) constraint binds in every period, thus the agent does not receive a rent for relational incentives. However, he enjoys a rent whenever $w_t (= w_t^{nd}) > 0$, i.e., when reciprocity-based incentives are provided. Importantly, though, these "warm-glow" rents cannot be used to provide relational incentives in earlier periods: If the agent was bound to lose them after a deviation (for example because of a firing threat as with efficiency wages), the upfront wage would not be non-discretionary anymore, and the agent would not reciprocate.[21]

Third, $U_t(\mathscr{H}^{t,A^*}) = U_t(\mathscr{H}^{t-1,A-cheat})$ follows because it is without loss of generality to provide relational incentives only with a current bonus. Thus, continuation play is not affected by the agent's

[21] This would be different if either bonus or discretionary wages also triggered direct reciprocal responses by the agent. Then, the respective payments would merely assume a larger relative weight in the optimal incentive scheme (see Sections 4.1 and A.3).

actions, which finally implies that the profit-maximizing relational contract is sequentially optimal and the optimization problem has a recursive structure.

Collecting all results, binding (IC) constraints as well as $U_t(\mathscr{H}^{t,A^*}) = U_t(\mathscr{H}^{t-1,A-cheat})$ yield $b_t = c(e_t) - c(\tilde{e}_t) - \eta w_t \theta (e_t - \tilde{e}_t)$. Plugging this into the principal's profits and (DE) constraints, the optimization problem becomes to maximize

$$\pi_t = e_t\theta - b_t - w_t = e_t\theta - (c(e_t) - c(\tilde{e}_t) - \eta w_t \theta (e_t - \tilde{e}_t)) - w_t$$

in every period t, subject to

$$c(e_t) - \eta w_t \theta e_t \leq \delta \Pi_{t+1} + c(\tilde{e}_t) - \eta w_t \theta \tilde{e}_t. \tag{DE}$$

First, I show that Lemma 1 also holds in this more general setting

Lemma 12 *Assume the (DE) constraint does not bind in period $t < T$. Then, there exists a $\overline{\eta} > 0$ such that setting a strictly positive wage is optimal for $\eta > \overline{\eta}$, whereas the optimal wage is zero for $\eta \leq \overline{\eta}$.*

The proof can be found in Appendix C.

Second, I explicitly take the (DE) constraint into account and relate Lemma 2 to the general setting.

Lemma 13 *Assume the (DE) constraint binds in period $t < T$. Then, equilibrium effort is smaller than with a non-binding (DE) constraint. Moreover, if paying a fixed wage is optimal in the situation with a non-binding (DE) constraint (i.e., if $\eta > \overline{\eta}$), the fixed wage now is strictly larger. Otherwise (i.e., if $\eta \leq \overline{\eta}$), there exists a $\tilde{\eta}_t < \overline{\eta}$ such that setting a strictly positive wage is optimal for $\eta > \tilde{\eta}_t$, whereas the optimal wage equals zero for $\eta \leq \tilde{\eta}_t$. Finally, $\tilde{\eta}_t$ is increasing in δ.*

The proof can be found in in Appendix C.

This implies that reciprocity-based incentives can improve the power of relational incentives for a given value of η, and vice versa (this complementarity between the two means to provide incentives is further fueled by a positive effect of η on future profits, see Proposition 4).

Generally, the (DE) constraint might or might not bind in any period $t < T$ depending on discount factor δ, reciprocity parameter η, and productivity θ. Moreover, the constraint becomes "tighter" over time since on-path profits decline. I have displayed the resulting consequences for equilibrium effort, compensation, and payoffs above, in Proposition 1 and Lemma 5.

Finally, also in the general model η has a positive effect on equilibrium profits and effort.

Proposition 4 *Equilibrium profits Π_t and effort e_t increase in η.*

The proof can be found in Appendix C.

C. Appendix – Proofs

Proof of Lemma 1 See the proof to Lemma 12 below. ■

Proof of Lemma 2 To prove existence of $\bar{\delta}(\eta)$, I plug first-best values into the (DE) constraint and assess the conditions for it to hold.

For $\eta \leq 1$, the (DE) constraint becomes $1/3 \leq \delta\eta/4$, thus $\delta \geq \bar{\delta}(\eta) \equiv 4/3\eta$ which is decreasing in η.

For $\eta > 1$, the (DE) constraint becomes

$$\frac{3\eta^2 - 1}{6\eta^3} \leq \delta\frac{\eta}{4}, \tag{2}$$

or $\delta \geq \bar{\delta}(\eta) \equiv 2\left(3\eta^2 - 1\right)/3\eta^4$, which is decreasing in η.

For the remainder of the proof assume $\delta < \bar{\delta}(\eta)$. To prove the remainder of the Lemma, I set up the Lagrange function of the principal's optimization problem,

$$\begin{aligned} L = {} & e_1 - \frac{e_1^3}{3} + \eta w_1 e_1 - \frac{2}{3}\left(\sqrt{\eta w_1}\right)^3 - w_1 \\ & + \lambda_{DE}\left[\delta\frac{\eta}{4} - \frac{2}{3}\left(\sqrt{\eta w_1}\right)^3 - \frac{e_1^3}{3} + \eta w_1 e_1\right] + w_1\lambda_w, \end{aligned}$$

where $\lambda_w, \lambda_{DE} \geq 0$ represent the Lagrange multipliers for respective constraints. Note that $\lambda_{DE} > 0$ for $\delta < \bar{\delta}(\eta)$.

First-order conditions are

$$\begin{aligned} \frac{\partial L}{\partial e_1} &= 1 - e_1^2 + \eta w_1 + \lambda_{DE}\left[-e_1^2 + \eta w_1\right] = 0 \\ \frac{\partial L}{\partial w_1} &= \eta e_1 - \sqrt{\eta^3 w_1} - 1 + \lambda_{DE}\left[\eta e_1 - \sqrt{\eta^3 w_1}\right] + \lambda_w = 0. \end{aligned}$$

First, note that $\partial L/\partial w_t \mid_{w_t=0} = \eta\sqrt{(1+\lambda_{DE_t})}-1$. This is positive for $\eta > \sqrt{1/(1+\lambda_{DE_t})}$, which establishes existence of $\tilde{\eta} < 1$ such that a strictly positive wage is optimal for $\eta > \tilde{\eta}$ and not otherwise.

Second, we compute equilibrium effort and wage levels.

Assume $\eta > 1$. Then,

$$e_1 = \frac{1+\eta^2(1+\lambda_{DE})}{2\eta(1+\lambda_{DE})} < \frac{1+\eta^2}{2\eta} = e^{FB}(\eta > 1)$$
$$w_1 = \frac{\left(\eta^2(1+\lambda_{DE})-1\right)^2}{4\eta^3(1+\lambda_{DE})^2} > \frac{\left(\eta^2-1\right)^2}{4\eta^3} = w^{FB}(\eta > 1)$$

Assume $\tilde{\eta} < \eta \le 1$. Then,

$$e_1 = \frac{1+\eta^2(1+\lambda_{DE})}{2\eta(1+\lambda_{DE})} < 1 = e^{FB}(\eta < 1)$$
$$w_1 = \frac{\left(\eta^2(1+\lambda_{DE})-1\right)^2}{4\eta^3(1+\lambda_{DE})^2} > 0 = w^{FB}(\eta < 1)$$

Assume $\tilde{\eta} < \eta \le 1$. Then,

$$e_1 = \frac{1}{\sqrt{(1+\lambda_{DE_t})}} < 1 = e^{FB}(\eta < 1)$$
$$w_1 = 0 = w^{FB}(\eta < 1)$$

■

Proof of Lemma 3 For $\pi_1 > \pi_2$ see the proof to Lemma 14.

First, I show that $e_1 > e_2$:

- If $w_1 > 0$, $e_1 = \frac{1+\eta^2(1+\lambda_{DE})}{2\eta(1+\lambda_{DE})}$ which is larger than $e_2 = \eta/2$ for any $\lambda_{DE} \ge 0$.
- If $w_1 = 0$, $e_1 = \frac{1}{\sqrt{(1+\lambda_{DE})}}$. This is larger than $e_2 = \eta/2$, if

  $$2\sqrt{\frac{1}{1+\lambda_{DE}}} > \eta,$$

  which holds since $w_1 = 0$ implies $\eta \le \tilde{\eta} = \sqrt{1/(1+\lambda_{DE})}$.

Second, I show that $w_1 < w_2$. This is immediate if $w_1 = 0$. Otherwise, $w_1 = \frac{\left(\eta^2(1+\lambda_{DE})-1\right)^2}{4\eta^3(1+\lambda_{DE})^2}$, which is smaller than $w_2 = \eta/4$ if

$$\frac{1}{2(1+\lambda_{DE})} < \eta^2.$$

This holds given $\eta > \tilde{\eta} = \sqrt{1/(1+\lambda_{DE_t})}$.

Finally, note that $u_1 = 2/3\left(\sqrt{\eta w_1}\right)^3 + w_1$. Again, for $w_1 = 0$ it is immediate that this is smaller than $u_2 = \eta/4 + \eta^3/12$. Moreover, u_1 increases in w_1, with

$$\frac{\partial w_1}{\partial(1+\lambda_{DE})} = \frac{\left(\eta^2(1+\lambda_{DE})-1\right)}{2\eta^3(1+\lambda_{DE})^3} > 0 \text{ for } \eta > \tilde{\eta}.$$

■

Proof of Lemma 4 In the second period,

$$\frac{de_2}{d\eta} = \frac{1}{2}.$$

In the first period, we again distinguish between $\eta > \tilde{\eta}$ and $\eta \leq \tilde{\eta}$. Moreover, note that the Lagrange multiplier λ_{DE} decreases in π_2 and consequently in η.

If $\eta \leq \tilde{\eta}$, $e_1 = \sqrt{\theta/(1+\lambda_{DE})}$ (with $\lambda_{DE} \geq 0$), therefore

$$\frac{de_1}{d\eta} = -\frac{1}{2}\sqrt{\frac{1}{(1+\lambda_{DE})^3}}\frac{\partial\lambda_{DE}}{\partial\eta} \geq 0,$$

with a strict inequality only if (DE) binds.

If $\eta > \tilde{\eta}$, $e_1 = \frac{1+\eta^2(1+\lambda_{DE})}{2\eta(1+\lambda_{DE})}$ (with $\lambda_{DE} \geq 0$), therefore

$$\frac{\partial e_1}{\partial\eta} = \frac{\eta^2(1+\lambda_{DE})-1}{2\eta^2(1+\lambda_{DEt})} - \frac{1}{2\eta(1+\lambda_{DE_t})^2}\frac{\partial\lambda_{DE}}{\partial\eta} > 0.$$

$de_1/d\eta$ is larger if (DE) binds because $\partial\lambda_{DE}/\partial\eta < 0$ and

$$\frac{\eta^2(1+\lambda_{DE})-1}{2\eta^2(1+\lambda_{DEt})} > \frac{\eta^2-1}{2\eta^2}$$

if $\lambda_{DE} > 0$.

■

Proof of Proposition 1 Note that this proof makes use of some results proven later; it is put here to preserve the same order as in the main text. Before proving the Proposition 1, though, we confirm the following Lemma:

Lemma 14 *For every $\delta > 0$, the (DE) constraint in period $T-1$ holds for first-best effort and wage levels if η is sufficiently large. For any values η and θ, the (DE) constraint in period $T-1$ does not hold for first-best effort and wage levels if the discount factor is sufficiently small.*

Furthermore, $\Pi_{t-1} > \Pi_t$ for all $t \leq T$.

Proof: The (DE) constraint for period $T-1$ equals

$$\delta\Pi_T + c(\tilde{e}_{T-1}) - \eta w_{T-1}\theta\tilde{e}_{T-1} - c(e_{T-1}) + \eta w_{T-1}\theta e_{T-1} \geq 0,$$

with

$c'(\tilde{e}_{T-1}) - \eta w_{T-1}\theta = 0$. Moreover, $\Pi_T = e_T\theta - \frac{c'(e_T)}{\eta\theta} > 0$, with $\eta\theta^2 - c''(e_T) = 0$, thus $d\Pi_T/d\eta = c'(e_T)/\eta^2\theta > 0$, and first-best effort and wage are characterized by

$$\theta - c'(e) + \eta w\theta = 0$$
$$\eta\theta\,(e - \tilde{e}) - 1 + \lambda_w = 0.$$

First, note that because $\tilde{e}$ maximizes $\eta w\theta e - c(e)$ and $e_{T-1} > \tilde{e}_{T-1}$, $c(\tilde{e}_{T-1}) - \eta w_{T-1}\theta\tilde{e}_{T-1} - c(e_{T-1}) + \eta w_{T-1}\theta e_{T-1} < 0$ for all $w_{T-1} \geq 0$. Therefore first-best effort cannot be implemented for $\delta \to 0$.

To show that first-best values in period $T-1$ can be implemented if η is sufficiently large, I focus on $\eta > \overline{\eta}$, then first-best values can be re-written to

$$w = \frac{c'(e) - \theta}{\eta\theta} > 0$$
$$e - \tilde{e} = \frac{1}{\eta\theta}.$$

The latter implies that $e - \tilde{e}$ decreases in η, and $e \to \tilde{e}$ for $\eta \to \infty$. Moreover, plugging $\eta\theta\,(e - \tilde{e}) = 1$ into (DE) yields

$$\delta\left(e_T\theta - \frac{c'(e_T)}{\eta\theta}\right) + c(\tilde{e}) - c(e) + w \geq 0.$$

Since $e \to \tilde{e}$ for $\eta \to \infty$ implies $c(\tilde{e}) - c(e) \to 0$ in that case, thus first-best values satisfy the (DE) constraint for $\eta \to \infty$.

Concerning the second part of the Lemma, again note that the (DE) constraint for period t equals $\delta\Pi_{t+1} + c(\tilde{e}_t) - \eta w_t \theta \tilde{e}_t - c(e_t) + \eta w_t \theta e_t \geq 0$. It follows that, *for a given w_t*, the maximum implementable effort in period t is strictly increasing in Π_{t+1}, therefore per-period profits π_t are weakly increasing in Π_{t+1}. This implies that per-period profits in periods $t < T$ can be expressed as functions of Π_{t+1}, i.e. $\pi_t(\Pi_{t+1})$, with $\pi_t' \geq 0$.

The profit-maximizing spot reciprocity contract is the principal's optimal choice in the last period T, hence $\pi_T = e_T\theta - \frac{c'(e_T)}{\eta\theta}$, with $\eta\theta^2 - c''(e_T) = 0$. In all previous periods, the principal still the option to implement the spot reciprocity contract (by setting $b_t = 0$ and the optimal spot wage), therefore $\pi_t \geq \pi_T \, \forall t$.

Now, I apply proof by induction to verify that $\Pi_{t-1} > \Pi_t$. First, $\Pi_{T-1} > \Pi_T$ because

$$\Pi_{T-1} = \pi_{T-1} + \delta\Pi_T \geq \pi_T + \delta\Pi_T = \Pi_T(1+\delta) > \Pi_T.$$

For the induction step, assume that $\Pi_t > \Pi_{t+1}$. Since $\pi_t'(\Pi_{t+1}) \geq 0$, $\pi_{t-1} \geq \pi_t$. Therefore, $\Pi_{t-1} = \pi_{t-1} + \delta\Pi_t \geq \pi_t + \delta\Pi_t > \pi_t + \delta\Pi_{t+1} = \Pi_t$, which completes the proof. ■

Now I am ready to deliver the

Proof of Proposition 1 Take an arbitrary period $t > T$ and recall first-order conditions

$$\theta + \left(\eta w_t \theta - c'(e_t)\right)(1 + \lambda_{DE_t}) = 0$$
$$\eta\theta(e_t - \tilde{e}_t)(1 + \lambda_{DE_t}) - 1 + \lambda_{w_t} = 0.$$

Hence, $w_t = w_{t-1}$ and $e_t = e_{t-1}$ if $\lambda_{DE_t} = \lambda_{DE_{t-1}} = 0$. By Lemma 13, if $\lambda_{DE_{t-1}} = 0$ but $\lambda_{DE_t} > 0$, then $w_t \geq w_{t-1}$ and $e_t < e_{t-1}$. Now, assume that $\lambda_{DE_{t-1}} > 0$. It follows that in this case also $\lambda_{DE_t} > 0$ because $\Pi_{t+1} > \Pi_t$. By the same argument, if $\lambda_{DE_t} = 0$ in a period t, this also holds for all previous periods.

To show that the wage schedule is increasing in periods $t < T$ and the effort path decreasing, I first assume $\lambda_{w_t} = 0$, thus first-order conditions become

$$\theta + \left(\eta w_t \theta - c'(e_t)\right)(1 + \lambda_{DE_t}) = 0$$
$$\eta\theta(e_t - \tilde{e}_t)(1 + \lambda_{DE_t}) - 1 = 0.$$

The bordered Hessian equals

$$\left(1+\lambda_{DE_t}\right)\left(\eta\theta\left(e_t-\tilde{e}_t\right)\right)^2\left[c''(e_t)-\eta\theta^2+\eta\theta^2\left(\frac{\eta\theta^2-c''(\tilde{e}_t)}{c''(\tilde{e}_t)}\right)\right]$$

and must be positive to guarantee a maximum. Thus, the term in squared brackets is positive which is relevant for the following steps.

Moreover, combining both first-order conditions yields

$$\eta\theta^2\left(e_t-\tilde{e}_t\right)-c'(e_t)+\eta w_t\theta=0$$

which, together with

$$\delta\Pi_{t+1}+c(\tilde{e}_t)-\eta w_t\theta\tilde{e}_t-c(e_t)+\eta w_t\theta e_t=0,$$

determines e_t and w_t if (DEt) binds (i.e., if it is not satisfied for first best effort and wage). Then,

$$\begin{aligned}
\frac{de_t}{d\delta\Pi_{t+1}}&=\frac{\begin{vmatrix}0 & -\eta\theta^2\frac{d\tilde{e}_t}{dw_t}+\eta\theta\\ -1 & \eta\theta\left(e_t-\tilde{e}_t\right)\end{vmatrix}}{\begin{vmatrix}\eta\theta^2-c''(e_t) & -\eta\theta^2\frac{d\tilde{e}_t}{dw_t}+\eta\theta\\ -c'(e_t)+\eta w_t\theta & \eta\theta\left(e_t-\tilde{e}_t\right)\end{vmatrix}}\\
&=\frac{\eta\theta\left(\frac{c''(\tilde{e}_t)-\eta\theta^2}{c''(\tilde{e}_t)}\right)}{\eta\theta\left(e_t-\tilde{e}_t\right)\left[\eta\theta^2-c''(e_t)+\eta\theta^2\frac{c''(\tilde{e}_t)-\eta\theta^2}{c''(\tilde{e}_t)}\right]}\\
\frac{dw_t}{d\delta\Pi_{t+1}}&=\frac{\begin{vmatrix}\eta\theta^2-c''(e_t) & 0\\ -c'(e_t)+\eta w_t\theta & -1\end{vmatrix}}{\begin{vmatrix}\eta\theta^2-c''(e_t) & -\eta\theta^2\frac{d\tilde{e}_t}{dw_t}+\eta\theta\\ -c'(e_t)+\eta w_t\theta & \eta\theta\left(e_t-\tilde{e}_t\right)\end{vmatrix}}\\
&=\frac{c''(e_t)-\eta\theta^2}{\eta\theta\left(e_t-\tilde{e}_t\right)\left[\eta\theta^2-c''(e_t)+\eta\theta^2\left(\frac{c''(\tilde{e}_t)-\eta\theta^2}{c''(\tilde{e}_t)}\right)\right]},
\end{aligned}$$

where the denominator must be negative.

I now show that $c''(e_t)-\eta\theta^2>0$ and $c''(\tilde{e}_t)-\eta\theta^2<0$ (which implies that e_t exceeds the effort in a profit-maximizing spot contract, whereas $\tilde{e}_t$ is below that level). First, note that if these conditions hold for a given $\delta\Pi_{t+1}$, they also hold for all higher levels of continuation profits. The reason is that, if $c''(e_t) - \eta\theta^2 > 0$ and $c''(\tilde{e}_t) - \eta\theta^2 < 0$ for some $\delta\Pi_{t+1}$, e_t is increasing and w_t decreasing in $\delta\Pi_{t+1}$, where the latter reduces $\tilde{e}_t$. Second, assume $\delta\Pi_{t+1} \to 0$. Then, the outcome approaches the optimum of the one-period contract, in which effort is characterized by $c''(e) - \eta\theta^2 = 0$ (see the proof to Lemma 10). Now, assume to the contrary that $c''(\tilde{e}_t) - \eta\theta^2 \geq 0$ for $\delta\Pi_{t+1} \to 0$. Then, $de_t/d\delta\Pi_{t+1} \leq 0$, thus $c''(e_t) - \eta\theta^2 \leq 0$. But this contradicts $e_t > \tilde{e}_t$. It follows that $c''(\tilde{e}_t) - \eta\theta^2 < 0$. Moreover, $c''(e_t) - \eta\theta^2 > 0$ because $de_t/d\delta\Pi_{t+1} > 0$ and e_t approaches the optimal effort in a one-period contract if $\delta\Pi_{t+1} \to 0$.

All this implies that

$$\frac{de_t}{d\delta\Pi_{t+1}} > 0 \text{ and}$$
$$\frac{dw_t}{d\delta\Pi_{t+1}} < 0$$

if the (DEt) constraint binds in period t (otherwise, $de_t/d\delta\Pi_{t+1} = dw_t/d\delta\Pi_{t+1} = 0$) and $w_t > 0$. Moreover, with a binding (DEt) constraint and taking into account that $b_t = c(e_t) - c(\tilde{e}_t) - \eta w_t\theta(e_t - \tilde{e}_t)$,

$$\begin{aligned}\frac{db_t}{d\delta\Pi_{t+1}} =& c'(e_t)\frac{de_t}{d\delta\Pi_{t+1}} - \eta w_t\theta\frac{de_t}{d\delta\Pi_{t+1}} - \eta\frac{dw_t}{d\delta\Pi_{t+1}}\theta(e_t - \tilde{e}_t) \\ =& \eta\theta(e_t - \tilde{e}_t)\left(\frac{de_t}{d\delta\Pi_{t+1}}\theta - \frac{dw_t}{d\delta\Pi_{t+1}}\right) > 0,\end{aligned}$$

whereas

$$\frac{d(w_t + b_t)}{d\delta\Pi_{t+1}} \gtrless 0.$$

With $w_t = 0$, effort e_t is constrained by

$$\delta\Pi_{t+1} - c(e_t) \geq 0.$$

If this constrained binds, equilibrium effort and bonus strictly increase in Π_{t+1}.

■

Proof of Lemma 5. For the following comparative statics, I again compute the consequences of a higher continuation profit. Moreover, I assume that (DEt) binds (otherwise, a higher $\delta\Pi_{t+1}$ clearly has no effect on π_t and u_t)

First, I consider the case $w_t > 0$.

Then,

$$u_t = w_t + b_t - c(e_t) + \eta w_t e_t \theta$$
$$= w_t - c(\tilde{e}_t) + \eta w_t \theta \tilde{e}_t \text{ and}$$

$$\frac{du_t}{d\delta\Pi_{t+1}} = \frac{dw_t}{d\delta\Pi_{t+1}} (1 + \eta\theta\tilde{e}_t) < 0$$

Moreover,

$$\begin{aligned}
\pi_t &= e_t\theta - w_t - b_t \\
&= e_t\theta - c(e_t) - w_t + c(\tilde{e}_t) + \eta w_t \theta (e_t - \tilde{e}_t) \text{ and} \\
\frac{d\pi_t}{d\delta\Pi_{t+1}} &= \left(\theta - c'(e_t)\right) \frac{de_t}{d\delta\Pi_{t+1}} - \frac{dw_t}{d\delta\Pi_{t+1}} \\
&+ \eta \frac{dw_t}{d\delta\Pi_{t+1}} \theta (e_t - \tilde{e}_t) + \eta w_t \theta \frac{de_t}{d\delta\Pi_{t+1}} \\
&= \left(\theta \frac{de_t}{d\delta\Pi_{t+1}} - \frac{dw_t}{d\delta\Pi_{t+1}}\right) [1 - \eta\theta (e_t - \tilde{e}_t)] > 0
\end{aligned}$$

The latter follows from the first-order condition, $\eta\theta (e_t - \tilde{e}_t)(1 + \lambda_{DE_t}) - 1 = 0$, thus $1 > \eta\theta (e_t - \tilde{e}_t)$ if $\lambda_{DE_t} > 0$.

Second, I consider the case $w_t = 0$.

Then

$$\begin{aligned}
u_t &= 0, \\
\pi_t &= e_t\theta - c(e_t), \text{ and} \\
\frac{d\pi_t}{d\delta\Pi_{t+1}} &= \left(\theta - c'(e_t)\right) \frac{de_t}{d\delta\Pi_{t+1}} > 0,
\end{aligned}$$

because $\theta - c'(e_t) > 0$ with a binding (DEt) constraint and $w_t = 0$. ■

Proof of Lemma 6. For a given $w \geq \overline{w}$, the agent chooses an effort level that maximizes $u = w + \eta (w - \overline{w}) \theta e - c(e)$, hence effort is characterized by $\eta (w - \overline{w}) \theta - c'(e) = 0$, with

$$\frac{de}{dw} = \frac{\eta\theta}{c''(e)} > 0.$$

Taking this into account, the principal maximizes her profits $\pi = e\theta - w$, subject to $w \geq \overline{w}$. First ignoring the latter constraint, the principal's first-order condition equals

$$\eta\theta^2 - c''(e) = 0,$$

thus effort is independent of $\overline{w}$. This implies that $w - \overline{w} (> 0)$ must be independent of $\overline{w}$, hence $dw/d\overline{w} = 1$.

■

Proof of Proposition 2. In any period t, the principal maximizes

$\pi_t = e_t\theta - c(e_t) + \eta\,(w_t - \overline{w})\,\theta\,(e_t - \tilde{e}_t) + c(\tilde{e}_t) - w_t$, with $\eta\,(w_t - \overline{w})\,\theta - c'(\tilde{e}_t) = 0$, subject to (DE) and $w_t \geq \overline{w}$. First, I assume that (DE) does not bind (which is possible if η and/or δ are sufficiently large – see the proof to Lemma 14 which can readily be adapted to the present setting). Then, the Lagrange function equals

$$\begin{aligned} L_t =& e_t\theta - c(e_t) + \eta\,(w_t - \overline{w})\,\theta\,(e_t - \tilde{e}_t) \\ & + c(\tilde{e}_t) - w_t + \lambda_{w_t}\,(w_t - \overline{w}), \end{aligned}$$

with first order conditions (which already take into account that $-\eta\,(w_t - \overline{w})\,\theta + c'(\tilde{e}_t) = 0$)

$$\begin{aligned} \frac{\partial L_t}{\partial e_t} &= \theta - c'(e_t) + \eta\,(w_t - \overline{w})\,\theta = 0 \\ \frac{\partial L_t}{\partial w_t} &= \eta\theta\,(e_t - \tilde{e}_t) - 1 + \lambda_{w_t} = 0. \end{aligned}$$

I start with $\lambda_{w_t} = 0$. Then,

$$\frac{de}{d\overline{w}} = \frac{\begin{vmatrix} \eta\theta & \eta\theta \\ \eta\theta\frac{d\tilde{e}_t}{d\overline{w}} & -\eta\theta\frac{d\tilde{e}_t}{dw_t} \end{vmatrix}}{\begin{vmatrix} -c''(e_t) & \eta\theta \\ \eta\theta & -\eta\theta\frac{d\tilde{e}_t}{dw_t} \end{vmatrix}}$$

$$= \frac{-\eta^2\theta^2\left(\frac{d\tilde{e}_t}{d\overline{w}} + \frac{d\tilde{e}_t}{dw_t}\right)}{\eta^2\theta^2\frac{c''(e_t)-c''(\tilde{e}_t)}{c''(\tilde{e}_t)}} = 0$$

$$\frac{dw}{d\overline{w}} = \frac{\begin{vmatrix} -c''(e_t) & \eta\theta \\ \eta\theta & \eta\theta\frac{d\tilde{e}_t}{d\overline{w}} \end{vmatrix}}{\begin{vmatrix} -c''(e_t) & \eta\theta \\ \eta\theta & -\eta\theta\frac{d\tilde{e}_t}{dw_t} \end{vmatrix}}$$

$$= \frac{\eta^2\theta^2\frac{c''(e_t)-c''(\tilde{e}_t)}{c''(\tilde{e}_t)}}{\eta^2\theta^2\frac{c''(e_t)-c''(\tilde{e}_t)}{c''(\tilde{e}_t)}} = 1.$$

If $\lambda_{w_t} > 0$, effort is characterized by $\eta\theta e_t - 1$ and clearly independent of $\overline{w}$.

Moreover, the threshold $\bar{\eta}$ above which a wage $w_t > \overline{w}$ is optimal is independent of $\overline{w}$:

$$\frac{\partial \pi_t}{\partial w_t} |_{w_t=\overline{w}} = \eta\theta e_t - 1,$$

where e_t is characterized by $\theta - c'(e_t) = 0$. As above, $\eta\theta e_t - 1$ is increasing in η; it is positive for large η and negative for small η, which confirms that $\overline{\eta}$ exists and is independent of $\overline{w}$.

Now, I include the respective (DE) constraints, which yields the Lagrange function of the principal's maximization problem in a period t

$$\begin{aligned} L_t &= e_t\theta - c(e_t) + \eta\,(w_t - \overline{w})\,\theta\,(e_t - \tilde{e}_t) + c(\tilde{e}_t) - w_t \\ &\quad + \lambda_{DE_t}\left[\delta\Pi_{t+1} - c(e_t) + \eta\,(w_t - \overline{w})\,\theta\,(e_t - \tilde{e}_t) + c(\tilde{e}_t)\right] \\ &\quad + \lambda_{w_t}\,(w_t - \overline{w}). \end{aligned}$$

First-order conditions are

$$\begin{aligned}\frac{\partial L}{\partial e_t} =& \theta + \left[-c'(e_t) + \eta\,(w_t - \overline{w})\,\theta\right](1+\lambda_{DE_t}) = 0\\ \frac{\partial L}{\partial w_t} =& \eta\theta\,(e_t - \tilde{e}_t)(1+\lambda_{DE_t}) - 1 + \lambda_{w_t} = 0.\end{aligned}$$

Thus, with a binding (DEt) constraint, effort and wage are characterized by

$$\begin{aligned}&\eta\theta^2(e_t-\tilde{e}_t) - c'(e_t) + \eta\,(w_t-\overline{w})\,\theta\\ &+\lambda_{w_t}\left[c'(e_t) - \eta\,(w_t-\overline{w})\,\theta\right] = 0\\ &\delta\Pi_{t+1} - c(e_t) + \eta\,(w_t-\overline{w})\,\theta\,(e_t-\tilde{e}_t) + c(\tilde{e}_t) = 0.\end{aligned}$$

For the following, I take into account that Π_t decreases in $\overline{w}$: I have already shown (in the proof to Lemma 6) that $\Pi_T = \pi_T$ is decreasing in $\overline{w}$. Therefore, (DE) in period $T-1$ is tightened; together with a direct negative effect of a higher $\overline{w}$ (equilibrium effort for given payments goes down), this reduces profits π_{T-1} and Π_{T-1}. This effect carries over to all earlier periods.

Now, assume $\lambda_{w_t} = 0$. Then,

$$\begin{aligned}\frac{de}{d\overline{w}} =& \frac{\begin{vmatrix} -\left[\eta\theta^2\left(-\frac{d\tilde{e}_t}{d\overline{w}}\right) - \eta\theta\right] & -\eta\theta^2\frac{d\tilde{e}_t}{dw_t} + \eta\theta \\ -\left[\frac{d\delta\Pi_{t+1}}{d\overline{w}} - \eta\theta\,(e_t-\tilde{e}_t)\right] & \eta\theta\,(e_t-\tilde{e}_t)\end{vmatrix}}{\begin{vmatrix} \eta\theta^2 - c''(e_t) & -\eta\theta^2\frac{d\tilde{e}_t}{dw_t} + \eta\theta \\ -c'(e_t) + \eta\,(w_t-\overline{w})\,\theta & \eta\theta\,(e_t-\tilde{e}_t)\end{vmatrix}}\\ =& \frac{\frac{\eta\theta^2 - c''(\tilde{e}_t)}{c''(\tilde{e}_t)}\frac{d\delta\Pi_{t+1}}{d\overline{w}}}{(e_t-\tilde{e}_t)\left[c''(e_t) - \eta\theta^2 + \eta\theta^2\frac{\eta\theta^2-c''(\tilde{e}_t)}{c''(\tilde{e}_t)}\right]} < 0\\ \frac{dw}{d\overline{w}} =& \frac{\begin{vmatrix} \eta\theta^2 - c''(e_t) & -\left[\eta\theta^2\left(-\frac{d\tilde{e}_t}{d\overline{w}}\right) - \eta\theta\right] \\ -c'(e_t) + \eta\,(w_t-\overline{w})\,\theta & -\left[\frac{d\delta\Pi_{t+1}}{d\overline{w}} - \eta\theta\,(e_t-\tilde{e}_t)\right]\end{vmatrix}}{\begin{vmatrix} \eta\theta^2 - c''(e_t) & -\eta\theta^2\frac{d\tilde{e}_t}{dw_t} + \eta\theta \\ -c'(e_t) + \eta\,(w_t-\overline{w})\,\theta & \eta\theta\,(e_t-\tilde{e}_t)\end{vmatrix}}\\ =& 1 + \frac{\frac{d\delta\Pi_{t+1}}{d\overline{w}}\left(\eta\theta^2 - c''(e_t)\right)}{\eta\theta\,(e_t-\tilde{e}_t)\left[c''(e_t) - \eta\theta^2 + \eta\theta^2\frac{\eta\theta^2-c''(\tilde{e}_t)}{c''(\tilde{e}_t)}\right]} > 1.\end{aligned}$$

If $\lambda_{w_t} > 0$, effort is characterized by $\delta\Pi_{t+1} - c(e_t) = 0$, with $de_t/d\overline{w} < 0$. To derive the treshold $\tilde{\eta}$

above which a positive w_t is optimal note that

$$\lambda_{w_t} = \frac{c'(e_t) - \eta\theta(w_t - \overline{w}) - \eta\theta^2(e_t - \tilde{e}_t)}{[c'(e_t) - \eta\theta(w_t - \overline{w})]}.$$

Thus,

$$\lambda_{w_t} > 0 \Leftrightarrow \frac{c'(e_t)}{e_t\theta^2} \equiv \tilde{\eta} > \eta, \text{ with}$$
$$\frac{d\tilde{\eta}}{de_t} = \frac{c''(e_t)e_t - c'(e_t)}{e_t^2\theta^2} > 0,$$

where the inequality follows from $c''' > 0$.

■

Proof of Proposition 3. First, I show that, for $p \to 1$, a separating contract yields higher profits than a pooling contract. There, note that, in any profit-maximizing equilibrium, (ICS), the selfish type's (IC) constraint, is tighter than (ICR), the reciprocal type's (IC) constraint:

$$-\frac{e_1^3}{3} + \delta w_2 \geq 0 \tag{ICS}$$
$$-\frac{e_1^3}{3} + \eta w_1 e_1 + \delta\left[w_2 + \frac{2\left(\sqrt{\eta w_2}\right)^3}{3}\right]$$
$$\geq \frac{2}{3}\left(\sqrt{\eta w_1}\right)^3. \tag{ICR}$$

With $w_1 = 0$, (ICS) is tighter than (ICR) for any second-period wage w_2 because second-period utilities are larger for the reciprocal type. A strictly positive w_1 can only possibly be optimal for the principal if it further relaxes (ICR) ((ICS) is unaffected by w_1), which confirms that (ICS) is tighter than (ICR) in any profit-maximizing equilibrium. This implies that a strictly higher effort level can be implemented with a separating contract (then however only exerted by the reciprocal type) than with a pooling contract (then exerted by both). For $p \to 1$, profits under both regimes approach $e_1 - w_1 + \delta\left(\sqrt{w_2\eta} - w_2\right)$, which is larger with a separating contract because of the higher effort implemented in this case for any given set of wages.

To show that a pooling contract yields higher profits than a separating contract for $p \to 0$, I first assume that the principal offers a pooling contract and explore its properties. Then, I do the same with a separating contract, and finally compare both alternatives.

Pooling contract In any profit-maximizing equilibrium, (ICS) is tighter than (ICR). Therefore, (ICS) determines feasible effort in a pooling contract. This also implies that $w_1 = 0$, because a positive w_1 might only relax (ICR).

Now, the principal maximizes Π_1, subject to her own (DE) constraint, $pe_2 - w_2 \geq 0$, as well as the selfish agent's (IC) constraint, $-\frac{e_1^3}{3} + \delta w_2 \geq 0$. This will bind because, otherwise, the principal could ask for a higher first-period effort level without violating any constraint. Moreover, the reciprocal type exerts an effort level $e_2 = \sqrt{w_2 \eta}$ in the second period, whereas the selfish type's second period effort amounts to zero, hence $\Pi_1 = e_1 + \delta \left(p\sqrt{w_2\eta} - w_2\right)$.

Taking all this into account, the Lagrange function becomes

$$L = e_1 + \delta \left[p\sqrt{\frac{e_1^3}{3\delta}\eta} - \frac{e_1^3}{3\delta} \right] + \lambda_{DE} \left[p\sqrt{\frac{e_1^3}{3\delta}\eta} - \frac{e_1^3}{3\delta} \right],$$

and the first order condition

$$\frac{\partial L}{\partial e_1} = 1 + \left[\frac{p\eta}{2\sqrt{\frac{e_1^3}{3\delta}\eta}} - 1 \right] \frac{e_1^2}{\delta} \left(\delta + \lambda_{DE}\right) = 0.$$

First, assume $\lambda_{DE} = 0$. Then, e_1 is characterized by

$$2\sqrt{\frac{\eta}{3\delta}} \left(1 - e_1^2\right) + p\eta\sqrt{e_1} = 0. \tag{3}$$

Second, assume $\lambda_{DE} > 0$. Then, e_1 is determined by the binding (DE) constraint,

$$e_1 = \sqrt[3]{3\delta p^2 \eta}.$$

To compute the condition for when (DE) binds, I plug $e_1 = \sqrt[3]{3\delta p^2 \eta}$ into the first order condition,

$$
\begin{aligned}
1+\left[\frac{p\eta}{2\sqrt{\frac{e_1^3}{3\delta}\eta}}-1\right]\frac{e_1^2}{\delta}(\delta+\lambda_{DE}) \\
=1-\frac{1}{2}\frac{e_1^2}{\delta}(\delta+\lambda_{DE}) \\
=1-\frac{1}{2}\frac{\left(\sqrt[3]{3\delta p^2\eta}\right)^2}{\delta}(\delta+\lambda_{DE})=0 \\
\Leftrightarrow \lambda_{DE}=2\delta\frac{\left[1-\frac{1}{2}\left(\sqrt[3]{3\delta p^2\eta}\right)^2\right]}{\left(\sqrt[3]{3\delta p^2\eta}\right)^2}
\end{aligned}
$$

Therefore, (DE) binds if $1-\frac{1}{2}\left(\sqrt[3]{3\delta p^2\eta}\right)^2\geq 0$, or

$$
p^2\leq\frac{\left(\sqrt{2}\right)^3}{3\delta\eta}.
$$

In this case, which is the relevant one for $p\to 0$, the principal's profits with a pooling equilibrium are

$$
\Pi_1^P=e_1=\sqrt[3]{3\delta p^2\eta}.
$$

Otherwise, $\Pi_1^P=e_1+\delta\left[p\sqrt{\frac{e_1^3}{3\delta}\eta}-\frac{e_1^3}{3\delta}\right]=e_1\left[1+\frac{e_1^2-2}{3}\right]$, where e_1 is characterized by (3).

Separating contract In case she offers a separating contract, the principal maximizes $\Pi_1=p\left[e_1+\delta\left(e_2-w_2\right)\right]-w_1$, where $e_2=\sqrt{w_2\eta}$, subject to her own (DE) constraint, $e_2-w_2\geq 0$ (which is relevant in case the agent turns out to be reciprocal), the non-negativity constraint $w_1\geq 0$, as well as the reciprocal agent's binding (IC) constraint,

$$
\begin{aligned}
-\frac{e_1^3}{3}+\eta w_1 e_1+\delta\left[w_2+\frac{2\left(\sqrt{\eta w_2}\right)^3}{3}\right] \\
=\frac{2\left(\sqrt{\eta w_1}\right)^3}{3}.
\end{aligned}
\tag{IC}
$$

There, note that

$$\begin{aligned}\frac{de_1}{dw_1} &= \eta\frac{e_1-\sqrt{\eta w_1}}{e_1^2-\eta w_1} = \frac{\eta}{e_1+\sqrt{\eta w_1}}\\ \frac{de_1}{dw_2} &= \frac{\delta\left[1+\sqrt{\eta w_2}\eta\right]}{e_1^2-\eta w_1}.\end{aligned}$$

Therefore, the Lagrange function becomes $L = p\left[e_1+\delta\left(\sqrt{w_2\eta}-w_2\right)+\lambda_{DE}\left(\sqrt{w_2\eta}-w_2\right)\right]-w_1+\lambda_{w_1}w_1$, with first order conditions

$$\begin{aligned}\frac{\partial L}{\partial w_1} =& p\frac{\eta}{e_1+\sqrt{\eta w_1}}-1+\lambda_{w_1}=0\\ \frac{\partial L}{\partial w_2} =& p\left[\frac{\delta\left[1+\sqrt{\eta w_2}\eta\right]}{e_1^2-\eta w_1}+\delta\left(\frac{\eta}{2\sqrt{w_2\eta}}-1\right)+\lambda_{DE}\left(\frac{\eta}{2\sqrt{w_2\eta}}-1\right)\right]=0\end{aligned}$$

For later use, note that the first condition implies that $w_1 = 0$ for $p \to 0$ (because e_1 is bounded away from zero for any strictly positive δ).

First, assume $\lambda_{DE} = 0$, hence

$$\frac{1+\sqrt{\eta w_2}\eta}{e_1^2-\eta w_1}+\frac{\eta}{2\sqrt{w_2\eta}}-1=0.$$

This, together with the reciprocal agent's (IC) constraint, determines outcomes if $w_1 = 0$.

If $w_1 > 0$, outcomes are further specified by

$$p\frac{\eta}{e_1+\sqrt{\eta w_1}}-1=0.$$

Now, assume $\lambda_{DE} > 0$. Then, a binding (DE) constraint implies $w_2 = \eta$.

If $w_1 = 0$, (IC) yields

$$e_1 = \sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}$$

To compute the condition for when $w_1 = 0$ (if (DE) binds), I plug these values into the first first order condition, $p\frac{\eta}{\sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}}-1+\lambda_{w_1}=0$. Therefore, $w_1 = 0$ if

$$
\begin{aligned}
&p\frac{\eta}{\sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}}-1\leq 0\\
\Leftrightarrow &p^3\leq\frac{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}{\eta^3}.
\end{aligned}
$$

To compute the condition for when (DE) binds (if $w_1 = 0$), I plug these values into the second first-order-condition. Therefore, (DE) binds for

$$
\frac{\delta\left[1+\eta^2\right]}{\left(\sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}\right)^2}-\frac{1}{2}\delta\geq 0,
$$

or

$$
\delta^2\leq\frac{8\left[1+\eta^2\right]^3}{9\left[\eta+\frac{2\eta^3}{3}\right]^2}.
$$

The right hand side of this condition is larger than 1, and (DE) *always* binds if $w_1 = 0$. Therefore, (DE) always binds if $p \to 0$ because then, $w_1 = 0$ (see above). Note, though, that this might change in a more general setup with a longer time horizon.

All this implies that, for $p \to 0$, profits with a separating contract are

$$
\Pi_1^S = pe_1 = p\sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}.
$$

Comparison For $p \to 0$, profits with a pooling contract are $\Pi_1^P = \sqrt[3]{3\delta p^2\eta}$, and $\Pi_1^S = p\sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}$ for a separating contract. Therefore,

$$
\begin{aligned}
&\Pi_1^P > \Pi_1^S\\
\Leftrightarrow &\sqrt[3]{3\delta p^2\eta}\geq p\sqrt[3]{3\delta\left[\eta+\frac{2\eta^3}{3}\right]}\\
\Leftrightarrow &1\geq p\left(1+\frac{2\eta^2}{3}\right),
\end{aligned}
$$

which holds for $p \to 0$. ■

Proof of Lemma 8. The principal maximizes

$$\Pi_1 = e_1 - e_1^3/3 + \eta w_1 e_1 - 2/3\left(\sqrt{\eta w_1}\right)^3 - w_1 + \delta\left(\frac{\eta}{4} - w_1\right),$$

subject to $w_1 \geq 0$ and

$$\frac{e_1^3}{3} - \eta w_1 e_1 + \frac{2}{3}\left(\sqrt{\eta w_1}\right)^3 \leq \delta\left(\frac{\eta}{4} - w_1\right). \tag{DE}$$

This yields the Lagrange function

$$\begin{aligned} L = e_1 - (e_1)^3/3 + \eta w_1 e_1 - 2/3\left(\sqrt{\eta w_1}\right)^3 - w_1 + \delta\left(\frac{\eta}{4} - w_1\right) \\ + \lambda_{w_1} w_1 + \lambda_{DE}\left[\eta w_1 e_1 + \delta\left(\frac{\eta}{4} - w_1\right) - \frac{2}{3}\left(\sqrt{\eta w_1}\right)^3 - \frac{e_1^3}{3}\right], \end{aligned}$$

where $\lambda_{w_1} \geq 0$ represents the Lagrange multiplier for the agent's limited liability constraint, and $\lambda_{DE} \geq 0$ the Lagrange multiplier for the principal's dynamic enforcement constraint.

First order conditions are

$$\begin{aligned} \frac{\partial L}{\partial e_1} =& 1 - e_1^2 + \eta w_1 + \lambda_{DE}\left[\eta w_1 - e_1^2\right] = 0 \\ \frac{\partial L}{\partial w_1} =& \eta e_1 - \eta\sqrt{\eta w_1} - 1 - \delta + \lambda_{w_1} \\ & + \lambda_{DE}\left[\eta e_1 - \delta - \eta\sqrt{\eta w_1}\right] = 0. \end{aligned}$$

First, assume $\lambda_{DE} = 0$. Then, I have to consider the two cases $w_1 = 0$ and $w_1 > 0$.

If $w_1 = 0$, $e_1 = 1$ and $\Pi_1 = 2/3 + \delta\eta/4$. Moreover, $d\Pi_1/dw_1 \mid_{w_1=0} = \sqrt{\eta^2} - 1 - \delta$, therefore $w_1 = 0$ for $\eta^2 \leq (1+\delta)^2$, whereas $w_1 > 0$ for $\eta^2 > (1+\delta)^2$. Recall that the condition for a positive wage in case (DE) is not binding in the main part (i.e., without an adjustment of the reference wage) equals $\eta > 1$.

Furthermore, $e_1 > e_2 \Leftrightarrow \eta^2 < 4$, which holds because $\eta^2 < (1+\delta)^2$. Moreover, $0 = w_1 < w_2 = \frac{\eta}{4}$, and $\frac{de_1}{d\eta} = 0 < \frac{de_2}{d\eta}$.

To check the feasibility of the case $\lambda_{DE} = 0$ and $w_1 = 0$, I plug the respective values into the (DE) constraint, and obtain

$$\frac{16}{9\delta^2} \leq \eta^2.$$

This is consistent with $\eta^2 \leq (1+\delta)^2$ if $3\delta(1+\delta) \geq 4$. Now, assume $\eta^2 > (1+\delta)^2$ and $\lambda_{DE} = 0$. Hence, $\lambda_{w_1} = 0$, and the first order conditions yield $e_1 = \frac{(1+\delta)^2+\eta^2}{2\eta(1+\delta)}$ and $w_1 = \frac{\left[\eta^2-(1+\delta)^2\right]^2}{4(1+\delta)^2\eta^3}$. Moreover, $e_1 > e_2 \Leftrightarrow \delta\eta^2 < (1+\delta)^2$, which only is consistent with $\eta^2 > (1+\delta)^2$ if δ is sufficiently small. In any case, $w_1 < w_2$.

To check the feasibility of the case $\lambda_{DE} = 0$ and $w_1 > 0$, I plug the respective values into the (DE) constraint, and obtain

$$2 \leq \delta\left(\frac{(1+\delta)^2\eta^2-1}{(1+\delta)^2}\right)+(1+\delta)^2\frac{1}{3}\frac{(2-\delta)}{\eta^2}.$$

The right hand side is increasing in η^2 if δ is large enough. Since $\eta^2 > (1+\delta)^2$, this condition holds if it is satisfied for $\eta^2 = (1+\delta)^2$. For this case, it becomes

$$\frac{4}{3} \leq \delta^2(2+\delta)+\frac{2}{3}\delta-\frac{\delta}{(1+\delta)^2}.$$

There, the right hand side is increasing in δ and, for $\delta \to 1$, approaches $3+\frac{5}{12} > \frac{4}{3}$. Hence, this case is feasible if η and/or δ are large enough.

Now, assume that the (DE) constraint binds, hence $\lambda_{DE} > 0$.

First, I assume that $\lambda_{w_1} > 0$, hence $w_1 = 0$ and $e_1 = \sqrt{1/(1+\lambda_{DE})}$. To establish the existence of $\tilde{\eta}$, note that $\partial L/\partial w_1 \mid_{w_1=0}= \left(\eta\sqrt{1/(1+\lambda_{DE})}-\delta\right)(1+\lambda_{DE})-1$, which is positive for $\eta^2 > (1+\delta(1+\lambda_{DE}))^2/(1+\lambda_{DE})$. This threshold is larger than with a non-binding (DE) if $\lambda_{DE} > \left(1-\delta^2\right)/\delta^2$, which might or might not hold. Moreover, provided $\eta^2 \leq (1+\delta(1+\lambda_{DE}))^2/(1+\lambda_{DE})$, $e_1 > e_2 \Leftrightarrow \eta^2(1+\lambda_{DE}) < 4$, which might or might not hold.

Second, I assume $\eta^2 > (1+\delta(1+\lambda_{DE}))^2/(1+\lambda_{DE})$, hence $\lambda_{w_1} = 0$. Then, the first order conditions yield

$$e_1 = \frac{\eta^2(1+\lambda_{DE})+(1+\delta(1+\lambda_{DE}))^2}{2\eta(1+\lambda_{DE})(1+\delta(1+\lambda_{DE}))}$$
$$w_1 = \frac{\left[\eta^2(1+\lambda_{DE})-(1+\delta(1+\lambda_{DE}))^2\right]^2}{4\eta^3(1+\lambda_{DE})^2(1+\delta(1+\lambda_{DE}))^2}.$$

Now, $e_1 > e_2 \Leftrightarrow \frac{(1+\delta(1+\lambda_{DE}))^2}{\delta(1+\lambda_{DE})^2} > \eta^2$, which might or might not be consistent with $\eta^2 > (1+\delta(1+\lambda_{DE}))^2/(1+\lambda_{DE})$.

■

Proof of Lemma 9. In the second period, the principal maximizes $\pi_2 = e_2 - w_2$, where e_2 is given by

$$-e_2^2 - \frac{4}{3}e_2^3\eta + w_2\eta = 0.$$

This yields

$$\begin{aligned}
e_2 =& \frac{\sqrt{1+4\eta^2}-1}{4\eta} \\
w_2 =& \frac{e_2^2+\frac{4}{3}e_2^3\eta}{\eta} \\
\pi_2 =& e_2\left(\frac{8\eta^2+1-\sqrt{1+4\eta^2}}{12\eta^2}\right) \\
u_2 =& \frac{e_2^2\left(1+\eta e_2\right)^2}{\eta}.
\end{aligned}$$

Recall that last-period profits in the main setup are $\eta/4$, which is larger than the amount obtained here.

In the first period, at e_1, u_1 is decreasing in e_1. If it were increasing, the agent would further raise his effort level. This implies that (IC) is binding in a profit-maximizing equilibrium. If it were not binding, the principal could ask for a higher effort level without paying more.

Plugging the binding (IC) constraint,

$$b_1 = \frac{e_1^3}{3} - w_1 + \left(w_1 - \frac{\tilde{e}_1^3}{3}\right)\frac{(1+\eta\tilde{e}_1)}{(1+\eta e_1)},$$

into profits and the (DE) constraint yields the Lagrange function

$$\begin{aligned}
L = e_1 - \frac{e_1^3}{3} - \left(w_1 - \frac{\tilde{e}_1^3}{3}\right)\frac{(1+\eta\tilde{e}_1)}{(1+\eta e_1)} \\
+ \lambda_{w_1}w_1 + \lambda_{DE}\left[-\frac{e_1^3}{3} + w_1 - \left(w_1 - \frac{\tilde{e}_1^3}{3}\right)\frac{(1+\eta\tilde{e}_1)}{(1+\eta e_1)} + \delta\pi_2\right],
\end{aligned}$$

where $\lambda_{w_1} \geq 0$ represents the Lagrange multiplier for the agent's limited liability constraint, and $\lambda_{DE} \geq 0$ the Lagrange multiplier for the principal's dynamic enforcement constraint.

First order conditions are

$$\begin{aligned}
\frac{\partial L}{\partial e_1} =& 1-e_1^2+\left(w_1-\frac{\tilde{e}_1^3}{3}\right)\frac{\eta\left(1+\eta\tilde{e}_1\right)}{\left(1+\eta e_1\right)^2} \\
&+\lambda_{DE}\left[-e_1^2+\left(w_1-\frac{\tilde{e}_1^3}{3}\right)\frac{\eta\left(1+\eta\tilde{e}_1\right)}{\left(1+\eta e_1\right)^2}\right]=0 \\
\frac{\partial L}{\partial w_1} =& -\left(1-\tilde{e}_1^2\frac{d\tilde{e}}{dw_1}\right)\frac{\left(1+\eta\tilde{e}_1\right)}{\left(1+\eta e_1\right)}-\left(w_1-\frac{\tilde{e}_1^3}{3}\right)\frac{\eta}{\left(1+\eta e_1\right)}\frac{d\tilde{e}_1}{dw_1} \\
&+\lambda_{DE}\left[1-\left(1-\tilde{e}_1^2\frac{d\tilde{e}_1}{dw_1}\right)\frac{\left(1+\eta\tilde{e}_1\right)}{\left(1+\eta e_1\right)}-\left(w_1-\frac{\tilde{e}_1^3}{3}\right)\frac{\eta}{\left(1+\eta e_1\right)}\frac{d\tilde{e}_1}{dw_1}\right] \\
&+\lambda_{w_1}=0
\end{aligned}$$

Using $-\tilde{e}_1^2-4/3\tilde{e}_1^3\eta+w_1\eta=0$, which implies $w_1=\tilde{e}_1^2/\eta+4/3\tilde{e}_1^3$, those conditions become

$$\begin{aligned}
\frac{\partial L}{\partial e_1}&:1-\left(e_1^2-\tilde{e}_1^2\frac{\left(1+\eta\tilde{e}_1\right)^2}{\left(1+\eta e_1\right)^2}\right)\left(1+\lambda_{DE}\right)=0 \\
\frac{\partial L}{\partial w_1}&:-\frac{\left(1+\eta\tilde{e}\right)}{\left(1+\eta e_1\right)}\left(1+\lambda_{DE}\right)+\lambda_{w_1}+\lambda_{DE}=0
\end{aligned}$$

First, assume $\lambda_{DE}=0$. Then, I have to consider the two cases $w_1=0$ and $w_1>0$. However, $w_1>0$ and consequently $\lambda_{w_1}=0$ cannot be optimal, since in this case, the second condition would become $-\left(1+\eta\tilde{e}\right)/\left(1+\eta e_1\right)=0$.

Therefore, $\lambda_{DE}=0$ implies $w_1=0$; hence $\tilde{e}=0$ and

$$e_1=1.$$

Moreover $e_1=1>\left(\sqrt{1+4\eta^2}-1\right)/(4\eta)=e_2$ and $w_1=0<\left(e_2^2+\frac{4}{3}e_2^3\eta\right)/\eta=w_2$.

However, note that for two periods and $\delta\leq 1$, $\lambda_{DE}=0$ is not feasible: For $w_1=0$, $b_1=1/3$ and $e_1=1$, the (DE) constraint becomes

$$-\frac{1}{3}+\delta\frac{\left(1+4\eta^2\right)\sqrt{1+4\eta^2}-6\eta^2-1}{24\eta^3}\geq 0.$$

There, the second term increases in η and approaches $\delta 2/9$ for $\eta\to\infty$. Therefore, the constraint does not hold for any η if $\delta\leq 1$.

Now, assume that (DE) binds. Again, I start with $w_1 = 0$. Then, $e_1 = \sqrt{1/(1+\lambda_{DE})}$, and

$$\lim_{w_1 \to 0} \frac{\partial L}{\partial w_1} = -\frac{(1+\lambda_{DE})}{(1+\eta e_1)} + \lambda_{DE}$$
$$= -\frac{(1+\lambda_{DE})}{\left(1+\sqrt{\frac{\eta^2}{(1+\lambda_{DE})}}\right)} + \lambda_{DE},$$

which is positive for

$$\eta^2 > \frac{1+\lambda_{DE}}{\lambda_{DE}^2}.$$

Put differently,

$$e_1 = \sqrt{\frac{1}{(1+\lambda_{DE})}},$$

if $\eta^2 \lambda_{DE}^2 - \lambda_{DE} - 1 \leq 0$, hence if $\lambda_{DE} \leq \left(1+\sqrt{1+4\eta^2}\right)/(2\eta^2)$. In this case,

$$e_1 \geq \sqrt{\frac{1}{\left(1+\frac{1+\sqrt{1+4\eta^2}}{2\eta^2}\right)}}$$
$$= \sqrt{\frac{2\eta^2}{2\eta^2+1+\sqrt{1+4\eta^2}}}$$

This is larger than $e_2 = \left(\sqrt{1+4\eta^2}-1\right)/(4\eta)$, if

$$12\eta^4 > 0.$$

Therefore, $e_1 > e_2$ and $w_1 < w_2$.

Now, assume that $\lambda_{DE} > \left(1+\sqrt{1+4\eta^2}\right)/(2\eta^2)$, hence $w_1 > 0$. Solving the first first order condition for λ_{DE} and plugging it into the second yields

$$\eta - \frac{[1+\eta\theta(e_1+\tilde{e}_1)][e_1(1+e_1\eta)+\tilde{e}_1(1+\eta\tilde{e}_1)]}{(1+\eta e_1)} = 0,$$

which, together with the binding (DE) constraint, determines e_1 as well as $\tilde{e}_1$ (and consequently w_1). Making use of $-\tilde{e}_1^2 - \frac{4}{3}\tilde{e}_1^3\eta + w_1\eta = 0 \Rightarrow w_1 = \frac{\tilde{e}_1^2}{\eta} + \frac{4}{3}\tilde{e}_1^3$, the latter becomes

$$-\frac{(e_1^3-\tilde{e}_1^3)}{3} + \tilde{e}_1^2(e_1-\tilde{e}_1)\frac{(1+\tilde{e}_1\eta)}{(1+\eta e_1)} + \delta\pi_2 = 0,$$

In order to prove $e_1 > e_2$ and $w_1 < w_2$, I first show that e_1 is increasing and $\tilde{e}_1$ is decreasing in $\delta\pi_2$:

$$\frac{de_1}{d(\delta\pi_2)} = \frac{\begin{vmatrix} 0 & -\frac{\eta\left\{e_1^2\eta+\eta\tilde{e}_1^2+2(e_1+\tilde{e}_1)(1+\eta\tilde{e}_1)\right\}+(1+2\eta\tilde{e}_1)}{(1+\eta e_1)} \\ -1 & -\frac{-\left(e_1^2+e_1\tilde{e}_1+\tilde{e}_1^2\right)+(e_1-\tilde{e}_1)(e_1+2\tilde{e}_1)}{3}+\frac{2\tilde{e}_1e_1+3e_1\tilde{e}_1^2\eta-3\tilde{e}_1^2-4\tilde{e}_1^3\eta}{(1+\eta e_1)} \end{vmatrix}}{\begin{vmatrix} \frac{\tilde{e}_1\eta(1+\eta\tilde{e}_1)^2-[(1+\eta\tilde{e}_1)(1+e_1\eta)+\eta e_1(1+2e_1\eta)](1+\eta e_1)}{(1+\eta)^2} & -\frac{\eta\theta\left\{e_1^2\eta+\tilde{e}_1^2\eta+2(e_1+\tilde{e}_1)(1+\eta\tilde{e}_1)\right\}+(1+2\eta\tilde{e}_1)}{(1+\eta e_1)} \\ -e_1^2+\tilde{e}_1^2\frac{(1+\eta\tilde{e}_1)^2}{(1+\eta e_1)^2} & \tilde{e}_1^2+\frac{2\tilde{e}_1e_1+3e_1\tilde{e}_1^2\eta-3\tilde{e}_1^2-4\tilde{e}_1^3\eta}{(1+\eta e_1)} \end{vmatrix}}$$

There, the numerator equals

$$-\frac{\eta\left\{e_1^2\eta+\eta\tilde{e}_1^2+2(e_1+\tilde{e}_1)(1+\eta\tilde{e}_1)\right\}+(1+2\eta\tilde{e}_1)}{(1+\eta e_1)} < 0,$$

and the denominator

$$\frac{\tilde{e}_1\eta(1+\eta\tilde{e}_1)^2-(\eta\tilde{e}_1+1)(1+e_1\eta)^2-\eta e_1(1+2e_1\eta)(1+\eta e_1)}{(1+\eta e_1)^2}\left[2(e_1-\tilde{e}_1)\tilde{e}_1\frac{1+2\eta\tilde{e}_1}{(1+\eta e_1)}\right]$$
$$+\left(-e_1^2+\tilde{e}_1^2\frac{(1+\tilde{e}_1\eta)^2}{(1+\eta e_1)^2}\right)\frac{\eta\theta\left\{e_1^2\eta+\tilde{e}_1^2\eta+2(e_1+\tilde{e}_1)(1+\eta\tilde{e}_1)\right\}+(1+2\eta\tilde{e}_1)}{(1+\eta e_1)},$$

which is negative because of $e_1 > \tilde{e}_1$. Therefore,

$$\frac{de_1}{d(\delta\pi_2)} > 0.$$

If $\delta\pi_1 = 0$, $b_1 = 0$, and π_1 is maximized by setting $w_1 = w_2$, implying $e_1 = e_2$. Therefore, $e_1 > e_2$ given $\delta\pi_1 > 0$.

Moreover,

$$\frac{d\tilde{e}_1}{d(\delta\pi_2)} = \frac{\begin{vmatrix} \frac{\tilde{e}_1\eta(1+\eta\tilde{e}_1)^2-[(1+\eta\tilde{e}_1)(1+\eta e_1)+\eta e_1(1+2\eta e_1)](1+\eta e_1)}{(1+\eta e_1)^2} & 0 \\ -e_1^2+\tilde{e}_1^2\frac{(1+\eta\tilde{e}_1)^2}{(1+\eta e_1)^2} & -1 \end{vmatrix}}{\begin{vmatrix} \frac{\eta\tilde{e}_1(1+\eta\tilde{e}_1)^2-[(1+\eta\tilde{e}_1)(1+\eta e_1)+\eta e_1(1+2\eta e_1)](1+\eta e_1)}{\left(1+\eta e_1^*\theta\right)^2} & -\frac{\eta\theta\left\{e_1^2\eta+\tilde{e}_1^2\eta+2(e_1+\tilde{e}_1)(1+\eta\tilde{e}_1)\right\}+(1+2\eta\tilde{e}_1)}{(1+\eta e_1)} \\ -e_1^2+\tilde{e}_1^2\frac{(1+\eta\tilde{e}_1)^2}{(1+\eta e_1)^2} & \frac{2\tilde{e}_1(e_1-\tilde{e}_1)(1+2\tilde{e}_1)}{(1+\eta e_1)} \end{vmatrix}}$$

This is negative, since the denominator is negative and the numerator, which equals

$$\frac{[(1+\eta\tilde{e}_1)(1+\eta e_1)+\eta e_1(1+2\eta e_1)](1+\eta e_1)-\eta\tilde{e}_1(1+\eta\tilde{e}_1)^2}{(1+\eta e_1)^2},$$

is positive.

Therefore,

$$\frac{dw_1}{d(\delta\pi_2)} < 0.$$

If $\delta\pi_1 = 0$, $b_1 = 0$, and π_1 is maximized by setting $w_1 = w_2$. Therefore, $w_1 < w_2$ given $\delta\pi_1 > 0$.

■

Proof of Lemma 11 The principal maximizes Π_1, subject to (IC) and (DE) constraints for every period, $U_t(\mathscr{H}^{t,A^*}) = U_t(\mathscr{H}^{t-1,A-cheat})$

$$b_t - c(e_t) + \eta w_t^{nd} e_t \theta + \delta U_{t+1}(\mathscr{H}^{t,A^*})$$

$$\geq -c(\tilde{e}_t) + \eta w_t^{nd} \tilde{e}_t \theta + \delta U_{t+1}(\mathscr{H}^{t,A-cheat}) \quad \text{(IC)}$$

$$-b_t + \delta \Pi_{t+1}(\mathscr{H}^{t,P^*}) \geq 0. \quad \text{(DE)}$$

After the principal deviates (downwards), η drops to zero, and continuation payoffs of principal and agent are zero. For this proof, I focus on deviations by the agent, hence assume (DE) constraints hold on and off the equilibrium path and η remains constant. I only have to take care of the possibility of upward deviations by the principal (i.e., increasing future payments of w_t^{nd} after a deviation by the agent), which do not reduce η. If these upward deviations are optimal off the equilibrium path, they affect the size of $U_{t+1}(\mathscr{H}^{t,A-cheat})$ and hence the agent's incentives to provide equilibrium effort.

First, it is without loss of generality to set $w_t^d = 0$ after all histories: Assume there is a profit-maximizing equilibrium with $w_t^d > 0$. Reducing it to zero and increasing b_{t-1} by δw_t^d leaves all payoffs and constraints unaffected, thus there exists another profit-maximizing equilibrium with $w_t^d = 0$ in all periods t and for all histories. In the following, I consider such an equilibrium.

Second, w_t^{nd} is – by definition – independent of the agent's past effort choices. Thus, I need to prove consistency in the sense that it is indeed optimal for the principal to not change w_t^{nd} after a deviation by the agent. In this respect, I assume that all w_t^{nd} in a profit-maximizing relational contract are (weakly) smaller than the wage in a reciprocity spot contract and later verify that this is indeed optimal (see Proposition 1). Then, firing the agent after he did not perform accordingly is *not* subgame perfect and can thus be ruled out as a potential response of the principal. The reason is that, with non-discretionary wages not exceeding the profit-maximizing wage in a reciprocity spot contract, the principal makes positive profits even if no relational incentives are provided on top (if some w_t^{nd} were larger, I would have to check whether spot contracts with "too high" wages still generate positive profits). This also implies that the principal does not lower non-discretionary wages after a deviation by the agent.

Third, I need to verify that increasing w^{nd} after a deviation by the agent is not optimal (otherwise, a deviation might increase the agent's continuation utility and consequently his incentives to deviate). But this follows from the definition of w_t^{nd}, which states that the agent only reciprocates to wage components that are independent of the agent's past effort, hence increasing the wage after a deviation of the agent would not induce a stronger reciprocal reaction.

All this implies that $U_{t+1}(\mathscr{H}^{t,A-cheat})$ contains the same non-discretionary wage stream $\left\{w_\tau^{nd}\right\}_{\tau=t+1}^T$ as $U_{t+1}(\mathscr{H}^{t,A^*})$. Moreover, I can set $U_{t+1}(\mathscr{H}^{t,A-cheat}) = \sum_{\tau=t+1}^T \delta^{\tau-t}\left(w_\tau^{nd} - c(\tilde{e}_\tau) + \eta w_\tau^{nd}\tilde{e}_\tau\theta\right)$, which corresponds to the agent's minmax payoff given $\left\{w_\tau^{nd}\right\}_{\tau=t}^T$ (and provided $w_t \geq 0$, which rules out negative upfront payments to extract the agent's "reciprocity rent). The reason is that, using standard arguments, a series of spot contracts always constitutes an equilibrium of such a finitely repeated game.

Fourth, I show that for given values w_t^{nd} and e_t, it is (weakly) optimal for the principal to set $b_t - c(e_t) + \eta w_t^{nd} e_t\theta = -c(\tilde{e}_t) + \eta w_t^{nd}\tilde{e}_t\theta$ in all periods. To do so, I proceed sequentially and start with period $t = 1$:

- Assume $b_1 - c(e_t) + \eta w_1^{nd} e_1\theta > -c(\tilde{e}_t) + \eta w_1^{nd}\tilde{e}_1\theta$. Reduce b_1 by a small $\varepsilon > 0$, which increases Π_1 and relaxes the first-period (DE) constraint.

- Assume $b_1 - c(e_t) + \eta w_1^{nd} e_1\theta < -c(\tilde{e}_t) + \eta w_1^{nd}\tilde{e}_1\theta$. Because $w^d = 0 \forall t$, the (IC) constraint for period $t = 1$ requires at least one period $\tau > 1$ in which $b_\tau - c(e_\tau) + \eta w_\tau^{nd} e_\tau\theta > -c(\tilde{e}_\tau) + \eta w_\tau^{nd}\tilde{e}_\tau\theta$. Assume τ_1 is the first of these periods. Reduce b_{τ_1} by $\varepsilon > 0$ and increase b_1 by $\delta^{\tau_1-1}\varepsilon$. Proceed until either $b_1 - c(e_1) + \eta w_1^{nd} e_1\theta = -c(\tilde{e}_1) + \eta w_1^{nd}\tilde{e}_1\theta$ or $b_{\tau_1} - c(e_{\tau_1}) + \eta w_{\tau_1}^{nd} e_{\tau_1}\theta = -c(\tilde{e}_{\tau_1}) + \eta w_{\tau_1}^{nd}\tilde{e}_{\tau_1}\theta$. In the latter case, move to the second period $\tau_2 > \tau_1$ in which $b_{\tau_2} - c(e_{\tau_2}) + \eta w_{\tau_2}^{nd} e_{\tau_2}\theta > -c(\tilde{e}_{\tau_2}) + \eta w_{\tau_2}^{nd}\tilde{e}_{\tau_2}\theta$ (such a period must exist as long as $b_1 - c(e_1) + \eta w_1^{nd} e_1\theta < -c(\tilde{e}_1) + \eta w_1^{nd}\tilde{e}_1\theta$), reduce b_{τ_2} by $\varepsilon > 0$ and increase b_1 by $\delta^{\tau_2-1}\varepsilon$, and so on. Continue until $b_1 - c(e_1) + \eta w_1^{nd} e_1\theta = -c(\tilde{e}_1) + \eta w_1^{nd}\tilde{e}_1\theta$.

In period $t = 2$, proceed accordingly if $b_2 - c(e_2) + \eta w_2^{nd} e_2\theta \neq 0$, as well as in all subsequent periods.

It follows that $u_t = w_t^{nd} + b_t - c(e_t) + \eta w_t^{nd} e_1\theta = w_t^{nd} - c(\tilde{e}_t) + \eta w_t^{nd}\tilde{e}_t\theta$, and consequently that $U_t(\mathscr{H}^{t-1,A^*}) = U_t(\mathscr{H}^{t-1,A-cheat})$ in all periods t, and that all (IC) constraints hold as equalities.

Finally, these results imply that there exists a sequentially optimal profit-maximizing equilibrium, in the sense that maximizing Π_1 is equivalent to maximizing each per-period profit π_t, subject to (DE) and binding (IC) constraints. This is because the agent's incentives to exert effort in any period t are solely determined by payments made in period t, w_t^{nd} and b_t. There, b_t is bounded by the principal's future payoff stream, thus maximizing each π_t ceteris paribus maximizes Π_1, but also yields the largest maximum feasible value of b_t without adverse effect on (IC) constraints.

■

Proof of Lemma 12 If the (DE) constraint does not bind in a period t, the principal maximizes profits $\pi_t = e_t\theta - c(e_t) + c(\tilde{e}_t) + \eta w_t \theta (e_t - \tilde{e}_t) - w_t$, subject to $w_t \geq 0$, where $\tilde{e}_t$ is characterized by $-c'(\tilde{e}_t) + \eta w_t \theta = 0$.

First ignoring the non-negativity constraint on w_t, first order conditions are

$$\begin{aligned}
&\theta - c'(e_t) + \eta w_t \theta = 0 \\
&\left(c'(\tilde{e}_t) - \eta w_t \theta\right) \frac{d\tilde{e}_t}{dw_t} + \eta \theta (e_t - \tilde{e}_t) - 1 \\
&= \eta \theta (e_t - \tilde{e}_t) - 1 = 0.
\end{aligned}$$

Since the second-order partial derivatives, $\partial^2 \pi_t / \partial e_t^2$ and $\partial^2 \pi_t / \partial w_t^2$, are negative, this problem cannot have a minimum. Therefore, if $\frac{\partial \pi_t}{\partial w_t} |_{w_t=0}$ (evaluated at the effort level obtained by the first-order condition) is non-positive, the optimal wage is zero; if it is strictly positive, the optimal wage is positive as well:

$$\frac{\partial \pi_t}{\partial w_t} |_{w_t=0} = \eta \theta (e_t - \tilde{e}_t) - 1 = \eta \theta e_t - 1,$$

where e_t is characterized by $\theta - c'(e_t) = 0$. Thus, $\eta \theta e_t - 1$ is increasing in η; it is positive for large η and negative for small η, which confirms the existence of $\overline{\eta}$. If $c(e) = e^3/3$ and $\theta = 1$ (then, $\theta - c'(e) = 0 \Leftrightarrow e = 1$), $\eta \theta e - 1 = \eta - 1$, yielding the threshold $\overline{\eta} = 1$ (Lemma 1).

■

Proof of Lemma 13 Including the respective (DE) constraints, the Lagrange function of the principal's maximization problem in a period t becomes

$$\begin{aligned}
L_t = {} & e_t\theta - c(e_t) + c(\tilde{e}_t) + \eta w_t \theta (e_t - \tilde{e}_t) - w_t \\
& + \lambda_{DE_t} \left[\delta \Pi_{t+1} + c(\tilde{e}_t) - \eta w_t \theta \tilde{e}_t - c(e_t) + \eta w_t \theta e_t\right] + w_t \lambda_{w_t},
\end{aligned}$$

where $\lambda_{w_t} \geq 0$ represents the Lagrange multiplier for the agent's limited liability constraint and $\lambda_{DE_t} \geq 0$ represents the Lagrange multiplier for the principal's dynamic enforcement constraint.

First-order conditions are

$$\theta + \left(\eta w_t \theta - c'(e_t)\right)(1 + \lambda_{DE_t}) = 0$$
$$\eta\theta\,(e_t - \tilde{e}_t)(1 + \lambda_{DE_t}) - 1 + \lambda_{w_t} = 0,$$

where the latter yields $e_t > \tilde{e}_t$ (unless $e_t = \tilde{e}_t = 0$).

Solving the first condition for $1 + \lambda_{DE_t}$ and plugging this into the second condition yields

$$\lambda_{w_t} = \frac{(c'(e_t) - \eta w_t \theta) - \eta\theta^2\,(e_t - \tilde{e}_t)}{(c'(e_t) - \eta w_t \theta)}$$

The denominator is positive because $e_t > \tilde{e}_t$, thus

$$\lambda_{w_t} > 0 \Leftrightarrow \frac{c'(e_t)}{e_t\theta^2} \equiv \tilde{\eta} > \eta, \text{ with}$$
$$\frac{d\tilde{\eta}}{de_t} = \frac{c''(e_t)e_t - c'(e_t)}{e_t^2\theta^2} > 0,$$

where the inequality follows from $c''' > 0$.

With $w_t = 0$, profits are constrained by $\delta\Pi_{t+1} - c(e_t) \geq 0$, with $\theta - c'(e_t) = 0$ if the constraint does not bind and $\theta - c'(e_t) > 0$ if it does. In the latter case e_t is strictly increasing in $\delta\Pi_{t+1}$. Therefore, $\tilde{\eta} < \bar{\eta}$, with $\tilde{\eta}$ increasing in continuation profits $\delta\Pi_{t+1}$.

■

Proof of Proposition 4. First, I demonstrate that profits are increasing in η. In Lemma 10, I have shown that $d\pi_T/d\eta > 0$. In any earlier period, profits are $\pi_t = e_t\theta - c(e_t) - w_t + c(\tilde{e}_t) + \eta w_t \theta\,(e_t - \tilde{e}_t)$. Keeping wage, bonus, and equilibrium effort fixed, an increase in η would yield higher profits:

$$\frac{\partial \pi_t}{\partial \eta} = \left(c'(\tilde{e}_t) - \eta w_t \theta\right)\frac{\partial \tilde{e}_t}{\partial \eta} + w_t\theta\,(e_t - \tilde{e}_t) = w_t\theta\,(e_t - \tilde{e}_t) \geq 0.$$

Thus, also if wage, bonus, and/or effort are adapted in response, profits (weakly) have to go up. Moreover, higher future profits relax the (DE) constraint for period t. Further taking into account the results of Lemmas 12 and 13, the following holds:

$$\frac{d\pi_t}{d\eta} \begin{cases} = 0 & \text{if } \eta < \bar{\eta} \text{ and (DEt) is slack} \\ > & \text{otherwise.} \end{cases}$$

Therefore, in all periods t,

$$\frac{d\Pi_t}{d\eta} > 0.$$

This has the following consequences for equilibrium effort. If $\eta < \bar{\eta}$ and (DEt) is slack, $de_t/d\eta = 0$. If $w_t = 0$ and (DEt) binds, effort is characterized by $\delta\Pi_{t+1} - c(e_t) = 0$ and strictly increases in η. If $w_t > 0$ and (DEt) is slack, effort and wage are characterized by

$$\theta - c'(e) + \eta w\theta = 0$$
$$\eta\theta\,(e - \tilde{e}) - 1 = 0.$$

Then,

$$\frac{de^{FB}}{d\eta} = \frac{\begin{vmatrix} -w\theta & \eta\theta \\ -\theta\,(e-\tilde{e}) & -\eta\theta\frac{d\tilde{e}}{dw} \end{vmatrix}}{\begin{vmatrix} -c''(e) & \eta\theta \\ \eta\theta & -\eta\theta\frac{d\tilde{e}}{dw} \end{vmatrix}}$$
$$= \frac{w\eta^2\theta^2 + c''(\tilde{e})}{\eta^2\theta\,(c''(e) - c''(\tilde{e}))} > 0.$$

If $w_t > 0$ and (DEt) binds, effort and wage are characterized by

$$\eta\theta^2\,(e_t - \tilde{e}_t) - c'(e_t) + \eta w_t\theta = 0$$
$$\delta\Pi_{t+1} + c(\tilde{e}_t) - \eta w_t\theta\tilde{e}_t - c(e_t) + \eta w_t\theta e_t = 0.$$

Then,

$$\frac{de_t}{d\eta} = \frac{\begin{vmatrix} -\left[\theta^2 (e_t - \tilde{e}_t) - \eta\theta^2 \frac{\partial \tilde{e}_t}{\partial \eta} + w_t\theta\right] & -\eta\theta^2 \frac{d\tilde{e}_t}{dw_t} + \eta\theta \\ -\left[\frac{d\delta\Pi_{t+1}}{d\eta} + w_t\theta (e_t - \tilde{e}_t)\right] & \eta\theta (e_t - \tilde{e}_t) \end{vmatrix}}{\begin{vmatrix} \eta\theta^2 - c''(e_t) & -\eta\theta^2 \frac{d\tilde{e}_t}{dw_t} + \eta\theta \\ -c'(e_t) + \eta w_t\theta & \eta\theta (e_t - \tilde{e}_t) \end{vmatrix}}$$

$$= \frac{\eta\theta^3 (e_t - \tilde{e}_t)^2 + \frac{d\delta\Pi_{t+1}}{d\eta}\eta\theta \left(\frac{\eta\theta^2 - c''(\tilde{e}_t)}{c''(\tilde{e}_t)}\right)}{\eta\theta (e_t - \tilde{e}_t)\left[c''(e_t) - \eta\theta^2 + \eta\theta^2 \frac{\eta\theta^2 - c''(\tilde{e}_t)}{c''(\tilde{e}_t)}\right]} > 0.$$

■

References

Abreu, D. (1988). On the theory of infinitely repeated games with discounting. *Econometrica*, 56(2):383–396.

Ahammer, A., Fahn, M., Grübl, D., and Winter-Ebmer, R. (2022). Layoffs and motivation.

Akerlof, G. A. (1982). Labor contracts as partial gift exchange. *Quarterly Journal of Economics*, 97(4):543–569.

Akerlof, R., Ashraf, A., Macchiavello, R., and Rabbani, A. (2021). Layoffs and productivityat a bangladeshi sweater factory.

Al-Ubaydli, O., Andersen, S., Gneezy, U., and List, J. A. (2015). Carrots that look like sticks: Toward an understanding of multitasking incentive schemes. *Southern Economic Journal*, 81(3):538–561.

Andreoni, J. (1989). Giving with impure altruism: Applications to charity and ricardian equivalence. *Journal of Political Economy*, 97(6):1447–1458.

Becker, G. S. (1974). A theory of social interactions. *Journal of Political Economy*, 82(6):1063–1093.

Bernheim, B. D. and Rangel, A. (2004). Addiction and cue-triggered decision processes. *American Economic Review*, 94(5):1558–1590.

Bewley, T. F. (1999). *Why Wages Don't Fall During a Recession*. Harvard Univ. Press.

Bolton, G. E., Brandts, J., Katok, E., Ockenfels, A., and Zwick, R. (2008). Chapter 55 testing theories of other-regarding behavior: A sequence of four laboratory studies. volume 1 of *Handbook of Experimental Economics Results*, pages 488–499. Elsevier.

Bolton, G. E., Brandts, J., and Ockenfels, A. (1998). Measuring motivations for the reciprocal responses observed in a simple dilemma game. *Experimental Economics*, 1(3):207–219.

Bolton, G. E. and Ockenfels, A. (2000). Erc: A theory of equity, reciprocity, and competition. *American Economic Review*, 90(1):166–193.

Bolton, G. E. and Ockenfels, A. (2005). A stress test of fairness measures in models of social utility. *Economic Theory*, 25(4):957–982.

Boosey, L. and Goerg, S. (2018). The timing of discretionary bonuses: Effort, signals, and reciprocity. *IZA Discussion Paper No. 11580*.

Brown, M., Falk, A., and Fehr, E. (2004). Relational contracts and the nature of market interactions. *Econometrica*, 72(3):747–780.

Cabral, L., Ozbay, E. Y., and Schotter, A. (2014). Intrinsic and instrumental reciprocity: An experimental study. *Games and Economic Behavior*, 87:100–121.

Camerer, C. and Weber, R. (2013). Experimental organizational economics. In Gibbons, R. and Roberts, J., editors, *The Handbook of Organizational Economics*, pages 213–262. Princeton University Press.

Cascio, W. F. (1993). Downsizing: What do we know? what have we learned? *Academy of Management Perspectives*, 7(1):95–104.

Chen, Y., Cramton, P., List, J. A., and Ockenfels, A. (2021). Market design, human behavior, and management. *Management Science*, 67(9):5317–5348.

Cho, I.-K. and Kreps, D. M. (1987). Signaling games and stable equilibria. *The Quarterly Journal of Economics*, 102(2):179–221.

Cox, J. C., Friedman, D., and Gjerstad, S. (2007). A tractable model of reciprocity and fairness. *Games and Economic Behavior*, 59(1):17 – 45.

Cox, J. C., Friedman, D., and Sadiraj, V. (2008). Revealed altruism. *Econometrica*, 76(1):31–69.

Danilov, A. and Sliwka, D. (2017). Can contracts signal social norms? experimental evidence. *Management Science*, 63(2):459–476.

DellaVigna, S. (2009). Psychology and economics: Evidence from the field. *Journal of Economic Literature*, 47(2):315–372.

DellaVigna, S., List, J. A., Malmendier, U., and Rao, G. (2019). Estimating social preferences and gift exchange with a piece-rate design. *Unpublished Working Paper*.

DellaVigna, S. and Pope, D. (2018). What Motivates Effort? Evidence and Expert Forecasts. *The Review of Economic Studies*, 85(2):1029–1069.

DeVaro, J., Kim, J.-H., and Vikander, N. (2018). Non-performance pay and relational contracting: Evidence from ceo compensation. *The Economic Journal*, 128(613):1923–1951.

Dohmen, T., Falk, A., Huffman, D., and Sunde, U. (2009). Homo reciprocans: Survey evidence on behavioural outcomes. *Economic Journal*, 119(536):592–612.

Dreber, A., Fudenberg, D., and Rand, D. G. (2014). Who cooperates in repeated games: The role of altruism, inequity aversion, and demographics. *Journal of Economic Behavior & Organization*, 98:41–55.

Dufwenberg, M., Heidhues, P., Kirchsteiger, G., Riedel, F., and Sobel, J. (2011). Other-regarding preferences in general equilibrium. *The Review of Economic Studies*, 78(2):613–639.

Dufwenberg, M. and Kirchsteiger, G. (2004). A theory of sequential reciprocity. *Games and Economic Behavior*, 47(2):268–298.

Dur, R. and Tichem, J. (2015). Altruism and relational incentives in the workplace. *Journal of Economics & Management Strategy*, 24(3):485–500.

Eliaz, K. and Spiegler, R. (2018). Managing intrinsic motivation in a long-run relationship. *Economics Letters*, 165:6–9.

Englmaier, F. and Leider, S. (2012a). Contractual and organizational structure with reciprocal agents. *American Economic Journal: Microeconomics*, 4(2):146–183.

Englmaier, F. and Leider, S. (2012b). Gift exchange in the lab - it is not (only) how much you give ... *Working Paper*.

Fahn, M. and Hakenes, H. (2019). Teamwork as a Self-Disciplining Device. *American Economic Journal: Microeconomics*.

Fahn, M. and Klein, N. (2019). Relational contracts with private information on the future value of the relationship: The upside of implicit downsizing costs. *American Economic Journal: Microeconomics*, 11(4):33–58.

Fahn, M., Schade, A., and Schuessler, K. (2017). What drives reciprocal behavior? the optimal provision of incentives over the course of careers. *CESifo Working Paper No. 6635*.

Fahn, M. and Zanarone, G. (2021). Pay transparency under subjective performance evaluation. *Unpublished Working Paper*.

Falk, A., Fehr, E., and Fischbacher, U. (2008). Testing theories of fairness – intentions matter. *Games and Economic Behavior*, 62(1):287–303.

Falk, A. and Fischbacher, U. (2006a). A theory of reciprocity. *Games and Economic Behavior*, 54(2):293–315.

Falk, A. and Fischbacher, U. (2006b). A theory of reciprocity. *Games and Economic Behavior*, 54(2):293–315.

Fehr, E., Brown, M., and Zehnder, C. (2009a). On reputation: A microfoundation of contract enforcement and price rigidity. *Economic Journal*, 119(536):333–353.

Fehr, E. and Fischbacher, U. (2002). Why social preferences matter – the impact of non-selfish motives on competition, cooperation and incentives. *The Economic Journal*, 112(478):C1–C33.

Fehr, E., Goette, L., and Zehnder, C. (2009b). A behavioral account of the labor market: The role of fairness concerns. *Annual Review of Economics*, 1(1):355–384.

Fehr, E., Kirchsteiger, G., and Riedl, A. (1993). Does fairness prevent market clearing? An experimental investigation. *Quarterly Journal of Economics*, 108(2):437–459.

Fehr, E., Kirchsteiger, G., and Riedl, A. (1998). Gift exchange and reciprocity in competitive experimental markets. *European Economic Review*, 42(1):1–34.

Fehr, E. and Schmidt, K. (2006). The economics of fairness, reciprocity and altruism – experimental evidence and new theories. In Kolm, S. and Ythier, J., editors, *Handbook on the Economics of Giving, Reciprocity and Altruism*, pages 615–691. Amsterdam: Elsevier.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, 114(3):817–868.

Frederiksen, A., Lange, F., and Kriechel, B. (2017). Subjective performance evaluations and employee careers. *Journal of Economic Behavior Organization*, 134:408 – 429.

Gibbons, R. and Henderson, R. (2012). *What Do Managers Do?: Exploring Persistent Performance Differences among Seemingly Similar Enterprises*, pages 680–731. Princeton University Press.

Gibbons, R. and Murphy, K. J. (1992). Optimal incentive contracts in the presence of career concerns: Theory and evidence. *Journal of Political Economy*, 100(3):468–505.

Gneezy, U. and List, J. A. (2006). Putting behavioral economics to work: Testing for gift exchange in labor markets using field experiments. *Econometrica*, 74(5):1365–1384.

Halonen-Akatwijuka, M. and Hart, O. (2020). Continuing Contracts. *The Journal of Law, Economics, and Organization*, 36(2):284–313.

Haltiwanger, J. C., Lane, J. I., and Spletzer, J. R. (1999). Productivity differences across employers: The roles of employer size, age, and human capital. *The American Economic Review*, 89(2):94–98.

Hart, O. and Moore, J. (2008). Contracts as reference points. *The Quarterly Journal of Economics*, 123(1):1–48.

Hayes, R. M. and Schaefer, S. (2000). Implicit contracts and the explanatory power of top executive compensation for future performance. *The RAND Journal of Economics*, 31(2):273–293.

Heinz, M., Jeworrek, S., Mertins, V., Schumacher, H., and Sutter, M. (2020). Measuring the Indirect Effects of Adverse Employer Behaviour on Worker Productivity: a field Experiment. *The Economic Journal*, 130(632):2546–2568.

Hennig-Schmidt, H., Rockenbach, B., and Sadrieh, A. (2010). In search of workers' real effort reciprocity – a field and a laboratory experiment. *Journal of the European Economic Association*, 8(4):817–837.

Jayaraman, R., Ray, D., and de Véricourt, F. (2016). Anatomy of a contract change. *American Economic Review*, 106(2):316–58.

Kampkötter, P. and Sliwka, D. (2016). On the complementary use of experiments and field data to evaluate management practices - the case of subjective performance evaluations. *Journal of Institutional and Theoretical Economics*, 172(2):364–389.

Kessler, J. B. and Leider, S. (2012). Norms and contracting. *Management Science*, 58(1):62–77.

Kimbrough, E. O. and Vostroknutov, A. (2016). Norms make preferences social. *Journal of the European Economic Association*, 14(3):608 – 638.

Kölle, F., Quercia, S., and Tripodi, E. (2020). Social preferences under the shadow of the future. *Unpublished Working Paper*.

Kragl, J. and Schmid, J. (2009). The impact of envy on relational employment contracts. *Journal of Economic Behavior Organization*, 72(2):766 – 779.

Kreps, D., Milgrom, P., Roberts, J., and Wilson, R. (1982). Rational cooperation in the finitely repeated prisoners' dilemma. *Journal of Economic Theory*, 27(2):245–252.

Krupka, E. L., Leider, S., and Jiang, M. (2017). A meeting of the minds: Informal agreements and social norms. *Management Science*, 63(6):1708–1729.

Lallemand, T. and Rycx, F. (2009). Are Young and Old Workers Harmful for Firm Productivity? Technical report.

Landmann, A. and Vollan, B. (2020). Pro-sociality of democratic leaders: Evidence from village elections in the philippines. *Unpublished Working Paper*.

Levin, J. (2002). Multilateral contracting and the employment relationship. *The Quarterly Journal of Economics*, 117(3):1075–1103.

Levin, J. (2003). Relational incentive contracts. *American Economic Review*, 93(3):835–857.

Macleod, W. B. (2003). Optimal contracting with subjective evaluation. *American Economic Review*, 93(1):216–240.

MacLeod, W. B. (2007). Can contract theory explain social preferences? *American Economic Review*, 97(2):187–192.

MacLeod, W. B. and Malcomson, J. M. (1989). Implicit contracts, incentive compatibility, and involuntary unemployment. *Econometrica*, 57(2):447–480.

MacLeod, W. B., Malcomson, J. M., and Gomme, P. (1994). Labor turnover and the natural rate of unemployment: Efficiency wage versus frictional unemployment. *Journal of Labor Economics*, 12(2):276–315.

MacLeod, W. B., Valle Lara, V., and Zehnder, C. (2020). Worker empowerment and subjective evaluation: On building an effective conflict culture. *Unpublished Working Paper*.

Macneil, I. R. (1980). *The New Social Contract*. Yale University Press: New Haven.

Macneil, I. R. (1983). Values in contract: Internal and external. *Northwestern University Law Review*, 78:340–418.

Mailath, G. J. and Samuelson, L. (2006). *Repeated games and reputations: Long-run relationships*. Oxford University Press.

Malcomson, J. M. (2012). Relational incentive contracts. In Gibbons, R. and Roberts, J., editors, *The Handbook of Organizational Economics*, pages 1014 – 1065. Princeton University Press.

Malcomson, J. M. (2013). Relational incentive contracts. In Gibbons, R. and Roberts, J., editors, *The Handbook of Organizational Economics*, pages 1014 – 1065. Princeton University Press.

Malmendier, U. and Schmidt, K. M. (2017). You owe me. *American Economic Review*, 107(2):493–526.

Netzer, N. and Schmutzler, A. (2014). Explaining gift-exchange - the limits of good intentions. *Journal of the European Economic Association*, 12(6):1586–1616.

Peysakhovich, A. and Rand, D. G. (2016). Habits of virtue: Creating norms of cooperation and defection in the laboratory. *Management Science*, 62(3):631–647.

Prendergast, C. (1999). The provision of incentives in firms. *Journal of Economic Literature*, 37(1):7–63.

Rabin, M. (1993). Incorporating fairness into game theory and economics. *American Economic Review*, 83(5):1281–1302.

Reuben, E. and Suetens, S. (2012). Revisiting strategic versus non-strategic cooperation. *Experimental Economics*, 15(1):24–43.

Schmidt, K. M. (2011). Social preferences and competition. *Journal of Money, Credit and Banking*, 43(1):207–231.

Segal, U. and Sobel, J. (2007). Tit for tat: Foundations of preferences for reciprocity in strategic settings. *Journal of Economic Theory*, 136(1):197 – 216.

Skirbekk, V. (2004). Age and individual productivity: A literature survey. *Vienna Yearbook of Population Research*, 2:133–153.

Sliwka, D. and Werner, P. (2017). Wage increases and the dynamics of reciprocity. *Journal of Labor Economics*, 35(2):299–344.

Sobel, J. (2005). Interdependent preferences and reciprocity. *Journal of Economic Literature*, 43(2):392–436.

Yellen, J. L. (1984). Efficiency Wage Models of Unemployment. *American Economic Review*, 74(2):200–205.