Teamwork as a Self-Disciplining Device*

Matthias Fahn†
Ludwig Maximilian University of Munich

Hendrik Hakenes‡
University of Bonn, CEPR, MPI Bonn

May 6, 2014

Abstract

This paper shows that team formation can serve as an implicit commitment device to overcome problems of procrastination and self-control. In a situation where individuals have present-biased preferences, any effort that is costly today but rewarded at some later point in time is too low from the perspective of *earlier* periods. If agents interact repeatedly and can monitor each other, a relational contract involving teamwork can help to improve an agent's performance. The mutual promise to work harder is credible because an agent's punishment following a deviation – a reversion to individual (under-) production in the future – is rather unattractive from today's perspective. This holds even though the standard free-rider problem is present and teamwork renders no technological benefits. Moreover, we show that even if teamwork renders technological benefits, the performance of a team of agents with self-control problems can actually be better than the performance of a team of "normal" (fully time-consistent) agents.

Keywords: Procrastination, Hyperbolic Discounting, Self-Control Problems, Teamwork, Relational Contracts.

JEL-Classification: L22, L23.

---

*This is a preliminary version. We thank Florian Englmaier, Marina Halac, Fabian Herweg, Thomas Kittsteiner, Svetlana Katolnik, Daniel Krähmer, Matthias Kräkel, Takeshi Murooka, Muriel Niederle and Mike Powell, as well as seminar participants at the LMU Munich, the 17th Colloquium on Personnel Economics (Cologne) and the 18th SFB/TR 15 meeting (Mannheim) for helpful comments. All errors are our own.

†LMU Munich, Chair of Organizational Economics, Kaulbachstr. 45, 80539 München, Germany, matthias.fahn@econ.lmu.de.

‡Institute of Finance and Statistics, Adenauerallee 24-42, 53113 Bonn, hakenes@uni-bonn.de.

Remember teamwork begins by building trust. And the only way to do that is to overcome our need for invulnerability.

Patrick Lencioni, The Five Dysfunctions of a Team: A Leadership Fable

1 Introduction

Teams are formed in all kinds of circumstances. They can be found within firms to tackle complicated problems, academics have co-authors to jointly work on research projects, lawyers or doctors form partnerships, and potential entrepreneurs start a firm with friends instead of pursuing their ideas alone.[1] Due to its importance, economists have widely analyzed teamwork, thereby mainly focussing on two conflicting aspects. On the one hand, technological benefits and specialization render teamwork necessary in situations that involve complex or risky tasks. On the other hand, teamwork is associated with a free-rider problem: Because each member's contribution is a public good, an underprovision of contributions can result (see Alchian and Demsetz, 1972). Starting with Holmstrom (1982) – who shows in a static setting that the first-best is impossible to reach if no surplus is destroyed – the literature has tried to identify ways to overcome this public good problem. More recently, benefits of teamwork different from technological aspects have come into focus.[2] For example, internal monitoring and peer pressure can foster cooperation within a team and consequently increase productivity (Baron and Kreps, 1999).

This paper derives another inherent – and rather intuitive – benefit of teams: Driven by repeated interaction and mutual monitoring, teamwork can also boost motivation and help to overcome problems of self-control and procrastination. In a situation where individuals have present-biased preferences, any effort that is costly today but rewarded at some later point in time is too low from the perspective of *earlier* periods. As an example, take our daily work on research projects. Many distractions keep us from being focused and motivated – in particular since most of the rewards of doing research are not realized immediately (we all know how long it can take until an article is published). There are ways to increase our commitment, like conference deadlines or tools that temporarily block access to distracting websites. Arguably the mostly used remedy to tackle motivational issues is the collaboration with co-authors. Besides spurring our creativity and plenty other advantages, such a cooperation can also serve as a commitment device to overcome self-control problems. Promises made to our co-authors motivate us, in particular if we also want to work with them in the future. Formally, we show that cooperation in teams can be

[1]Lazear and Shaw (2007) show that almost all US firms use teams in one form or the other.

[2]Outside economics these aspects have been analyzed for much longer.

enforced – even though the standard free-rider problem is present and teamwork renders no technological benefits – because an agent's outside option after a deviation, a reversion to individual (under-) production in the future, is rather unattractive from today's perspective. We also show that even if teamwork renders technological benefits, the performance of a team of agents with self-control problems can actually be better than the performance of a team of "normal" (fully time-consistent) agents.

Empirical research on teamwork shows that the free-rider problem indeed is an issue. Encinosa, Gaynor, and Rebitzer (2007) analyze the behavior of medical groups and show that it reduces productivity in teams. Nalbantian and Schotter (1997) compute lab experiments and show that free-riding problems are prevalent in teams and reduce productivity. Erev, Bornstein, and Galili (1993) use real-world experiments involving picking oranges. There, group compensation is associated with a 30% lower production than individual compensation.

However, there also is plenty of evidence that teamwork can be beneficial even in the absence of exogenous technological benefits. Hamilton, Nickerson, and Owan (2003) show that a switch from individual- to team-output contracts in a garment firm improved worker productivity by 14%. Chan, Li, and Pierce (2012); Pizzini (2010) observe similar results in field experiments. In Jones, Kalmi, and Kauhanen (2010), the introduction of teamwork in a Finnish food-processing plant had a substantially positive impact on workers' efficiency, but only if combined with a group system of performance-related pay.

A potential explanation for inherent benefits of teamwork is the existence of peer pressure and internal monitoring in repeated interactions. This is supported by Mas and Moretti (2009), who show that a worker's productivity in a team is increased if he can be seen by another worker, in particular if both interact frequently. Furthermore, the availability of peers might give rise to a competition effect that can help to overcome self-control problems. Gneezy and Rustichini (2004), for example, provide evidence that young boys run races faster when running with another boy than when running alone.

In this paper, we show that the availability of peers helps to overcome self-control problems not only by competitive means, but that internal monitoring can also induce cooperation. Thereby, we develop an infinite-horizon model of two agents who can repeatedly work on individual projects and have present-biased preferences. Since production is costly today but rewards are realized one period later, an agent works less hard than he would have liked from the perspective of any earlier period. We assume that agents are sophisticated in the sense of O'Donoghue and Rabin (1999), i. e., aware of their time-inconsistency. Furthermore, no exogenous commitment device exists which agents might use to bind their future selves. However, forming a team can serve as an endogenous commitment device to increase individual effort levels. Thereby, agents jointly work on a project, share potential benefits, and make a mututal promise to work harder. Since effort is not verifiable but can only be observed by one's co-worker, the promise to work harder has to be self-enforcing, i. e., optimal from an individual's perspective. This is possible because any deviation is followed by a loss of trust between agents and a reversion to individual production. Future individual production, though, is regarded as suboptimal from an agent's perspective *today*. It is thus possible to enforce higher effort levels within a team, even though the latter is associated with the standard free-rider problem of team production. Since in the benchmark case teamwork renders no technological benefits, teamwork is therefore not possible for "normal" agents with time-consistent preferences. In this case, individual production is already at its first-best as regarded from *any* period, and a deviation therefore not costly. If teamwork is associated with technological benefits (like economies of scale), though – implying that also "normal" agents would rather work within a team than pursuing individual projects – agents with present-biased preferences might actually perform *better*. This is again driven by the lower outside option of hyperbolic agents and holds as long as the technological benefits of teamwork are not too large.

Related Literature. This paper contributes and relates to three strands of literature – team incentives, relational contracts and present-biased preferences. Optimal incentive giving in teams has been widely analyzed (starting with Holmstrom (1982)). This literature, though, mainly assumes that teams are formed exogenously and only joint performance schemes are feasible. Recently, a couple of papers have shown that the underlying free-rider problem can be overcome if team members are able to (partially) observe the performance of their peers and hence form relational contracts with each other. Che and Yoo (2001) show that given a team is formed exogenously, joint performance evaluation might be optimal, even though the principal observes individual performance signals. The resulting free-rider problem can be overcome by peer pressure and mutual monitoring, arising from repeated interaction and a relational contract formed between agents. Kvaløy and Olsen (2006) extend Che and Yoo's paper by assuming that the (imperfect) signal the principal receives is non-verifiable as well, and the relationship between principal and agents is also governed by relational contracts. They identify instances for which joint performance evaluation (compared to relative and independent performance evaluation) is optimal and show that this depends on the interaction between agents' discount factor and agents' productivities. Furthermore, Rayo (2007) derives optimal asset ownership if a verifiable joint performance scheme exists but relational contracts between agents are feasible.[3]

The literature has also identified instances where endogenous team formation can be optimal. Itoh (1991) shows that teamwork may induce agents to help each other. Bar-Isaac (2007) develops a reputational model where it can be optimal to form

[3]Mohnen, Pokorny, and Sliwka (2008) and Bartling (2011) use different arguments than peer pressure and mutual monitoring and show that social preferences can also render joint performance evaluation optimal. There, players' preferences for equal outcomes can channel incentives in a way to overcome the free-rider problem.

a team in order to maintain reputational incentives for older workers who want to sell a firm whose personal reputation is not at stake anymore. Corts (2007) shows that teamwork can help to overcome multitasking problems, by grouping tasks with a lower and those with a higher impact on observable signals. Mukherjee and Vasconcelos (2011) extend Corts' model by assuming that observable signals are not verifiable. Because teamwork requires higher maximum payments, it is also associated with a higher reneging temptation. Hence, teamwork only works if a firm's discount factor is sufficiently large. Extending the literature on endogenous team formation, and using relational contracts between team members as well, we show that teamwork can also enhance productivity if individuals have self-control problems.

Furthermore, we contribute to the literature on inconsistent time preferences and self-control problems. Strotz (1955) is the first to formalize this aspect by noting that an individual's discount rate between two periods might depend on the time of evaluation. He further discusses differences between those who recognize this inconsistency – and hence might try to bind their future selves – and those who do not. Phelps and Pollak (1968) state that in particular growth models should take the possibility of inconsistent time preferences into account as this affects savings. They also develop the base workhorse model to analyze inconsistent time preferences, namely that an individual always gives extra weight to utility now over any future period, but weighs all future instances equally. Laibson (1997) shows that illiquid assets can serve as a commitment device to bind future selves. O'Donoghue and Rabin (1999) focus on the distinction between individuals who are aware of their time inconsistency and those who are not; they label the former "sophisticated" and the latter "naive." They show that sophisticated agents are better off (compared to naive ones) when costs are immediate but rewards delayed, whereas naive agents are generally better off if rewards are immediate but costs delayed.

A huge amount of evidence confirms that people make decisions that are not consistent over time, for example when using credit cards or signing up for health clubs (DellaVigna and Malmendier, 2004, 2006). More recently, experimental evidence from the field and the lab used real-effort tasks to directly identify self-control problems. Kaur, Kremer, and Mullainathan (2010, 2013) perform a field experiment involving full-time workers in an Indian data entry firm. Quantity and quality of output can be easily measured, and workers receive a piece rate. The existence of self-control problems is supported by the observation that workers increase effort as the payday gets closer. In addition, many workers select an offered commitment device that would be dominated for individuals with exponential preferences. Furthermore, Augenblick, Niederle, and Sprenger (2013) perform a real-effort task lab experiment. There, participants show a significant present-bias as well, and many of them demand a binding commitment device if it is offered. Clearly, self-control problems exist. Many people are aware of that and opt for a commitment device whenever available. We contribute to this literature showing that by forming a team, individuals can create an *implicit* commitment device. Thereby, they use the benefits of future cooperation as a collateral to overcome self-control problems. In addition, we show that people with present-biased preferences can actually perform better than those without and – to our knowledge – are the first to derive such a result. It is driven by individuals with self-control problems being hurt more by a breakdown of teamwork.

Finally, we relate to the literature on relational contracts. Relational contracts are implicit arrangements based on observable but non-verifiable information. Theoretical foundations have been laid by Bull (1987) and MacLeod and Malcomson (1989) and later extended for the case with imperfect public monitoring by Levin (2003). This triggered various developments of the baseline model, thereby providing many explanations for real-world phenomena. As in Che and Yoo (2001), we do not analyze relational contracts between a principal and one or many agents, but assume that two identical individuals interact. There, we show that adding behavioral assumptions to relational contracting framework can yield new and interesting implications.

2 The Model

The Economy. Consider two risk-neutral agents $i = \{1, 2\}$ who live for infinitely many periods, $t \in \{0, 1, \ldots\}$. Each agent has access to an inexhaustible amount of projects. At each date, he can work on exactly one. An agent chooses an effort level e_t for his current project (we add an index for the agent when necessary). The payoff at date $t + 1$ equals V with probability e_t, otherwise zero. Hence, an agent can influence his success probability by increasing his effort. Effort leads to an immediate cost $c \cdot e_t^2/2$ at date t, with $c > 0$. Below we will impose further restrictions on c to guarantee interior solutions.

There are no technological linkages of projects across periods. The effort spent on a project in period t does not affect the likelihood that the project is successful in any later period. If an agent finishes one project, or abandons it, he can start a new project.

Agents discount future costs and future utilities in a quasi-hyperbolic way according to Laibson (1997); O'Donoghue and Rabin (1999). Immediate utilities are not discounted. Utilities after t periods are discounted with a factor $\beta\,\delta^t$, with β and δ in $(0; 1]$. Consequently, an agent's preferences are dynamically inconsistent. At date $t = 0$, an agent would pay $\beta\,\delta$ for a dollar at date $t = 1$, and at date $t = 1$ he would pay $\beta\,\delta$ for a dollar at date $t = 2$. However, at date $t = 0$, he would give up $\beta\,\delta^2$ instead of $\beta^2\,\delta^2$ for a dollar at date $t = 2$. In addition, we assume that agents are aware of their time-inconsistency, which according to O'Donoghue and Rabin (1999) is referred to as *sophistication*. In addition, there is no formal device for an agent to commit to any specific effort level.

Organization and Relational Contracts. At the beginning of every period $t \geq 1$, agents decide whether they pursue projects on their own, i.e., engage in individual production, or whether they form a team. The latter implies that both agents jointly work on one project, and that the payoff V – if realized – is shared equally. For now, we assume that there are no economies (or diseconomies) of scale (or scope) from teamwork.[4] The same amount of work can get done and costs of effort are the same. Hence, given agent 1 chooses effort $e_{1,t}$ and agent 2 chooses $e_{2,t}$, the joint expected payoff – realized in period $t+1$ – is $(e_{1,t} + e_{2,t})\,V$, and each expects to receive $(e_{1,t} + e_{2,t})\,V/2$.

Formally, teamwork implies that at the beginning of any period $t \geq 1$, both agents simultaneously decide whether they want to form a team in the respective period or not. Only if both agree, the team is formed and a joint project chosen (since all projects are identical with respect to effort costs, payoffs and success probabilites, any project can be the joint one); otherwise, agents work on individual projects. We assume that in a given period t where a team has been formed, both agents can only work on the joint project, i.e., there is short-term commitment (our results would be qualitatively the same without any commitment of players). Furthermore, starting a team involves an agreement that a realized payoff is shared equally – and this agreement is automatically enforced.[5] After a team has been formed and a joint project chosen, both agents simultaneously make their effort choices.

Only short-term contracts to start a team are feasible. Thereby, it is irrelevant whether this restriction also applies to individual projects or not (i.e., payoffs from a project that has been assigned a team project in a given period might have to be shared in any future period they are realized). It just is impossible to write a profit-sharing agreement involving *all* of an agent's potential projects. In other words, after agents have formed a team in a period t, they are always able to revert to individual production in *future* periods.[6]

Our definition of teamwork is solely made for concreteness. Any arrangement where one agent uses part of his effort in order to benefit the other agent would yield identical results. For example, one agent might directly spend some of his working time on one of the other agent's projects, and vice versa. Agents could also focus on different topics and explain their insights to each other. Plain profit sharing would also be feasible, as well as any combination of these aspects (like sharing the outputs of two projects and alternate working on it).

[4]This assumption is relaxed in section 4 below.

[5]We do not further pursue the exact enforcement mechanism. For example, these contracts could be court-enforceable. Thinking of researchers working on a joint project, enforcement could also be driven by reputational costs if one tried to unilaterally remove the co-author's name from a paper.

[6]Thinking of researchers, one researcher could abandon the project with one co-author and start working on a new project.

Finally, no formal contracts can be used to determine an agent's effort.[7] However, both agents can observe each other's effort, rendering mutual monitoring feasible. This implies that agents can form a relational contract specifying effort levels within the team. This relational contract is formed at the beginning of the game. For any period t, it specifies the actions both agents are supposed to take along the whole path of the game – contingent on the realized history up to period t. The relational contract implicitly determines when a team is supposed to be formed, as well as each agent's effort level on and off the equilibrium path. Both agents' contingent action plans, i.e. their strategies, have to be optimal for any feasible history, i.e., form a subgame perfect equilibrium of the dynamic game. However, given players' time inconsistency, we require a subgame perfect equilibrium to constitute a Nash equilibrium at each subgame, given players' preferences once a respective subgame is reached.

3 Equilibrium

There are two fundamentally different types of equilibrium: one in which agents form teams, and one in which they do not. We discuss both in this order. To make sure that we always have an interior solution, we assume for the remainder of this paper that

$$\frac{\delta V}{c} < \frac{1}{2}.$$

3.1 Individual Production and Self-Control Problems

First, we derive effort levels if agents work on their own. Since there is no commitment on any effort level, an agent decides how much he wants to work at the beginning of any period t, maximizing his discounted utility

$$u_t = \beta \, \delta \, e_t \, V - \frac{c \cdot e_t^2}{2}. \tag{1}$$

The solution to individual production, e^I, is the same in every period and equals

$$e^I = \frac{\beta \, \delta \, V}{c}. \tag{2}$$

In each period, the agent will spend this effort e^I. However, reasoning over how much effort he wants to spend in the future, he would come to a different result.

[7]Our results would still hold if an agent's effort were verifiable – if in that case the punishment after a deviation were restricted.

Thinking at date t how much he wants to work at a future date $\hat{t} > t$, he will maximize

$$\hat{u}_t = \beta\, \delta^{\hat{t}-t} \left(\delta\, e_{\hat{t}}\, V - \frac{c \cdot e_{\hat{t}}^2}{2}\right). \tag{3}$$

For any period $\hat{t} > t$ this is maximized by first-best effort e^{FB}, i.e., by

$$e^{FB} = \frac{\delta\, V}{c}. \tag{4}$$

In other words, the agent is lazy and procrastinates. At any given date t, he plans to relax today ($e_t = e^I$) and work hard starting tomorrow ($e_{\hat{t}} = e^{FB}$ for all $\hat{t} > t$). However, when tomorrow comes, he again opts for an easygoing job that day ($e_{t+1} = e^I$), once more delaying the hard work for the day after.

3.2 Team of Agents

Consider the following relational contract formed at date $t = 0$: In every period $t \geq 0$, the agents form a team involving one joint project on which both work simultaneously. In addition, agent i is supposed to exert team-effort e^T in period t. For tractability, we focus on symmetric equilibria where effort e^T is the same among agents. Furthermore, relational contracts can be stationary, i. e., team-effort is the same in every period,[8] allowing us to omit time subscripts.[9] To support team-effort e^T, we have to specify what happens after a deviation. There are two possibilities for an agent to deviate. First, an agent could refuse to join the team. Second, after forming the team, the agent could provide an effort level different from e^T. Given any such deviation, we follow Abreu (1988) who shows that any observable deviation should be responded by the strongest feasible punishment. In our case, that means that cooperation within the relational contract irretrievably breaks down, and agents could either resume to individual production or stick to teamwork – with effort levels determined by the static Nash equilibrium. Due to the free-rider problem, static Nash effort is one half of indivdiual production. Hence, individual production is preferred by agents compared to teamwork when the static Nash equilibrium is played by both of them.[10]

[8]This is because agents are risk-neutral and information is symmetric. For a further elaboration on this issue see Levin (2003).

[9]However, this does not hold for period $t = 0$, the first period of the game. There, it is optimal for agents to only induce effort levels e^I. Full stationarity, though, could be gained by assuming that production is only possible from period $t = 1$ onwards. Since the exact specification is irrelevant for our main results, the following analysis only considers periods $t \geq 1$.

[10]This is formally shown below, in Lemma 4, and holds as long as teamwork renders no technological benefits. With technological benefits, teamwork – with both agents exerting effort determined by the static Nash equilibrium – might be chosen even after a deviation.

In the following we analyze whether such a relational contract can be sustained as a subgame perfect equilibrium, and in particular whether team effort e^T can exceed the effort level of individual production, e^I or might even reach e^{FB} – the first-best effort as regarded from the point of view of earlier periods. There, note that e^{FB} also is an agent's preferred symmetric future effort level given a team is formed: In a period t and thinking about his preferred effort level at a future date $\hat{t} > t$, he maximizes $\hat{u}_t^T = \beta\,\delta^{\hat{t}-t}\left[\delta\,\left(e_{\hat{t}}^T + e_{\hat{t}}^T\right)V/2 - c\cdot\left(e_{\hat{t}}^T\right)^2/2\right]$, which is solved for e^{FB}.

Now, once a team has been formed and given agents stick to their agreement, an agent's expected discounted utility stream in a period $t \geq 1$ is

$$
\begin{aligned}
U^T &= \beta\,\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2} + \sum_{t=1}^{\infty}\beta\,\delta^t\left(\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2}\right)\\
&= \beta\,\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2} + \frac{\beta\,\delta}{1-\delta}\left(\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2}\right). \qquad (5)
\end{aligned}
$$

U^T can only be enforced by a relational contract if a deviation is never optimal. As laid out above, an agent has two options to deviate. He can either refuse to join the team in a given period, or provide an effort level different from e^T once the team has been formed. Both deviations trigger a break-down of cooperation in all subsequent periods. If an agent refuses to join the team, he will work on an individual project and choose an effort level e^I. Hence, an agent's expected discounted utility stream in the case he refuses to join the team is

$$
\begin{aligned}
U^I &= \beta\,\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2} + \sum_{t=1}^{\infty}\beta\,\delta^t\left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right)\\
&= \beta\,\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2} + \frac{\beta\,\delta}{1-\delta}\left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right). \qquad (6)
\end{aligned}
$$

Joining the team but subsequently deviating in his effort choice, an agent would exert the static Nash effort level (denoted e^N), given the other agent chooses e^T. e^N is obtained by maximizing $-c\cdot(e^N)^2/2+\beta\,\delta\left(e^N+e^T\right)V/2$, which yields $e^N = \beta\,\delta\,V/2\,c$. Afterwards, the team breaks down and both agents work on individual projects from then on. Hence, an agent's expected discounted utility stream given he joins the team but then underprovides effort is

$$
\begin{aligned}
U^D &= \beta\,\delta\left(e^N + e^T\right)\frac{V}{2} - \frac{c\cdot(e^N)^2}{2} + \sum_{t=1}^{\infty}\beta\,\delta^t\left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right)\\
&= \beta\,\delta\left(e^N + e^T\right)\frac{V}{2} - \frac{c\cdot(e^N)^2}{2} + \frac{\beta\,\delta}{1-\delta}\left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right). \qquad (7)
\end{aligned}
$$

To sustain teamwork, an agent's equilibrium utility stream within the team has to be larger than given any possible deviation. Hence, an incentive compatibility (IC) constraint must be satisfied,

$$U^T \geq \max\left\{U^I,\, U^D\right\}. \tag{IC}$$

However, we can show that only for $U^D \geq U^I$ positive effort can be enforced within a team. Otherwise, team-effort would have to be so low that forming a team would in any case be dominated by individual production.

Lemma 1 *For $U^D < U^I$, forming a team cannot be optimal.*

All omitted proofs can be found in the appendix.

Therefore, the (IC) constraint becomes $U^T \geq U^D$, or

$$\begin{aligned} &\left(\beta\,\delta\,e^T\,\frac{V}{2} - \frac{c\cdot(e^T)^2}{2}\right) - \left(\beta\,\delta\,e^N\,\frac{V}{2} - \frac{c\cdot(e^N)^2}{2}\right) \\ +&\frac{\beta\,\delta}{1-\delta}\left[\left(\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2}\right) - \left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right)\right] \geq 0 \end{aligned} \tag{IC}$$

Here, the first line captures the standard free-rider problem of teamwork (and is negative for $e^T \neq e^N$); the second line gives the value of future cooperation, evaluated today. Only if the second line dominates, teamwork is feasible. If (IC) is not satisfied, no team is formed, and both agents have utilities U^I.

Note that the (IC) constraint must hold in every period t. This implies that – different from many other (formal) commitment devices analyzed in the literature – teamwork has to be optimal for every future self of an agent (taking every future self's continuation utility into account), not only for the period-0 self.

3.3 Results

In the following, we analyze what can be achieved within a team and what is not feasible, without making any claim which equilibrium is actually chosen (with the exception that we focus on symmetric equilibria). As a first result, we can show that if agents do *not* exhibit inconsistent time preferences, forming a team is not feasible.

Lemma 2 *For $\beta = 1$, no positive effort level can be enforced within a team.*

Obviously, a team is not needed if $\beta = 1$. We show that forming a team even is not possible in that case. This is driven by two aspects. On the one hand, the standard free-rider problem of team production is present, making an underprovision of effort optimal in the short run. On the other hand, an agent's outside option is already at the first best. Hence, a breakdown of the team is associated with no costs and a deviation always more tempting than working for the joint project.

Furthermore, teamwork is only (potentially) feasible for effort levels strictly above e^I.

Lemma 3 *No effort level $e^T \leq e^I$ can be enforced within a team.*

The intuition of Lemma 3 is similar to the one driving Lemma 2. For $e^T \leq e^I$, continuation utilities of individual production are higher than those of teamwork. Together with the free-rider problem, this indicates that teamwork is not only not worthwhile, but not even feasible for $e^T \leq e^I$. Lemma 2 also implies that if a team can be formed, the associated effort is higher than e^I, and teamwork can help agents to overcome their self-control problems.

In a next step, we show that forming a team teamwork is indeed feasible for $\beta < 1$ and that first-best effort e^{FB} might eventually be reached if δ is sufficiently large.

Proposition 1 *For every $\beta < 1$ and any effort level $e^T \in (e^I, e^{FB}]$, e^T can be enforced within a team if δ is sufficiently close to 1.*

For δ sufficiently large, today's value of future cooperation becomes so large that it necessarily dominates today's deviation gain. Proposition 1 establishes our first main result – that teamwork can help to overcome self-control problems. The next proposition makes the feasibility of teamwork more precise.

Proposition 2 *Positive effort within a team can be enforced if and only if $\delta \geq \underline{\delta} = (4 - 3\beta) / (8 - 11\beta + 4\beta^2)$.*

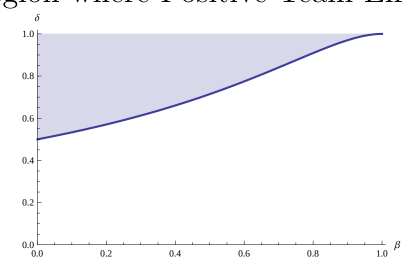
To obtain $\underline{\delta}$, we derive the level of team-effort that maximizes the left-hand-side of the (IC) constraint, denoted $\underline{e}^T$. Since it is unique, teamwork is only feasible if the (IC) constraint holds for $\underline{e}^T$. Two aspects are important. First of all, $\underline{\delta} < 1$ for $\beta < 1$, hence agents with self-control problems can generally form productive teams. Furthermore, $d\underline{\delta}/d\beta \geq 0$, implying that a lower β generally makes it *easier* to enforce any effort within a team.

The latter point is not that straightforward, since a lower β generally has two countervailing effects. On the one hand, it reduces e^I and an agent's outside option, thereby relaxing the (IC) constraint. On the other hand, the future becomes less valuable, which tightens the (IC) constraint. However, at the threshold $\underline{\delta}$ only effort

$\underline{e}^T$ can just be enforced, which is increasing in β (furthermore, $\underline{e}^T \to 0$ for $\beta \to 0$). Therefore, a lower β implies that the critical threshold of δ above which a team can be formed is reduced, however the enforceable effort at this threshold goes down.

The blue line in the following graph gives $\underline{\delta}$ as a function of β; the shaded region gives all combinations of δ and β for which positive effort within a team can be enforced.

Figure 1: Region where Positive Team-Effort is Feasible



We are particularly interested in the conditions for which a given effort level e^T can be enforced, especially for first-best effort $e^{FB} = \frac{\delta V}{c}$. In this case, the (IC) constraint becomes

$$-\left(2-\beta\right)^2 + \delta\left(4 - 7\beta^2 + 4\beta^3\right) \geq 0.$$

This implies

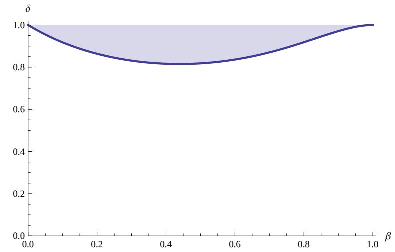
Proposition 3 *First-best effort e^{FB} within a team can be enforced if $\delta \geq \delta^{FB} = \left(2-\beta\right)^2 / \left(4 - 7\beta^2 + 4\beta^3\right)$.*

Note that $\delta^{FB} < 1$ for $\beta \in (0,1)$. Furthermore, δ^{FB} increases in β for large initial values of β, and decreases for small initial values of β (formally, $\frac{d\delta^{FB}}{d\beta} = \left[4\left(2-\beta\right)\left(1-\beta\right)\left(-2+5\beta-\beta^2\right)\right] / \left(4-7\beta^2+4\beta^3\right)^2$). Therefore, more severe self-control problems of team members can make it easier to sustain first-best effort within a team.

For a given effort level e^T, a lower β generally has two effects. On the one hand, it directly tightens the (IC) constraint because the future becomes less valuable. On the other hand, it relaxes the (IC) constraint by reducing off-equilibrium individual effort levels and consequently agents' outside options. Starting from $\beta = 1$ and reducing β, the second effect initially dominates if $e^T = e^{FB}$. For rather low values of β, the first effect dominates.

In the following Figure 2, the blue line gives δ^{FB}, and the shaded region shows all combinations of δ and β for which e^{FB} can be enforced.

Figure 2: Region where the First-Best can be Attained



Concluding, more severe self-control problems can help to improve team performance. This is a general feature of relational contracts, which work better if agents are vulnerable. Someone who is locked in a relationship because their outside option is unattractive is willing to sacrifice more in order to maintain cooperation. An agent's vulnerability might be more pronounced if finding an adequate replacement for one's partner is impossible or – as in our case – if being thrown back on one's own is particularly bad. McMillan and Woodruff (1999) provide empirical evidence for this connection. They analyze relational contracts between firms in Vietnam, more precisely the extent to which customers receive trade credit from their suppliers (due to the unavailability of contract-enforcing institutions at the time of the study, this aspect had to be governed by informal arrangements). They find that customers lacking alternative suppliers get more credit – because being locked in a relationship indicates higher trust and more future business.

4 Extension: Teamwork with Exogenous Benefits

We have shown that teamwork can help to overcome an agent's self-control problems. For "normal" agents, teamwork is not possible – however also not needed. In a next step, we show that even if teamwork renders technological benefits, implying that also normal agents would rather work within a team than on individual projects, hyperbolic agents can perform better than normal ones. Put differently, agents can benefit from being lazy. This is true as long as the exogenous benefits of teamwork are not too large, and agents' outside options are still constituted by individual projects (and not by teamwork with inefficiently low effort). The mechanism driving this result is equivalent to the one underlying our previous analysis: A lower β not only reduces continuation utilities in equilibrium, but also agents' off-equilibrium utilities. As long as the latter aspect dominates, a lower β can induce a higher performance within the team.

Here, we focus on one particular case of exogeonous team-benefits, and assume that if both agents work on the joint project, the probability to generate the payoff V in period $t + 1$ is $(e_1 + e_2)(1 + \alpha)$, with $\alpha \geq 0$ (and impose the assumption $\delta V (1 + \alpha)/c < 1/2$ to always guarantee an interior solution). A value $\alpha = 0$ yields the situation analyzed above; a value $\alpha > 0$ could be generated by discussions of the team members about the joint problems which deepens each agent's understanding, or by heterogeneities in the agents' abilities to tackle different aspects of a project.

Now, even absent cooperation, i.e. if agents solely maximize their stage payoffs (this situation determines the outside option in a relational contract), it might be optimal for agents to form a team if α is sufficiently large. In this case, the static Nash equilibrium is played, the per-period utility of agent i is $u_i^N = -c \cdot (e_i^N)^2/2 + \beta\delta\left(e_1^N + e_2^N\right)(1+\alpha)V/2$, and optimal static effort for both agents is $e^N = \beta\delta(1+\alpha)V/2c$.

Individual production is not affected by the existence of technological team benefits. It still yields a per-period utility $u^I = -c \cdot (e^I)^2/2 + \beta\delta e^I V$, and optimal effort for each agent is $e^I = \beta\delta V/c$. Off equilibrium, agents will work within a team if $u^N \geq u^I$. The relation between u^N and u^I hence determines the agents' outside options when they attempt to cooperate within a team. This is characterized by

Lemma 4 *For $e^T = e^N$, teamwork is preferred for $\alpha \geq \overline{\alpha} = 2/\sqrt{3}-1$ and individual production is preferred for $\alpha < \overline{\alpha}$.*

Proof of Lemma 4. This follows from plugging e^N and e^I into u^N and u^I, respectively. Then, $u^N = 3\beta^2\delta^2(1+\alpha)^2 V^2/8c$, $u^I = \beta^2\delta^2 V^2/2c$, and $u^N \geq u^I$ for $\alpha \geq 2/\sqrt{3}-1$. ■

Before analyzing the feasibility of teamwork, we have to be precise about the definition of first-best effort in this section. First-best effort – as regarded from earlier periods – now is different under individual production than within a team. Here, we focus on the highest feasible payoff an agent can possibly expect, which implies that the technological benefits of teamwork are enjoyed. Hence, we define first-best effort levels e_1^{FB} and e_2^{FB} as maximizing the joint team payoff as regarded from earlier periods, i.e.

$$-\frac{c \cdot e_1^2}{2} - \frac{c \cdot e_2^2}{2} + \delta(e_1 + e_2)(1+\alpha)V,$$

Since a potential output V is shared equally, no other definition of first-best effort could make both agents better off.

Therefore, the symmetric first-best effort level e^{FB} is

$$e^{FB} = \frac{\delta(1+\alpha)V}{c}.$$

Denoting equilibrium effort within a cooperative team e^T, an agent's equilibrium utility stream is

$$U^T = -c \cdot \frac{(e^T)^2}{2} + \beta\delta e^T(1+\alpha)V + \beta\frac{\delta}{1-\delta}\left(\delta e^T(1+\alpha)V - c \cdot \frac{(e^T)^2}{2}\right). \quad (8)$$

As before, an agent who deviates can either underprovide effort within the team (given the other agent chooses e^T) or immediately go for an individual project. However, as underproviding effort within a team is the "optimal" deviation for $\alpha = 0$ (as shown in Lemma 1 above), the same is true for larger values of α. After a deviation and the subsequent breakdown of cooperation, though, either teamwork or individual production might be optimal, depending on whether α is above $\overline{\alpha}$.

An agent's deviation utility is hence given by

$$U^D = \max\{-c \cdot \frac{(e^N)^2}{2} + \beta\delta\frac{V}{2}\left(e^N + e^T\right)(1+\alpha) + \beta\frac{\delta}{1-\delta}\left(\delta e^N (1+\alpha) V - c \cdot \frac{(e^N)^2}{2}\right), \\ -c \cdot \frac{(e^N)^2}{2} + \beta\delta\frac{V}{2}\left(e^N + e^T\right)(1+\alpha) + \beta\frac{\delta}{1-\delta}\left(\delta e^I V - c \cdot \frac{(e^I)^2}{2}\right)\}. \tag{9}$$

In the following, we treat both cases separately to precisely analyze the impact of an agent's time inconsistency on cooperation within a team.

4.1 Outside Option is Individual Production, i.e. $\alpha < \overline{\alpha}$

In this case, the (IC) constraint boils down to

$$\left(\beta\delta e^T (1+\alpha)\frac{V}{2} - c \cdot \frac{(e^T)^2}{2}\right) - \left(\beta\delta e^N (1+\alpha)\frac{V}{2} - c \cdot \frac{(e^N)^2}{2}\right) \\ +\beta\frac{\delta}{1-\delta}\left[\left(\delta e^T (1+\alpha) V - c \cdot \frac{(e^T)^2}{2}\right) - \left(\delta e^I V - c \cdot \frac{(e^I)^2}{2}\right)\right] \geq 0. \tag{IC'}$$

Generally, a lower α helps to enforce cooperation within a team, irrespective of whether agents exhibit time-inconsistencies or not. Hence, a larger α lets potential benefits of a lower β diminish. However, as long as α is not too large, the performance of teams with time-inconsistent agents can still be substantially better than of teams without inconsistencies. To show this, we focus on first-best effort e^{FB} and the conditions under which it can be enforced. For e^{FB}, the (IC') constraint becomes

$$-(1+\alpha)^2(2-\beta)^2 + \delta\left[(1+\alpha)^2\left(4+\beta^2\right) - 4(2-\beta)\beta^2\right] \geq 0.$$

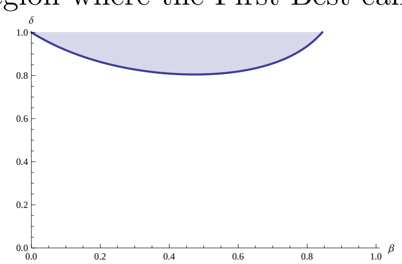
A larger α generally relaxes the constraint (unless $(2-\beta)^2 > \delta\left(4+\beta^2\right)$, when however the (IC') constraint for e^{FB} cannot hold in any case), for all degrees of agents' self-control problems. To make our point that agents can benefit from being lazy, we focus on situations where e^{FB} cannot be enforced for $\beta = 1$. For $\beta = 1$, the condition becomes $\delta \geq (1+\alpha)^2 / \left(5(1+\alpha)^2 - 4\right)$. Put differently, first-best effort is not feasible for a team of "normal" agents whenever $(1+\alpha)^2 < 4\delta/(5\delta - 1)$. Hence, let us assume that this is case and show that first-best can be enforced for $\beta < 1$.

Example 1. As a first example, take $\delta = 0.9(1+\alpha)^2 / \left(5(1+\alpha)^2 - 4\right)$, i.e., $(1+\alpha)^2 = 4\delta/(5\delta - 0.9)$ – and enforceable effort is strictly below e^{FB} for $\beta = 1$. Define δ'^{FB} as the discount level where (IC') evaluated at e^{FB} holds as an equality. Here, we have

$$\delta'^{FB} = \frac{4(2-\beta)^2 - 3.6(2-\beta)\beta^2}{4\left[(4+\beta^2) - 5(2-\beta)\beta^2\right]}.$$

It can be shown that there exists a $\overline{\beta} < 1$ such that $\delta'^{FB} \leq 1$ for $\beta \leq \overline{\beta}$, and $\delta'^{FB} > 1$ for $\beta > \overline{\beta}$. Hence, there exist values $\delta < 1$ for which first-best effort can be enforced for some $\beta < 1$. All respective combinations of δ and β are depicted in the following Figure 3, constituting the shaded region.

Figure 3: Region where the First-Best can be Attained

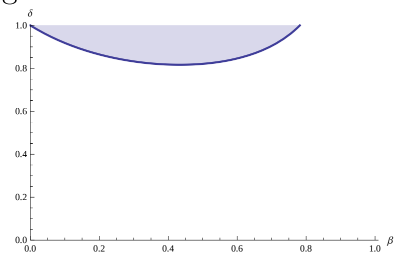


Example 2. As another example, assume $\delta = 0.8(1+\alpha)^2 / \left(5(1+\alpha)^2 - 4\right)$, i.e., $(1+\alpha)^2 = 4\delta/(5\delta - 0.8)$. Again define δ'^{FB} as the discount level where (IC') evaluated at e^{FB} holds as an equality, yielding

$$\delta'^{FB} = \frac{4(2-\beta)^2 - 3.2(2-\beta)\beta^2}{4\left[(4+\beta^2) - 5(2-\beta)\beta^2\right]}.$$

It can again be shown that there exist combinations of $\delta < 1$ and $\beta < 1$ such that first-best effort can be enforced. The shaded region in the following Figure 4 gives all that combinations of δ and β.

Figure 4: Region where the First-Best can be Attained



4.2 Outside Option is Teamwork

A team's outside option is constituted by teamwork of $\alpha \geq \overline{\alpha}$ *(and* if deviating agents can not be replaced[11]). In this case, the (IC) constraint is

$$\begin{aligned} &\left(\beta\delta e^T(1+\alpha)\frac{V}{2} - c\cdot\frac{(e^T)^2}{2}\right) - \left(\beta\delta e^N(1+\alpha)\frac{V}{2} - c\cdot\frac{(e^N)^2}{2}\right) \\ &+\beta\frac{\delta}{1-\delta}\left[\left(\delta e^T(1+\alpha)V - c\cdot\frac{(e^T)^2}{2}\right) - \left(\delta e^N(1+\alpha)V - c\cdot\frac{(e^N)^2}{2}\right)\right] \geq 0. \end{aligned} \tag{IC''}$$

Here, a lower β cannot yield a better team performance. This is driven by the difference between utilities in and out-of equilibrium already being quite large when agents choose teamwork in any case. Different from above – where the outside option is constituted by individual production – the left hand side of (IC) now is continuous in $e^T \geq e^N$. For $\beta = 1$, first-best effort can already be enforced for the relatively low discount factor $\delta = 0.5$. Therefore, if α is large enough to render teamwork the optimal off-equilibrium choice, the additional commitment by a lower β is not needed. Then, the negative effect – driven by a larger discounting of future utilities – dominates.

As an example, take $e^T = e^{FB}$. Then, the (IC") constraint boils down to

$$1 - \delta - \beta\delta \leq 0,$$

which is relaxed for larger values of β.

5 Conclusion

We have shown that teamwork can serve as an implicit commitment device to overcome problems of procrastination and self-control. Even if teamwork renders tech-

[11] If it were possible to replace a deviating agent and if an agent's deviation was observable by all others, individual production could always constitute the outside option.

nological benefits, the team-performance of "lazy" agents can actually be better than of agents without self-control problems. Next steps might be to analyze asymmetric equilibria and characterize the Pareto frontier. Furthermore, we might allow for heterogenous agents and analyze who should be matched with whom. In addition, it might be worthwhile to consider uncertainty concerning a project's success probability, which is resolved over time. We plan to pursue these issues in the future.

A Appendix - Omitted Proofs

Proof of Lemma 1. $U^D \geq U^I$ is equivalent to $e^T \geq \frac{3}{4}\frac{\beta\,\delta\,V}{c}$. To show that the case $U^D < U^I$ is not relevant for us, assume that we want to enforce team effort $\tilde{e}^T < \frac{3}{4}\frac{\beta\,\delta\,V}{c}$. Then, the (IC) constraint amounts to $\beta\,\delta\,\tilde{e}^T\,V - \frac{c\cdot(e^T)^2}{2} + \frac{\beta\,\delta}{1-\delta}\left(\delta\,\tilde{e}^T\,V - \frac{c\cdot(e^T)^2}{2}\right)$

$\geq \beta\,\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2} + \frac{\beta\,\delta}{1-\delta}\left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right)$. Note that $\beta\,\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2}$ is maximized for $e^T = e^I = \frac{\beta\,\delta\,V}{c}$, hence $\beta\,\delta\,\tilde{e}^T\,V - \frac{c\cdot(e^T)^2}{2} < \beta\,\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}$. $\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2}$ is concave in e^T and maximized for $e^T = e^{FB} > e^I$; hence, $\delta\,\tilde{e}^T\,V - \frac{c\cdot(e^T)^2}{2} < \delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}$ as well, and the (IC) constraint cannot hold for $e^T < \frac{3}{4}\frac{\beta\,\delta\,V}{c}$. ■

Proof of Lemma 2. Note that in this case, $e^I = e^{FB}$, and the (IC) constraint can be written as $\beta\,\delta\,e^T\,\frac{V}{2} - \frac{c\cdot(e^T)^2}{2} - \left(\beta\,\delta\,e^N\,\frac{V}{2} - \frac{c\cdot(e^N)^2}{2}\right)$

$+\frac{\delta}{1-\delta}\left[\left(\delta e^T V - \frac{c\cdot(e^T)^2}{2}\right) - \left(\delta e^{FB} V - \frac{c\cdot(e^{FB})^2}{2}\right)\right] \geq 0$. e^{FB} maximizes $\delta eV - \frac{c\cdot e^2}{2}$, hence $\left(\delta e^T V - \frac{c\cdot(e^T)^2}{2}\right) - \left(\delta e^{FB} V - \frac{c\cdot(e^{FB})^2}{2}\right) \leq 0$, with a strict inequality for $e^T \neq e^{FB}$; e^N maximizes $\beta\,\delta\,e\,\frac{V}{2} - \frac{c\cdot e^2}{2}$, hence $\beta\,\delta\,e^T\,\frac{V}{2} - \frac{c\cdot(e^T)^2}{2} - \left(\beta\,\delta\,e^N\,\frac{V}{2} - \frac{c\cdot(e^N)^2}{2}\right) \leq 0$, with a strict inequality for $e^T \neq e^N$. Since $e^{FB} \neq e^N$, at least one inequality has to be strict. Therefore, the left hand side of the (IC) constraint is strictly negative for any $e^T \geq 0$. ■

Proof of Lemma 3. The proof is almost equivalent to the proof of Lemma 1: Assume that $e^T \leq e^I$ (note that we already showed that $e^T \geq \frac{3}{4}e^I$, implying $U^D > U^I$). Because $e^I \leq e^{FB}$, the second line of the (IC) constraint, $\left(\delta e^T V - \frac{c\cdot(e^T)^2}{2}\right) - \left(\delta e^I V - \frac{c\cdot(e^I)^2}{2}\right) \leq 0$ for $e^T \leq e^I$, with a strict inequality for $e^T \neq e^I$; the first line of the (IC) constraint, $\beta\,\delta\,e^T\,\frac{V}{2} - \frac{c\cdot(e^T)^2}{2} - \left(\beta\,\delta\,e^N\,\frac{V}{2} - \frac{c\cdot(e^N)^2}{2}\right) \leq 0$, with a strict inequality for $e^T \neq e^N$. Since $e^I \neq e^N$, , at least one inequality has to be strict. Therefore, the left hand side of the (IC) constraint is strictly negative for $e^T \leq e^I$.■

Proof of Proposition 1. Recall the (IC) constraint, $\beta\,\delta\,e^T\,\frac{V}{2} - \frac{c\cdot(e^T)^2}{2} - \left(\beta\,\delta\,e^N\,\frac{V}{2} - \frac{c\cdot(e^N)^2}{2}\right)$

$+\frac{\delta}{1-\delta}\left[\left(\delta e^T V - \frac{c\cdot(e^T)^2}{2}\right) - \left(\delta e^I V - \frac{c\cdot(e^I)^2}{2}\right)\right] \geq 0.$

The second line of the (IC) constraint, $\left(\delta\,e^T\,V - \frac{c\cdot(e^T)^2}{2}\right) - \left(\delta\,e^I\,V - \frac{c\cdot(e^I)^2}{2}\right)$, is strictly positive for any $\beta < 1$ and $e^I < e^T \leq e^{FB}$. Following Lemmas 1 and 2, the first line of the (IC) constraint is negative but bounded. Hence, for $\delta \to 1$, the (IC) constraint is satisfied for any e^T with $e^I < e^T \leq e^{FB}$. ■

Proof of Proposition 2. First, we derive the level of e^T that maximizes the left-hand-side of the (IC) constraint. Only if (IC) holds for this effort level, positive effort within a team can at all be enforced.

The first derivative of the left-hand-side of (IC) with respect to e^T is $\beta\,\delta\,\frac{V}{2} - c \cdot e^T + \frac{\beta\,\delta}{1-\delta}\left(\delta\,V - c \cdot e^T\right)$, hence the left-hand-side of (IC) is maximized for $\underline{e}^T = \frac{\beta\,\delta\,\frac{V}{2}(1+\delta)}{c(1-\delta+\beta\,\delta)}$ (the second-order condition holds since the second derivative of the left-hand-side of (IC) with respect to e^T equals $-c\frac{1-\delta+\beta\,\delta}{1-\delta} < 0$).

Plugging this value into (IC) and re-arranging gives

$$-4 + 3\beta + 8\delta - 11\beta\delta + 4\beta^2\,\delta \geq 0,$$

which yields $\underline{\delta}$. ■

References

Abreu, D. (1988): "On the Theory of Infinitely Repeated Games with Discounting," *Econometrica*, 56(6), 1713–1733.

Alchian, A. A., and H. Demsetz (1972): "Production, Information Costs, and Economic Organization," *American Economic Review*, 62(5), 777–795.

Augenblick, N., M. Niederle, and C. Sprenger (2013): "Working Over Time: Dynamic Inconsistency in Real Effort Tasks," Working Paper.

Bar-Isaac, H. (2007): "Something to Prove: Reputation in Teams," *RAND Journal of Economics*, 38(2), 495–511.

Baron, J., and D. M. Kreps (1999): *Strategic Human Resources: Frameworks for General Managers*. Wiley & Sons, Hoboken, NJ.

Bartling, B. (2011): "Relative Performance or Team Evaluation? Optimal Contracts for Other-Regarding Agents," *Journal of Economic Behavior and Organization*, 79(3), 183–193.

Bull, C. (1987): "The Existence of Self-Enforcing Implicit Contracts," *Quarterly Journal of Economics*, 102(1), 147–159.

Chan, T., J. Li, and L. Pierce (2012): "Compensation and Peer Effects in Competing Sales Teams," Working Paper.

Che, Y.-K., and S.-W. Yoo (2001): "Optimal Incentives for Teams," *American Economic Review*, 91(3), 525–541.

Corts, K. S. (2007): "Teams versus Individual Accountability: Solving Multitask Problems through Job Design," *RAND Journal of Economics*, 38(2), 467–479.

DellaVigna, S., and U. Malmendier (2004): "Contract Design and Self-Control: Theory and Evidence," *Quarterly Journal of Economics*, 119(2), 353–402.

——— (2006): "Paying Not to Go to the Gym," *American Economic Review*, 96(3), 694–719.

Encinosa, W., M. Gaynor, and J. Rebitzer (2007): "The Sociology of Groups and the Economics of Incentives: Theory and Evidence on Compensation Systems," *Journal of Economic Behavior & Organization*, 62(2), 187–214.

Erev, I., G. Bornstein, and R. Galili (1993): "Constructive Intergroup Competition as a Solution to the Free Rider Problem: A Field Experiment," *Journal of Experimental Social Psychology*, 29(6), 463–478.

Gneezy, U., and A. Rustichini (2004): "Gender and Competiton at a Young Age," *American Economic Review*, 94(2), 377–381.

Hamilton, B., J. Nickerson, and H. Owan (2003): "Constructive Intergroup Competition as a Solution to the Free Rider Problem: A Field Experiment," *Journal of Political Economy*, 111(3), 465–497.

Holmstrom, B. (1982): "Moral Hazard in Teams," *Bell Journal of Economics*, 13(2), 324–340.

Itoh, H. (1991): "Incentives to Help in Multi-Agent Situations," *Econometrica*, 59(3), 611–636.

Jones, D., P. Kalmi, and A. Kauhanen (2010): "Teams, Incentive Pay, and Productive Efficiency: Evidence from a Food-Processing Plant," *Industrial and Labor Relations Review*, 63(4), 606–626.

Kaur, S., M. Kremer, and S. Mullainathan (2010): "Self -Control and the Development of Work Arrangements," *American Economic Review Papers and Proceedings*, 100(2), 624–628.

——— (2013): "Self-Control at Work," Working Paper.

Kvaløy, O., and T. E. Olsen (2006): "Team Incentives in Relational Employment Contracts," *Journal of Labor Economics*, 24(1), 139–169.

Laibson, D. (1997): "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics*, 112(2), 443–477.

Lazear, E. P., and K. L. Shaw (2007): "Personnel Economics: The Economist's View of Human Resources," *Journal of Economic Perspectives*, 21(4), 91–114.

Levin, J. (2003): "Relational Incentive Contracts," *American Economic Review*, 93(3), 835–857.

MacLeod, W. B., and J. M. Malcomson (1989): "Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment," *Econometrica*, 57(2), 447–480.

Mas, A., and E. Moretti (2009): "Peers at Work," *American Economic Review*, 99(1), 112–145.

McMillan, J., and C. Woodruff (1999): "Interfirm Relationships and Informal Credit in Vietnam," *Quarterly Journal of Economics*, 114(4), 1285–1320.

Mohnen, A., K. Pokorny, and D. Sliwka (2008): "Transparency, Inequity Aversion, and the Dynamics of Peer Pressure in Teams: Theory and Evidence," *Journal of Labor Economics*, 26(4), 693–720.

Mukherjee, A., and L. Vasconcelos (2011): "Optimal Job Design in the Presence of Implicit Contracts," *RAND Journal of Economics*, 42(1), 44–69.

Nalbantian, H., and A. Schotter (1997): "Productivity Under Group Incentives: An Experimental Study," *American Economic Review*, 87(3), 314–341.

O'Donoghue, T., and M. Rabin (1999): "Doing it Now or Later," *American Economic Review*, 89(1), 103–124.

Phelps, E., and R. Pollak (1968): "On Second-best National Saving and Game-Equilibrium Growth," *Review of Economic Studies*, 35(x), 185–199.

Pizzini, M. (2010): "Group-Based Compensation in Professional Service Firms: An Examination of Medical Group Practices," *The Accounting Review*, 85(1), 343–380.

Rayo, L. (2007): "Relational Incentives and Moral Hazard in Teams," *Review of Economic Studies*, 74(3), 937–963.

Strotz, R. (1955): "Myopia and Inconsistency in Dynamic Utility Maximization," *Review of Economic Studies*, 23(3), 165–180.