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DOING IT WHEN OTHERS DO: A STRATEGIC MODEL OF PROCRASTINATION

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This paper develops a strategic model of procrastination in which present-biased agents prefer to perform an onerous task with someone else. This turns their decision of when to perform the task into a procrastination game—*a dynamic coordination game between present-biased players. The model characterizes the conditions under which interaction mitigates or exacerbates procrastination. A procrastinator matched with a worse procrastinator may perform her task* earlier *than she otherwise would: she wants to avoid the increased temptation that her peer's company would generate. Procrastinators can thus use bad company as a commitment device to mitigate their self-control problem.* (*JEL* C72, C73, D03, D91)

"Fellowship in woe doth woe assuage, as palmers' chat makes short their pilgrimage."
— W. Shakespeare, The rape of Lucrece

I. INTRODUCTION

Several onerous activities that we tend to procrastinate, we also prefer to perform in the company of others, as company makes such activities feel less unpleasant.[1] This implies that our procrastination behavior is often affected by the procrastination behavior of others.

This paper develops a strategic model of time-inconsistent procrastination that captures this feature and explores its implications. As in the seminal, individual model of procrastination by O'Donoghue and Rabin (1999), individuals are present biased, that is, they have time-inconsistent preferences for immediate gratification, and must perform an onerous task. The key and novel feature of my model is that individuals prefer to perform the onerous task when someone else does, as they enjoy company. This simple assumption turns their individual decision problem, that is, when to perform the onerous task, into a dynamic game of coordination between present-biased players, which I call the "procrastination game." In the procrastination game, the players have potentially heterogeneous present-bias and are "sophisticated," that is, aware of their present bias.[2] The task must be performed by a final period, gets increasingly costly over time, and is less costly if performed when the other player does.

As an example, consider a student who must write an essay by a deadline. As the deadline gets closer, working on the essay gets increasingly stressful. The benefit (the grade) is obtained in the future, past the deadline, and does not depend on when the essay is written. Working on the essay may feel less onerous in the company of a friend.

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1. Rao, Mobius, and Rosenblat (2012) find that students are more likely to get vaccinated against the flu when their friends do, and the excess clustering of friends at inoculation clinics suggests that they coordinate their vaccination decisions. Banarjee, Cohen-Cole, and Zanella (2007) find that women's probability of getting breast cancer screening increases with the frequency of screenings among their coworkers and neighbors, and that this effect does not seem to be due to learning, since the women in this sample were employees of a health organization and thus informed about the benefits of screening.

2. I will also explore how the unawareness of the present-bias affects the main results of the model.

ABBREVIATIONS

ODR: O'Donoghue and Rabin
PPE: Perception-Perfect Equilibrium

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Similarly, applying for a new job, for a nursery place, or filing taxes, all get increasingly stressful as the deadline approaches, yield a benefit in the future, independently of when the task is performed, and feel less unpleasant when performed with a friend, a colleague or a relative.

The procrastination game developed in this paper is used to characterize the conditions under which interaction mitigates or exacerbates procrastination relative to the case in which individuals act in isolation. It shows how individuals should be matched with each other in order to mitigate overall procrastination, thereby improving their welfare and reducing inefficient delay.

The impact of interaction on procrastination will crucially depend on each individual's "procrastination type," which is given by their procrastination behavior in isolation.

The first core result of this paper is the "avoidance of bad company." A procrastinator paired with a worse procrastinator may perform her task earlier than she would in isolation: the expectation of bad company can push her to act earlier. This result illustrates a novel and surprising mechanism through which procrastinators can influence each other's behavior. Consider two individuals who both procrastinate in isolation but to a different extent: a severe procrastinator called Alice, who would perform the task in the last of out three periods in isolation, and a moderate procrastinator called Bob, who would perform the task in the second period in isolation. If they are sufficiently present biased, the unique equilibrium of the procrastination game is for Alice to still perform the task in the last period, and for Bob to perform it in the first, that is, earlier than he would in isolation. The intuition is the following. Alice's present bias is too strong for her to perform the task earlier than on the last date, regardless of Bob's behavior. Bob knows that he would perform the task in the second period in isolation, but that in the presence of Alice he would no longer be able to resist the temptation to delay the task to the last period, as Alice's company would make delaying additionally tempting. Hence he will perform the task on the first date, earlier than he otherwise would, to avoid the increased temptation that Alice's company would generate on the second date. This shows that the bad company of a "hardcore" procrastinator can induce a peer with a self-control problem to procrastinate less—it can be used as a commitment device to mitigate one's own self-control problem. Note that, if Bob had a weaker present bias, he would know he could afford to wait until the second period, as he would then resist the temptation to delay further. Thus, one's completion date may vary nonmonotonically with their present bias. The avoidance of bad company carries over to a procrastination game with more than three periods or with more than two players.

More generally, the model shows that the interaction between two "heterogeneous procrastinators"—two individuals who would both procrastinate in isolation but to a different extent—will weakly reduce procrastination.[3] That is, they will either behave as in isolation, one will do the task earlier ("avoidance of bad company"), or both of them will ("mutual reduction of procrastination"). In the latter case, the present bias of the severe procrastinator Alice is smaller than in the "avoidance of bad company" case. While she would not do the task in the first period in isolation, she would in the presence of Bob. Thus, Alice and Bob will coordinate to do the task in the first period, earlier than either of them would in isolation. The result that company *can* mitigate self-control problems is consistent with evidence on social arrangements and self-control in the workplace.[4]

The interaction between two "homogeneous procrastinators"—two individuals who procrastinate to the same extent in isolation—will weakly reduce procrastination, whereas the interaction between two "homogeneous nonprocrastinators" will weakly exacerbate procrastination. In either case, behaving as they would in isolation will always be an equilibrium, but there may also be additional equilibria: homogenous procrastinators may coordinate on an earlier date, and homogenous nonprocrastinators may coordinate on a later date. Interaction may also be harmful when a procrastinator interacts with a nonprocrastinator. These results imply that matching individuals with each other will not necessarily reduce overall procrastination: who is matched with whom matters.

The second core result of this paper is that the matching that minimizes overall procrastination may not be *stable*, that is, there may exist a pair of procrastinators who both prefer to be matched with each other over their assigned partner. This

3. Provided that the extent to which they value company is not large enough to make delaying optimal. This will be further discussed later.

4. Kaur, Kremer, and Mullainathan (2010) find that having a peer with above average productivity increases workers' work hours and make them less likely to demand commitment. This suggests that peers do not simply influence productivity, but also self-control problems.

is policy relevant, as it suggests that simply letting individuals freely choose their partner may not minimize overall procrastination in a group. Principals who can observe or elicit individuals' tendencies to procrastinate should make the matching. For example, a teacher who wants to help her students not to delay their assignments may suggest that each of them works on her assignment in the company of a classmate, and propose a list of pairs. Similarly, an employee of a job centre who wants to help job applicants not to delay their job searches may suggest that each of them works on the job searches in the company of another job applicant, and propose a suitable match. In either of these examples, individuals' time preferences can be inferred from (and thus proxied by) past behavior, or elicited through a questionnaire (Falk et al. 2016) for a parsimonious and experimentally validated survey module to measure time preferences see. However, in some situations observing or eliciting individuals' time preferences may be hard or unfeasible, or there may be additional obstacles (e.g., unknown costs) that make it hard to implement my model's implications in practice. When time preferences cannot be known, a policy implication can still be drawn: it is better to match individuals randomly than to let them freely choose their partner—as freedom of choice would not lead to a matching that minimizes overall procrastination.

As an ancillary contribution, the procrastination game serves as a possible microfounded model of peer effects in self-control. It describes novel mechanisms through which present-biased peers can influence each other's behavior.[5]

This paper relates to four strands of the literature. First, this paper contributes to the theoretical literature on time-inconsistent procrastination.[6] O'Donoghue and Rabin (1999) show that a sophisticated individual will procrastinate on an onerous activity less than a naïve one. My model extends theirs by arguing that a present-biased individual may prefer to do an onerous activity with others, and that this turns her decision problem into a procrastination game. Brocas and Carrillo (2001) show that competing on a task can mitigate present-biased people's tendency to procrastinate, whereas cooperating on a task can exacerbate procrastination. Building on that, Sogo (2019) shows that competition can exacerbate procrastination when individuals underestimate the magnitude of their self-control problems. My paper complements their work by showing how present-biased individuals can influence each other's procrastination even when they do not work on joint or competing tasks.

Second, this paper relates to the game-theoretical literature on self-control. Battaglini, Benabou, and Tirole (2005) explore how observing each other's behavior affects time-inconsistent people's ability to overcome self-control problems, in an environment where people have incomplete information about their ability to resist temptation and can learn from observing others. Interestingly, the result that bad company can be desirable is also obtained in their model, although for a different reason: the ex ante ideal peer is someone with a slightly worse self-control problem than one's own, as "if such a peer can do it, then we can too." Fahn and Hakenes (2019) show that if agents interact repeatedly and can monitor each other, a relational contract involving teamwork can serve as a self-disciplining device to overcome self-control problems. My paper explores an alternative mechanism through which people affect each other's capability to overcome self-control problems. Takeoka and Ui (2014) explore a game where players have self-control preferences à la Gul and Pesendorfer (2001) and demand commitment. Their model differs from mine as it uses a different model of self-control (and, most importantly, one that does not involve time-inconsistency) and focuses on commitment behavior.

Third, this paper contributes to the literature incorporating time-inconsistent preferences into game theory. A number of papers introduce time-inconsistent preferences into extensive form games (Akin 2007; Lu 2016; Sarafidis 2006; Schweighofer-Kodritsch 2018). I introduce time-inconsistent preferences into dynamic games with simultaneous moves, and propose how to use risk-dominance and payoff-dominance as equilibrium selection criteria in such games.

This paper is structured as follows. Section II introduces the procrastination game under sophistication. Section III characterizes and

5. See Manski (2000) for a review of social interaction models where an agent's preference depends on the behavior of others. See Nakajima (2007) for an application to smoking behavior: in his model an agent's smoking utility depends on the smoking status of peers.

6. Procrastination may occur even in the absence of time-inconsistency. In Akerlof (1991) procrastination occurs because the cost of doing a task is more salient when it is immediate than when it is delayed. In the model of team production and moral hazard by Weinschenk (2016), time-consistent team members procrastinate to free-ride on the team's future effort provision.

discusses the equilibrium outcomes of the model, focusing on the interaction between two individuals who would both procrastinate in isolation, but to a different extent. Section IV explores matching in a population of procrastinators. Section V presents extensions, and discusses a more general model with more than three periods or more than two players. Section VI concludes and discusses avenues for future research.

II. THE PROCRASTINATION GAME

I extend the individual model of procrastination by O'Donoghue and Rabin (1999) (henceforth, ODR) to a strategic setting.

A. Model

Let $\mathcal{G}$ denote a dynamic game which I call the procrastination game. The game has three periods, denoted $t = 1,2,3$, but in the third period there is no decision to be taken. Let $\{A, B\}$ denote the set of players and let $a_{i,t} \in \{0, 1\}$ denote the action that each player i plays in each period t. Each player must perform an individual task. In each period, she must choose either to do the task immediately ($a_{i,t} = 1$) or to wait ($a_{i,t} = 0$). If she waits, she will face the same decision in the following period. If she waits until the third period, she must do the task then.[7]

Time-inconsistency. Each player i has quasi-hyperbolic, time-inconsistent preferences.[8] Let u_t denote an individual's utility at time t. Her intertemporal utility at time $t = 1$, U_i^1, is,

$$U_i^1 \equiv u_1 + \beta_i \delta u_2 + \beta_i \delta^2 u_3, \quad \text{where} \quad 1 \geq \beta_i > 0, \ \ \delta \leq 1. \tag{1}$$

δ represents time-consistent impatience and β_i captures a time-inconsistent preference for immediate gratification. If $\beta_i = 1$, (1) is equivalent to exponential discounting and the player is time-consistent. If $\beta_i < 1$, (1) describes quasi-hyperbolic discounting and the player is present-biased. Following the literature, I consider the individual in each period as a separate "self" who chooses her current behavior to maximize her current preferences, whereas her future selves will choose her future behavior. A time-inconsistent individual's decision problem can then be modeled as a sequential game between her selves at different points in time. She is "sophisticated" if she is able to fully predict her future (mis)behavior. I assume that both players are sophisticated. The alternative assumption is that she is "naïve": she mistakenly thinks that she will behave as a time-consistent individual in the future. This case will be discussed in Section B.3 (Supporting information).

As this paper is concerned with procrastination arising from time-inconsistency, I assume that $\beta_i < 1$. Second, I assume that $\delta = 1$.[9]

Task. The task requires only one period of effort and is completed once begun. It has immediate costs and delayed benefits that are normalized to zero.[10] Let $\mathbf{c} \equiv (c_1, c_2, c_3)$ denote the cost schedule, where $c_t \geq 0$ for each $t \leq 3$.

ASSUMPTION 1. In any procrastination game $\mathcal{G}$, $c_3 > c_2 > c_1$.

I assume that costs increase over time because a model of time-inconsistent procrastination is meant to describe situations in which delaying is not optimal from an ex ante perspective (i.e., the perspective of a fictitious period 0 where a player weighs all future periods equally) and arises from time-inconsistency. Moreover, many onerous tasks get increasingly costly over time, as the tasks feel more stressful as the deadline approaches or as delaying generates monetary costs (e.g., delaying the payment of a fine).

Preferences. Letting τ_i denote the period in which player i completes the task, τ_{-i} the completion date of the other player, and κ the extent

7. See Section V for a discussion of a more general model with more than 2 players or more than 3 periods, and Appendix B (Supporting information) for the details.

8. Evidence shows that, when considering two future periods, people give stronger relative weight to the earlier period as it gets closer, which implies that the discount factor increases with the time horizon or, in other words, people are hyperbolic discounters. Changing the delay might then change people's preferences over two options and lead to time-inconsistency (Thaler 1981). This motivated the introduction of a quasi-hyperbolic model of discounting (Laibson 1997; Phelps and Pollak 1968). This simplification of hyperbolic discounting assumes a declining discount rate between the current period and the next one, but a constant discount rate thereafter.

9. This assumption is without loss of generality. Note that $\delta = 1$ implies that, with two periods, (1) would be equivalent to exponential discounting. That is why a three-period case is the simplest case to consider.

10. Following ODR, as $\delta = 1$, the benefits can be interpreted as being obtained in a period after the final one, independently of when the task is completed. Moreover, the benefits are assumed to be constant over time. The latter assumption is not necessary, for example, the benefits could potentially be decreasing over time. However, when both costs and benefits are time-dependent, it becomes more difficult to isolate the impact of present bias on completion behavior, as behavior would also depend on the relative magnitude of costs and benefits.

to which she values company, her intertemporal utility in period t from doing the task in $\tau_i \geq t$ is given by

$$U_i^t(\tau_i|\tau_{-i}) \equiv \begin{cases} -c_{\tau_i} & \text{if } \tau_i = t \neq \tau_{-i} \\ -c_{\tau_i}(1-\kappa) & \text{if } \tau_i = t = \tau_{-i} \\ -\beta_i c_{\tau_i} & \text{if } \tau_{-i} \neq \tau_i > t \\ -\beta_i c_{\tau_i}(1-\kappa) & \text{if } \tau_i = \tau_{-i} > t \end{cases}.$$

In each period t, if player i decides to do the task immediately ($\tau_i = t$), she will suffer that period's cost, c_τ. If she decides to wait ($\tau_i > t$), she will face the same decision in the following period. Her decision will depend not only on her degree of present bias, β_i, but also on her opponent's completion date, τ_{-i}. Whenever she does the task in the same period as her peer (i.e., $\tau_{-i} = \tau_i$), that period's cost will be reduced by κc_{τ_i}.[11]

ASSUMPTION 2. In any procrastination game $\mathcal{G}$, $\kappa \in \left(0, 1 - \max\left\{\frac{c_1}{c_2}, \frac{c_2}{c_3}\right\}\right]$.

Assumption 2 ensures that the cost reduction generated by company is positive, but not so large as to make the cost of doing the task no longer increasing over time. The intuition is the following. People value each other's company, but up to a point—the extent to which they value company will not be so large as to make delaying optimal from an ex ante perspective. This assumption may seem strong (and, as discussed later, rules out some equilibria), but if players had an unboundedly strong preference for coordination, then trivially any coordinated outcome would be an equilibrium.[12]

The players' preferences are common knowledge; hence the procrastination game is a game of complete information. It describes situations in which individuals know each other's tendency to procrastinate, as is the case for close social ties like spouses, siblings and close friends.[13]

Benchmark case. If the players are assumed *not* to value company, that is, $\kappa = 0$, their preferences become

$$U_i^t(\tau_i, \tau_{-i}) \equiv \begin{cases} -c_{\tau_i}, & \text{if } \tau_i = t; \\ -\beta_i c_{\tau_i}, & \text{if } \tau_i > t. \end{cases}$$

Their decision problem becomes equivalent to that of an individual who acts in isolation, as in ODR. Thus, their individual model of procrastination is obtained as a special case of my model and will be used as a benchmark model throughout this paper.

B. Strategy and Solution Concept

For $i \in \{A, B\}$, let $\mathcal{S}_i$ denote the strategy set and $U_i : \mathcal{S}_A \times \mathcal{S}_B \to \mathbb{R}$ the payoff function. A *pure strategy* is given by $\mathbf{s}_i \equiv (a_{i,1}, a_{i,2}(a_{-i,1})) = (a_{i,1}, (a_{i,2}(0), a_{i,2}(1))) \in \mathcal{S}_i$, where, for $t \in \{1, 2\}$, $a_{i,t}$ specifies whether player $i \in \{A, B\}$ does the task in period t or waits, given that she has not yet done it. The strategy $\mathbf{s}_i$ specifies doing it in period t if $a_{i,t} = 1$, and waiting if $a_{i,t} = 0$. In addition to specifying when player i will actually do the task, a strategy also specifies what she "would" do in periods after she has already done it. A player's strategy in $t = 2$, $a_{i,2}$, will depend on whether the opponent has done the task in $t = 1$. Note that the definition of strategy in a procrastination game embeds ODR's definition of strategy. When $\kappa = 0$ the former becomes equivalent to the latter. Let this $\kappa = 0$ or benchmark strategy be denoted by $\tilde{\mathbf{s}}_i$.

In each period t, each self-t player i plays an action $a_{i,t} \in \{0, 1\}$ to maximize (2), where $a_{i,t} = 1$ if $\tau_i = t$ and $a_{i,t} = 0$ if $\tau_i > t$.

ODR's solution concept under sophistication, called *perception-perfect strategy* for sophisticates, requires that the individual chooses optimally given her current preferences and her knowledge of her future behavior. A sophisticate does the task today if and only if, given her current preferences, doing it now is preferred to waiting for her future selves to do it. Because the sophisticate's decision problem can be modeled as a sequential game with perfect information and a finite number of periods, it can be solved via backward induction.

In a procrastination game, a perception-perfect strategy for sophisticates requires that, at each subgame, each player chooses optimally given her current preferences, her knowledge of

11. The cost reduction generated by company could potentially be assumed to be fixed. However, this would imply that, in a setting with increasing costs, the cost reduction generated by company would be bigger in earlier periods than in later ones. Since there is no reason why the beneficial effect of company should vary over time, the case of a fixed company-induced cost reduction is not insightful.

12. It could alternatively be assumed that individuals dislike company ($\kappa < 0$), or, more plausibly, that they have heterogeneous preferences for company. Exploring behavior under heterogeneous attitudes towards company is left for future research.

13. As further discussed in Section VI, an incomplete information version of my model would allow for describing situations in which individuals do not know each other's tendency to procrastinate.

her future behavior *and* her knowledge of her opponent's behavior given her own.

In any dynamic game between present-biased agents, it is necessary to specify whether each player can correctly predict her opponent's future behavior. I call a player "peer-sophisticated" if in equilibrium her beliefs about her opponent's strategies are correct, and assume that in a procrastination game every player is peer-sophisticated.[14]

ASSUMPTION 3. In any procrastination game $\mathcal{G}$, every player $i \in \{A, B\}$ is peer-sophisticated.

When both players are sophisticated and peer-sophisticated, a pair of strategies $(\mathbf{s}_A, \mathbf{s}_B) \equiv ((a_{A,1}, a_{A,2}(a_{B,1})), (a_{B,1}, a_{B,2}(a_{A,1})))$ is an equilibrium of the game $\mathcal{G}$ if, in every node, each player $i \in \{A, B\}$ plays a perception-perfect strategy for sophisticates given her opponent's behavior.[15] I shall call the solution concept thus defined "Perception-Perfect Equilibrium" for sophisticates (hereafter PPE). Because both players are sophisticated and peer-sophisticated, backward induction can be used as a solution concept. A PPE is equivalent to a subgame perfect Nash equilibrium.

DEFINITION 1. (PPE). Given a procrastination game $\mathcal{G}$, a pair of strategies $(\mathbf{s}_A, \mathbf{s}_B)$ is a PPE for sophisticates if, for $i \in \{A, B\}$, $\mathbf{s}_i \equiv (a_{i,1}, a_{i,2}(a_{-i,1}))$ satisfies, for all $t \in \{1, 2\}$ and for every τ_{-i}, $a_{i,t} = 1$ if and only if $U_i^t(t, \tau_{-i}) \geq U_i^t(\tau_i', \tau_{-i})$, where $\tau_i' \equiv \min_{\tau_i > t}\{\tau_i a_{i,\tau_i} = 1\}$ and τ_{-i} is the completion date induced by $\mathbf{s}_{-i}$ and $\mathbf{s}_i$.[16]

III. EQUILIBRIA

In this section, I will characterize the equilibrium outcomes of the procrastination game when player A (she) and player B (he) are both sophisticated and have potentially heterogenous present-bias factors. Since time is discrete and multiple values of a player's present-bias factor can map into the same strategy, a player's "type" will be given by the behavior that her present-bias factor would lead to, were she acting in isolation.[17]

As discussed above, when $\kappa = 0$ the definition of strategy in a procrastination game becomes equivalent to the definition of strategy in isolation (ODR). Depending on whether $\frac{c_2}{c_3} < \frac{c_1}{c_2}$ or vice versa, there are four or three sophisticated types respectively. If $\frac{c_2}{c_3} < \frac{c_1}{c_2}$, two types procrastinate, albeit to a different extent: the "moderate procrastinator" performs the task in the second period, whereas the "severe procrastinator" waits until the last period to perform the task. The other two types perform the task in the first period. One of them does so because her bias is extremely small, while the other one does to prevent herself from procrastinating until the last period. If $\frac{c_2}{c_3} \geq \frac{c_1}{c_2}$, the "moderate procrastinator" does not exist: the types include only the "severe procrastinator" and the two types performing the task in the first period.

DEFINITION 2. (Types under sophistication). A sophisticate's type is given by the strategy she would choose in isolation.

For $i \in \{A, B\}$ and $\frac{c_2}{c_3} < \frac{c_1}{c_2}$, i's type is

i. "severe procrastinator" if $\widetilde{\mathbf{s}}_i = (0, 0)$, that is, if $\beta_i < \frac{c_1}{c_3}$;

ii. "moderate procrastinator" if $\widetilde{\mathbf{s}}_i = (0, 1)$, that is, if $\frac{c_1}{c_2} > \beta_i \geq \frac{c_2}{c_3}$;

iii. "non-procrastinator" if $\widetilde{\mathbf{s}}_i = (1, 1)$, that is, if $\beta_i \geq \frac{c_1}{c_2}$;

iv. "impatient non-procrastinator" if $\widetilde{\mathbf{s}}_i = (1, 0)$, that is, if $\frac{c_2}{c_3} > \beta_i \geq \frac{c_1}{c_3}$.[18]

For $i \in \{A, B\}$ and $\frac{c_2}{c_3} \geq \frac{c_1}{c_2}$, i's type is

i. "severe procrastinator" if $\beta_i < \frac{c_1}{c_3}$;

ii. "impatient non-procrastinator" if $\frac{c_2}{c_3} > \beta_i \geq \frac{c_1}{c_3}$;

iii. "non-procrastinator" if $\beta_i \geq \frac{c_2}{c_3}$.

The figure below illustrates the types under sophistication for $\mathbf{c} = (2,3.5,10)$.

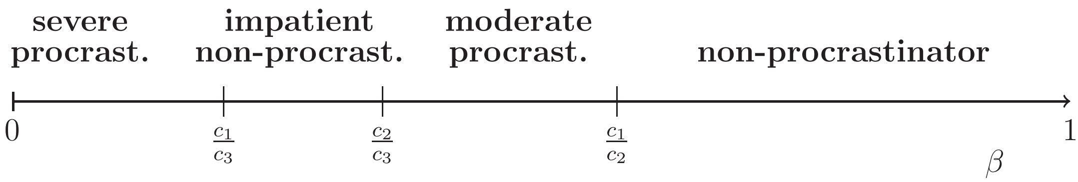
14. Note that this assumption combines ODR's notion of sequential rationality with regard to the player's own future selves with the standard notion from dynamic games of sequential rationality which incorporates the other player's strategy.

15. A perception-perfect strategy profile maps into the timing of completion, that is, $\tau_i \equiv \min_t\{t | a_{i,t} = 1\}$.

16. Note that the definition of τ_i' refers to what happens on the equilibrium path.

17. The term "type" is just used to denote different procrastination profiles. As mentioned, each player has complete information on the opponent's type.

18. As observed by ODR, a sophisticate's completion date does not vary monotonically with her β. A more present-biased person may do the task earlier than a less present-biased one as she knows that, if she waited, she would delay. The less present-biased person knows that she can afford to wait.



In most of the paper, I will assume that $\frac{c_2}{c_3} < \frac{c_1}{c_2}$, as the most interesting case is the interaction between two different types of procrastinators. Moreover, as discussed at the end of Section A, this kind of cost increase is plausible in several real-life situations, particularly for tasks involving performance. For completeness, in Appendix C (Supporting information) I will also present the equilibria of the model under the alternative cost assumption.[19]

A. Heterogeneous Types: Two Different Procrastinators

In this subsection, I assume that $\frac{c_2}{c_3} < \frac{c_1}{c_2}$ and analyze the interaction between a moderate procrastinator and a severe procrastinator.

PROPOSITION 1. *The interaction between a moderate procrastinator B and a severe procrastinator A weakly reduces procrastination: either they behave as in isolation, or one of them does the task earlier than in isolation, or both do it earlier.*

a. *Avoidance of bad company: If* $\beta_A < \frac{c_1(1-\kappa)}{c_3}$ *and* $\beta_B < \frac{c_2}{c_3(1-\kappa)}$, *the unique equilibrium of the procrastination game* $\mathcal{G}$ *will be* $(\mathbf{s}_A, \mathbf{s}_B) = ((0, (0, 0)), (1, (0, 1)))$.

b. *Mutual reduction of procrastination: If* $\beta_A \geqslant \frac{c_1(1-\kappa)}{c_3}$ *and* $\beta_B < \frac{c_2}{c_3(1-\kappa)}$, *the unique equilibrium of the procrastination game* $\mathcal{G}$ *will be* $(\mathbf{s}_A, \mathbf{s}_B) = ((1, (0, 0)), (1, (0, 1)))$.

Proof. See Appendix C (Supporting information). ■

Proposition 1 states that the interaction between a moderate procrastinator and a severe procrastinator who value each other's company will weakly mitigate procrastination, provided that the extent to which they value company is not so large as to make delaying optimal from an ex ante perspective (Assumption 2).[20] The most interesting result, which I label the "avoidance of bad company", is that the bad company of a severe procrastinator can push a moderate procrastinator to act earlier than she would in isolation.

Avoidance of bad company. If the present-bias of the severe procrastinator, A, is strong enough, she will leave the task undone until the last period, as she would do in isolation. She is too present-biased to benefit from B's company: regardless of B's behavior, she will choose to delay in both the first and the second period. What happens to B when he interacts with such a "hardcore" procrastinator? If his present-bias is sufficiently strong, he will bring the task forward to the first period. The intuition is the following. Being sophisticated, B knows that if he leaves the task until the second period, he will not be able to resist the temptation to delay one additional period to enjoy A's company. In fact, while if he is by himself, he is sufficiently patient to resist the temptation to delay, in the presence of A delaying becomes increasingly tempting. As a consequence, he decides to do the task earlier than he otherwise would, so as to avoid the increased temptation that A's company would generate.

It is interesting to note that, if B had a weaker present bias, he would perform the task *later*, in the second period. In fact, in the first period he would know that he could afford to wait until the second period, as he would be sufficiently patient to resist the temptation to delay further. This implies that a procrastinator's completion date may vary nonmonotonically with his degree of present-bias. As in the individual model of procrastination by ODR, in my procrastination game the nonmonotonicity of the completion date in the degree of present-bias is driven by sophistication. When B is more present-biased, it is

19. Note that under the alternative cost assumption, the only thing that changes, besides the disappearance of the moderate procrastinator, is the condition defining a nonprocrastinator. This implies that this assumption yields only three additional cases: the interaction between nonprocrastinator and severe procrastinator, the interaction between nonprocrastinator and impatient nonprocrastinator, and the interaction between two nonprocrastinators.

20. As discussed, Assumption 2 rules out that a moderate and severe procrastinators coordinate on the last date in equilibrium.

the awareness of his stronger bias that induces him to perform the task earlier to save himself from temptation.

Also note that, if A deviated from her optimal behavior and did the task in the first period, then B would do the task in the second period, that is, $a_{B,2}(a_{A,1} = 1) = 1$.

As further discussed in Section V, the avoidance of bad company carries over to a more general setting with more than three periods or more than two players.

EXAMPLE . Consider a procrastination game where $\mathbf{c} = (2{,}3.5{,}10)$, $\kappa = 0.4$, $\beta_A = 0.1$, and $\beta_B = 0.5$. In isolation, $\widetilde{\mathbf{s}}_A = (0, 0)$ and $\widetilde{\mathbf{s}}_B = (0, 1)$. B performs the task in the second period as $3.5 < \beta_B \times 10$. The unique equilibrium of the procrastination game is $(\mathbf{s}_A, \mathbf{s}_B) = ((0, (0, 0)), (1, (0, 1)))$. B would no longer perform the task in the second period, as, due to A's presence, $3.5 > \beta_B \times 10(1 - 0.4)$. Foreseeing this, B performs the task in the first period, as $2 < \beta_B \times 10(1 - 0.4)$.

Mutual reduction of procrastination. Suppose that B is a moderate procrastinator as above, and A is still a severe procrastinator but her bias is now weaker than in the previous case. Then, the unique equilibrium of the game will be for A and B to coordinate to do the task in the first period, earlier than either of them would in isolation. The intuition is the following. Unlike in the previous case, A is now sufficiently patient that, while she would not do the task in the first period by herself, she would in the presence of B, as his company makes doing the task in the first period less costly, and thus delaying less tempting. A prefers doing the task in the first period with B to doing it in the third period without him. Therefore, A's company induces B to do the task one period earlier than he would in isolation, and B's company induces A to do the task two periods earlier than in isolation.

Similarly, note that, if A deviated from her optimal behavior and did not do the task in the first period, then B would no longer do the task in the second period, that is, $a_{B,2}(a_{A,1} = 0) = 0$, as he would delay until the third period with A. Also note that if B's present-bias was weaker than assumed above, then there would also be an additional equilibrium in which A and B behave as in isolation.[21]

21. Coordinating on the second period is not an equilibrium because of Assumption 2.

It can be concluded that a moderate procrastinator and a severe procrastinator are weakly better off—from an ex ante perspective—interacting with each other than acting as in isolation: their interaction will not lead either of them to delay further, but can lead one or both to delay less.

Discussion. It is worth pointing out what the necessary conditions for the avoidance of bad company are and discussing their validity. The first condition is present-bias. As further discussed in Section V, in a variant of the game with exponential discounting, the avoidance of bad company is not obtained. In equilibrium two heterogeneous exponential discounters (who would perform the task in the second and third periods in isolation) would behave as in isolation or coordinate. Present-bias is supported by extensive evidence. The second condition is sophistication. As further discussed in Section V and Appendix B.3 (Supporting information), if the moderate procrastinator was naïve, he would fail to foresee the increased temptation generated by company in the second period. Empirical evidence supports the assumption of sophistication. Many onerous tasks are recurrent in nature and individuals can learn about their present-bias over time. The third condition is that the cost of performing the task increases over time, and, more specifically, the cost increase between the third period and the second is bigger than the cost increase between the first period and the second. If costs were nonincreasing, the avoidance of bad company would not occur (see Section V). As mentioned in Sections I and II, tasks often get increasingly onerous over time, as delaying may generate monetary or psychological costs. For many tasks involving performance, such as working on a school assignment or writing a work report, it is plausible that the increase in stress generated by delaying is nonlinear: the increase in anxiety a student or an employee will experience when postponing the task from the second date to the last will be bigger than the increase in anxiety generated by a delay between the first date and the second. The fourth condition is a (bounded) preference for company. As discussed in Section I, empirical evidence from vaccinations and cancer screening, as well as anecdotal evidence, suggest that people prefer to perform tasks when others do. It is reasonable to think that such a preference for coordination is not unbounded: people also care about performing tasks when it is not too costly to do so.

B. Heterogeneous Types: Other Cases

In this subsection, I summarize the main findings from the other cases of interaction between heterogeneous types.[22] A severe procrastinator and a nonprocrastinator/impatient nonprocrastinator will either behave as in isolation or coordinate on the third or first period. Similarly, a moderate procrastinator and a nonprocrastinator/impatient nonprocrastinator will either behave as in isolation or coordinate on the second or first period.

PROPOSITION 2. *The interaction between a procrastinator and a nonprocrastinator may mitigate or exacerbate procrastination: either they behave as in isolation, or they coordinate on one of the completion dates they would have chosen in isolation.*

Finally, a nonprocrastinator and an impatient nonprocrastinator will either behave as in isolation or coordinate on the second period. These results show that in some cases interaction may be harmful. Most notably, a nonprocrastinator may be induced by a moderate procrastinator or by a severe procrastinator to delay.

C. Homogeneous Types

In a procrastination game between players of the same type, behaving as in isolation is always an equilibrium. There can also be additional equilibria in which the players coordinate on an alternative date.[23] In particular, two procrastinators of the same type—two moderate procrastinators or two severe procrastinators—will perform the task when they would in isolation. If their present bias factors are sufficiently high, there will also be an additional equilibrium in which they perform the task in the first period. Two nonprocrastinators of the same type—two nonprocrastinators or two impatient nonprocrastinators—will perform the task in the first period as in isolation. If their present bias factors are sufficiently low, there will also be additional equilibria in which they perform the task at a later date. Thus, the interaction between two procrastinators of the same type is weakly beneficial and the interaction between two nonprocrastinators is weakly harmful.

PROPOSITION 3. *The interaction between two procrastinators of the same type weakly reduces procrastination: either they behave as in isolation or they coordinate on the first period. The interaction between two nonprocrastinators weakly exacerbates procrastination: either they behave as in isolation or they coordinate on a later date.*

Proof. See Appendix C (Supporting information). ■

The following remark summarizes the impact of interaction on procrastination.

REMARK . Procrastination is weakly mitigated when two procrastinators interact, and weakly exacerbated when two nonprocrastinators interact. It may be mitigated or exacerbated when a procrastinator and a nonprocrastinator interact.

These results have interesting implications for firms that want their employees to perform tasks on time. As pointed out by an anonymous referee, the cost reduction generated by company can be interpreted as economies of scale from teamwork. The first core implication is that working in teams *can* reduce procrastination, even when, as in my setting, employees work on individual tasks. However, simply letting employees work together will not necessarily help: the impact of teamwork on procrastination depends on the individual tendencies to procrastinate of the team members. As an example, two employees who both tend to procrastinate when they work by themselves—to the same extent or to a different extent—should be paired up, as their interaction may lead them to perform tasks earlier, but not later. In contrast, two employees who do not tend to procrastinate when they work by themselves should not be paired up, as their interaction may lead them to procrastinate. Hence teamwork is (weakly) better than individual production when employees have—similar or different—tendencies to procrastinate in isolation, and (weakly) worse when employees do not tend to procrastinate in isolation.

D. Equilibrium Selection

As shown above, procrastination games may yield multiple equilibria, especially when players have homogeneous types. Equilibrium selection in dynamic games with simultaneous

22. When I study the interaction between a moderate procrastinator and any of the other types, I implicitly assume that $\frac{c_2}{c_3} < \frac{c_1}{c_2}$ as the moderate procrastinator would not exist otherwise. I solve the model also under the cost assumption $\frac{c_2}{c_3} \geq \frac{c_1}{c_2}$ when such assumption leads to changes in the definition of types (see Appendix C, Supporting information).

23. If there is a unique equilibrium, it will be equivalent to the isolation behavior.

moves and time (in)consistent players is an unexplored and compelling area. In Appendix A (Supporting information), I define and analyze the two main equilibrium selection criteria, Pareto-dominance and risk-dominance, in procrastination games with homogeneous types and multiple equilibria. I find that for players of the same type, there is a general result: behaving as in isolation will always be the risk-dominant and payoff-dominant equilibrium—if not the unique one (Proposition 5). This implies that, even if the interaction between two players of the same type can lead to coordination on an earlier date (see Section C), such welfare-improving outcomes are not expected to be chosen. Company—whether potentially beneficial or potentially harmful—may not have any effect. This suggests that pairing up two different procrastinators is more likely to be beneficial than pairing up two procrastinators of the same type.

For players of different types, these selection criteria do not yield a general result: the risk-dominant outcome and payoff-dominant outcome will crucially depend on the costs and the degree of present-bias.

IV. MATCHING PROCRASTINATORS

The model's results imply that a principal who can observe the agents' tendencies to procrastinate can induce them to delay less by matching them with each other *in the appropriate way*, thereby improving their welfare and reducing inefficient delay. A natural and important question is then whether, given two types of agents, the efficient matching—the matching that minimizes overall procrastination—is stable. If it is, then principals can allow agents to match freely. If it is not, then a principal who can observe the agents' time preferences should sort types, and a principal who cannot observe them should match them randomly rather than allowing for free matching.

Consider a procrastination game between a severe procrastinator A with $\beta_A < \frac{c_1(1-\kappa)}{c_3}$ and a moderate procrastinator B with $\beta_B < \min\left\{\frac{c_2}{c_3(1-\kappa)}, \frac{c_1}{c_2}\right\}$. In the unique equilibrium of the game B will do the task earlier than he would in isolation, and A will do the task when she would in isolation. If two severe procrastinators with $\beta_A < \frac{c_1(1-\kappa)}{c_3}$ interact, in the unique equilibrium of the game they will both perform the task in the third period as in isolation. If two moderate procrastinators with $\beta_B < \min\left\{\frac{c_2}{c_3(1-\kappa)}, \frac{c_1}{c_2}\right\}$ interact, in the risk- and payoff-dominant equilibrium of the game they will both perform the task in the second period as in isolation. This implies that, in a population of severe procrastinators A with $\beta_A < \frac{c_1(1-\kappa)}{c_3}$ and a moderate procrastinators B with $\beta_B < \min\left\{\frac{c_2}{c_3(1-\kappa)}, \frac{c_1}{c_2}\right\}$, overall procrastination will be lower if each person is paired with someone of the opposite type (negative assortative matching), rather than with someone of the same type (positive assortative matching). In what follows, I explore whether the matching that minimizes overall procrastination is stable.

Consider a finite set of individuals $\Omega = \{1, 2, \ldots, n\}$ and two even sets Ω_A and Ω_B of agents of type A and B. Let $\Omega = \Omega_A \cup \Omega_B$. A matching μ is a one to one mapping from Ω onto itself such that for all $i, j \in \Omega$, if $\mu(i) = j$, then $\mu(j) = i$, where $\mu(i)$ denotes the partner of individual i under the matching.[24] If $\mu(i) = i$, then agent i is single under μ.

A matching μ is *positively assortative* when, if $i \in \Omega_x$, then $\mu(i) \in \Omega_x$, for $x \in \{A, B\}$ and $\mu(i) \neq i$ for all $i \in \Omega_x$. If $n_x \leq n_{-x}$, a matching μ is *negatively assortative* when, if $i \in \Omega_x$, then $\mu(i) \in \Omega_{-x}$ for all $i \in \Omega_x$ and for $x \in \{A, B\}$. As individuals of the same type are indistinguishable, individuals only care about which type they are matched to.

A matching μ is stable, from an *ex ante* perspective, if (a) each player strictly prefers her partner to being single, and (b) for no pair $\{i, j\} \in \Omega$ it is the case that i strictly prefers j to $\mu(i)$ and j strictly prefers i to $\mu(j)$.[25]

PROPOSITION 4. *In a population* Ω *of severe procrastinators A with* $\beta_A < \frac{c_1(1-\kappa)}{c_3}$ *and moderate procrastinators B with* $\beta_B < \min\left\{\frac{c_2}{c_3(1-\kappa)}, \frac{c_1}{c_2}\right\}$, *a matching* μ *is stable if and only if it is positively assortative.*

Proof. See Appendix C (Supporting information). ■

A matching between a moderate procrastinator with $\beta_B < \min\left\{\frac{c_2}{c_3(1-\kappa)}, \frac{c_1}{c_2}\right\}$ and a severe

24. This is a version of what is known as the roommate problem (Gale and Shapley 1962).

25. Stability is defined using an ex ante perspective as at time 0 individuals are not present-biased and prefer to commit to perform the task earlier.

procrastinator with $\beta_A < \frac{c_1(1-\kappa)}{c_3}$, despite being the matching that minimizes overall procrastination, will not be stable.[26] This is due to the fact that two severe procrastinators will strictly prefer being with each other to being each with someone of the other type. In fact, when two severe procrastinators are matched with each other, they will both do the task in the last period, thereby facing a cost $c_3(1-\kappa)$, whereas when either is matched with someone of the other type in the unique equilibrium of the game they will do the task in the last period by themselves (as their partner will do the task earlier), thereby facing a cost $c_3 > c_3(1-\kappa)$.[27]

This result implies that, when a principal can observe the agents' tendencies to procrastinate, then he will prefer to sort types rather than allow for free matching,[28] whereas when he cannot observe that, he will prefer to match the agents randomly rather than letting them choose their partner.

Now consider a procrastination game between a severe procrastinator A with $\beta_A \geq \frac{c_1(1-\kappa)}{c_3}$ and a moderate procrastinator B with $\beta_B < \min\left\{\frac{c_2}{c_3(1-\kappa)}, \frac{c_1}{c_2}\right\}$. In the unique equilibrium, A and B will coordinate on doing the task earlier than each of them would in isolation. In a population of severe types A and moderate types B satisfying these conditions, overall procrastination will be lower if A and B types are matched with each other than with their own types. A negatively assortative matching is then efficient and stable.

These results are relevant for firms wishing to reduce inefficient delays caused by their employees and to assess the potential advantages of teamwork. When employers know or can easily elicit their employees' tendencies to procrastinate, they should pair them up based on these characteristics. For example, they should pair up employees who tend to procrastinate in isolation, as teamwork will weakly reduce inefficient delay, but should not pair employees who do not procrastinate in isolation, as their interaction may lead them to procrastinate. When employers do not know their employees' tendencies to procrastinate, then it is better to pair them up randomly than to allow them to choose their teammates.

26. My definition of efficiency does not account for the benefit of company. An alternative approach would be to account for it. In this case, a positively assortative matching *could* be efficient.

27. It is assumed that re-matching is not possible. If nobody performed the task in the first period, then in the second period positively assortative matching would become efficient and thus a principal would want to allow for re-matching. If moderate procrastinators were aware of the possibility of re-matching, they would choose not to perform the task in the first period.

28. As discussed in the introduction, teachers and employers may be able to observe their agents' time preferences from their past procrastination behavior or elicit them through questionnaires.

V. EXTENSIONS

In this section I discuss a number of extensions. First, I discuss how my main results, particularly the avoidance of bad company, carry over to a more general setting with more than three periods or with more than two players. Second, I discuss variants of my model with naïveté, exponential discounting and nonincreasing costs to explore how the avoidance of bad company depends on sophistication, present-bias and increasing costs.

More than 3 periods. In a procrastination game between two heterogeneous procrastinators and with more than three periods, the avoidance of bad company and mutual reduction of procrastination equilibria still exist, provided that the two heterogeneous procrastinators would perform the task in *adjacent* periods in isolation. Most notably, the avoidance of bad company is still obtained as a unique equilibrium (Appendix B.1, Proposition 6, Supporting information). In a procrastination game between procrastinators and nonprocrastinators with more than three periods, coordination on the first period can still be an equilibrium (see Section B.1, Proposition 7, Supporting information) and becomes *more* likely, as delaying the task to the penultimate or last periods gets increasingly costly.

More than 2 players. The challenge of procrastination games with more than two players is that behavior depends on how a player's preference for company is assumed to vary with the number of players. At one extreme, it could be assumed that the company of one is enough: additional players do not further reduce the cost of performing the task. At the other extreme, it could be assumed that each additional player further reduces the cost by a fraction κ. Something in between seems more plausible: the company of each additional player further reduces the cost, but at a decreasing rate. I assume that a player's cost of performing the task in a given period is reduced by a fraction κ if another player performs the task in the same period, and is further reduced by a fraction $\frac{\kappa}{2}$ if a third player performs the task in the same period. Furthermore, I assume that the cost reduction generated by company cannot be so large as to make the task non-costly.

How do the avoidance of bad company and the mutual reduction of procrastination equilibria carry over to a setting with more players? In a procrastination game with one severe procrastinator A and two moderate procrastinators B_1 and B_2, the additional temptation generated by one severe procrastinator is enough to induce two moderate procrastinators to act earlier than they would in isolation (Appendix B.2, Proposition 8, Supporting information). As the number of moderate procrastinators increases, the avoidance of bad company equilibrium becomes less likely and the mutual reduction of procrastination more likely. The intuition is that, as the number of moderate procrastinators increases, the cost of acting for the severe procrastinator in the first period rather than in the third decreases.

In a procrastination game between procrastinators and nonprocrastinators, as the number of nonprocrastinators increases, coordination on the first period becomes more likely (Appendix B.2, Proposition 9, Supporting information).

Naïveté. In Appendix B.3 (Supporting information) I relax the assumption that both players are sophisticated. to explore whether a naïve player is able to avoid bad company. I find that, in a procrastination game between a naïve moderate procrastinator B and a (sophisticated) severe procrastinator A, the unique equilibrium will be to coordinate on performing the task in the last period (Proposition 10). In the first period, B delays as he thinks he will do the task in the second period. But in the second period, he will not be able to resist the temptation to delay further as A's company makes delaying additionally tempting. Thus, a naïve moderate procrastinator will *not* be able to avoid a severe procrastinator's bad company, as he will fail to foresee the additional temptation that bad company will generate. A player's capacity to avoid the exposure to peer-enhanced temptation requires her to be aware of her own and her peer's self-control problems. As in ODR, in my strategic setting naïveté exacerbates procrastination.

Exponential discounting. The avoidance of bad company result would not be obtained in a game between heterogenous exponential discounters who value each other's company. Consider an exponential discounter A, whose δ_A is such that she would perform the task in the third (and last) period in isolation, and an exponential discounter B, whose δ_B is such that he would perform the task in the second period in isolation. In equilibrium A and B will behave as they would in isolation and/or coordinate on one of the three periods.[29] This shows that, while a preference for company alone can induce coordination on a date that one or both of the two players would not choose in isolation (as in the mutual reduction of procrastination), the avoidance of bad company requires both preference for coordination and present-bias. In the procrastination game it is because of his present-bias (and sophistication) that B performs the task in the first period, without A. In contrast, in a coordination game between exponential discounters, B will not perform the task in the first period without A, as he prefers to perform it in the second period without A *and* knows that, when the second period comes, he will still prefer that.

Nonincreasing costs. It is interesting to observe that while the avoidance of bad company can push one to act earlier, it cannot push one to act *too* early, that is, when it is not optimal from an ex-ante perspective.[30] Suppose that the lowest-cost period is period 2. In equilibrium moderate procrastinator B will never perform the task in period 1 to avoid the increased temptation generated by severe procrastinator A in period 2. In fact, such behavior would require that (a) B prefers to do the task in period 3 with A than in period 2 alone, and (b) B prefers to do the task in period 1 alone than in period 3 with A. Conditions (a) and (b) are both satisfied if and only if the cost of doing the task in period 1 is lower than the cost of doing it in period 2.

VI. CONCLUSION

This paper has developed a strategic model of time-inconsistent procrastination to investigate the impact of social interaction on procrastination behavior when individuals value each other's company. The key and novel feature of the model is that individuals prefer to perform an onerous task when others do, as company makes the task feel less unpleasant. This simple assumption turns their individual task-completion decisions into a coordination game. The model is

29. In an exponential discounting-version of the numerical example above, where $\delta_A = 0.1$ and $\delta_B = 0.5$—and thus the completion dates of A and B in isolation would be periods 3 and 2 respectively—the unique equilibrium of the game is for A and B to coordinate on performing the task in the third period.

30. I thank an anonymous referee for bringing my attention to this case.

used to establish when the company of a peer reduces procrastination, and thus how principals can match individuals with each other to improve their welfare and reduce inefficient delay.

I find that interaction can lead to new, welfare-improving outcomes relative to the case in which people act in isolation. Most notably, the company of a severe procrastinator can push a moderate procrastinator to act earlier than he would in isolation, to avoid the additional temptation that his peer would generate (which I call "avoidance of bad company"). Whether interaction exacerbates or mitigates the procrastination that would emerge in individual decisions will crucially depend on each player's type, which is given by what their behavior in isolation would be. The interaction between two heterogeneous procrastinators weakly mitigates procrastination. Either they behave as they would in isolation, or one of them does the task earlier (avoidance of bad company), or both of them do (mutual reduction of procrastination). The interaction between two homogeneous procrastinators weakly reduces procrastination, and the interaction between two homogenous nonprocrastinators weakly exacerbates it. In either case, behaving as in isolation is still an equilibrium, but there may also be additional equilibria where two procrastinators coordinate on an earlier date and two nonprocrastinators on a later one. Interaction may also be harmful when a procrastinator interacts with a nonprocrastinator. This suggests that letting individuals free to choose their partner will not necessarily reduce overall procrastination in a group. Principals who can observe or elicit individuals' tendencies to procrastinate should match them on the basis of that. Principals who cannot observe individuals' tendencies to procrastinate should match them randomly rather than allow for free matching.

This paper raises a number of questions that future research can address. First, I assume that agents know each other's time-preferences. While this is plausible in the case of close social ties (e.g., spouses, siblings, flatmates, coworkers, close friends), it may be less so in the case of more distant social ties. A natural extension would be to develop an incomplete information version of my model and use it to explore how people influence each other's procrastination behavior—and thus how they should be matched with each other—when they do not know each other's time-preferences. Second, future work can extend my model to the case in which individuals differ in the extent to which they value (or dislike) company, and to the case in which individuals value the company of close ties more than the company of weaker ties. Third, future research can explore a sequential-move procrastination game. Who should move first, and who will want to move first? On the one hand, players may prefer to move first to pull the other towards their preferred completion date. On the other hand, present-bias may induce them to delay their decision by moving second. Finally, future research can test the avoidance of bad company result through laboratory or field experiments.

VII. CONFLICT OF INTEREST

The author declares that she has no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Supporting information