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Time-Inconsistent Bargaining and Cross-Commitments

Manuel A. Utset

College of Law, Florida State University, Tallahassee, FL 32306-1601, USA; mutset@law.fsu.edu

Abstract: The paper studies bargaining games involving players with present-biased preferences. The paper shows that the relative timing of bargaining rewards and bargaining costs will determine whether the players' present-bias will affect bargaining outcomes. In cases where players agree to a bargain in period 1 and experience all bargaining payoffs in period 2, the players will act in a time-consistent fashion. When time-inconsistent players incur immediate bargaining costs to produce delayed rewards, they will have an incentive to procrastinate. On the other hand, when players receive immediate bargaining rewards and incur delayed costs, they will have incentives to agree to bargains too soon and to agree to inefficient bargains. The paper shows that the players' awareness of their own and the other player's present-biased preferences will determine whether they engage in repeated time-inconsistent bargaining. A naïve player who engages in time-inconsistent bargaining will suffer welfare losses. We show that time-inconsistent bargaining can also create spillover welfare losses for other players. A time-consistent player who is counterparty-naïve about the other player can suffer spillover welfare losses that can be higher than those incurred by the time-inconsistent player. As a result, counterparty-sophisticated players will have an incentive to use cross-commitment devices to reduce the likelihood of spillover welfare losses. The paper also shows that cross commitment devices that target immediate payoffs dominate cross-commitments that target delayed payoffs. Finally, the paper shows that time-inconsistent bargaining can lead to inefficient delays in agreeing to bargains and in exiting bargaining relationships.

Keywords: time preferences; present bias; bargaining; commitment; delay

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1. Introduction

While standard economic models assume that agents have time-consistent preferences [1,2], both experiments and evidence from the field have shown that real-world agents routinely exhibit a preference for immediate gratification that can lead them to engage time-inconsistent behavior [1]. In the wake of these findings, a vast literature has developed on the welfare and policy implications of self-control problems due to present-biased preferences [1]. Agents who are not sufficiently aware of the magnitude of their present-bias may repeatedly reverse optimal long-term plans solely due to the pull of immediate gratification [2,3,6,14–16]. Each time that they engage in this sort of time-inconsistent behavior, they incur a welfare loss [17]. Lawmakers, in turn, have adopted consumer protection laws and other legal rules, including state-provided mandatory and default commitment devices, to reduce potential welfare losses [2].

While there is a growing literature on the effects of present-biased preferences on bargaining decisions, commentators have not yet given sufficient attention to a number of factors that will determine the extent to which players will incur large welfare losses due to their present-biased preferences. These factors include the relative timing of bargaining costs and bargaining rewards; the likelihood of repeated bargaining procrastination, preconsumption, and overconsumption; the interplay between self-awareness and counterparty-awareness; and the efficient use of self-commitment and cross-commitment devices.

This paper sets forth a general model of time-inconsistent bargaining in which bargaining payoffs can occur in the same or in different periods and in which players have different levels of awareness of their own and the other player's present-biased preferences. Moreover, the players can create cross-commitment devices by determining the relative timing of bargaining payoffs. The paper shows that present-biased preferences can affect bargaining outcomes only in contexts involving immediate and delayed bargaining payoffs. In particular, if players can reach a bargain in period 1 and experience all bargaining payoffs in period 2, they will behave in the same manner as the time-consistent, exponential discounters of standard bargaining models. Moreover, in take-it-or-leave-it bargaining situations in which players experience all bargaining payoffs in the period in which they reach a bargain, the players will again behave in a time-consistent manner. Players in the latter two types of bargaining scenarios will incur no welfare losses due to their present-biased preferences.

The paper distinguishes between two types of time-inconsistent bargaining contexts. In the first, players incur immediate bargaining costs in order to produce delayed bargaining rewards. In immediate-costs scenarios, time-inconsistent players will have an incentive to procrastinate agreeing to a bargain and following through with other planned bargaining actions. In the second context, players receive immediate bargaining rewards and incur delayed bargaining costs. In immediate-rewards scenarios, players will have an incentive to preconsume, agreeing to bargains too soon, and to overconsume, agreeing to one or more non-optimal bargains solely due to the added weight that time-inconsistent players give to immediate rewards. The paper shows that even a relatively small preference for immediate gratification can lead to repeated bargaining procrastination, and thus to large aggregate welfare losses. Repeated procrastination can help explain observed bargaining delays that are sometimes blamed on other types of informational frictions. Overconsumption of inefficient bargains can also produce large aggregate welfare losses for players who enter into a large number of transactions. Preconsumption, on the other hand, can sometimes improve the players' joint welfare since it can increase the likelihood that time-inconsistent players will follow through with a planned bargain. This will be true in bargaining scenarios in which the efficient result is for the players to agree to a bargain immediately. Drawing a clear distinction between bargaining procrastination, overconsumption, and preconsumption is therefore important for determining when present-biased preferences can produce welfare losses.

Both self-awareness and counterparty-awareness can affect bargaining outcomes. A player's level of self-awareness will depend on her ability to accurately predict how her future selves will behave when faced with immediate bargaining payoffs. A naïve player incorrectly believes that her future selves will exhibit no present-biased preferences and will thus act in a time-consistent manner. Sophisticated players are fully aware of the magnitude of their present-biased preferences and thus have rational expectations. Partially naïve players know that their future selves will exhibit present-biased preferences but underappreciate their true magnitude [26]. The paper introduces the concepts of counterparty-naïve, counterparty-sophisticated, and counterparty-partially naïve to describe a player's awareness of the present-biased preferences of other players. Counterparty-naïve players can make suboptimal bargaining decisions, in the same manner as when they bargain with other types of incomplete information.

The paper shows that a time-consistent player who is counterparty-naïve can suffer spillover welfare losses due to the other player's time-inconsistent behavior. In some instances, the counterparty-naïve player's welfare losses can be greater than those incurred by the time-inconsistent player. A counterparty-sophisticated player worried about potential spillover welfare losses will have an incentive to create cross-commitment devices to cause the other player to act in a time-consistent fashion. The paper shows that cross-commitment devices that target a time-inconsistent player's delayed payoffs are always dominated by cross-commitments that target immediate payoffs. Counterparty-sophisticated players can also use cross-commitment devices to increase their own bargaining power to extract rents from sufficiently naïve players [3]. Players who are sufficiently sophisticated about their own present-biased preferences will have an incentive to engage in pre-play commitment [4] and enter the game with time-consistent preferences. As a result, standard bargaining models would apply without modification.

The paper makes three main contributions to the literature on time-inconsistent bargaining. First, the paper shows that the relative timing of bargaining payoffs is a key driver of time-inconsistent bargaining. Moreover, the paper shows that drawing a clear distinction between procrastination, preconsumption, and overconsumption can help to better specify the contexts in which time-inconsistent bargaining will occur. The paper's second contribution is to identify contexts in which cross-commitment and pre-play commitment devices come into play and the consequences of using those devices. Relatedly, the paper shows that, in order to minimize the costs of cross-commitment and pre-commitment devices, players should first target immediate payoffs.

The paper's third contribution is to identify a set of intertemporal bargaining decisions that are particularly susceptible to preference reversals. We show that, all other things being equal, time-inconsistent bargainers are more likely to: delay agreeing to a bargain; reject worthwhile bargains and accept non-worthwhile ones; and delay entering and exiting bargaining relationships, including delaying exercising their outside options. The current literature on time-inconsistent bargaining has focused on how present-biased preferences affect the two key bargaining decisions: making a proposal and accepting or rejecting a proposal. We show that the same factors play a role in other bargaining decisions, such as entry and exit decisions.

This paper is related to the growing literature that extends the insights from single-person self-control models to bargaining contexts involving two or more players with different levels of awareness of their own and the other players' present-biased preferences [5]. Sarafidis [50] introduces the concept of naïve backward induction to model naïve players. In games between two naïve players, some bargains are reached immediately, while others are subject to inefficient delays. In games between a naïve and a sophisticated player, the naïve player will have a bargaining advantage—the sophisticated player will offer a higher portion of the surplus to get an agreement. Akin [45] models players who hold correct beliefs about the present-biased preferences of other players. The author concludes that two naïve players will never reach a bargain and that a sophisticated player will offer a naïve player a larger share of the surplus to get her to agree [6]. Haan and Hauk [52] show that bargaining breakdowns occur in games between two naïve players who are sophisticated about each other's present-bias. Additionally, the authors show that if players are sophisticated about their own present-bias, but naïve about the other player's bias, they agree to a bargain immediately. Kodritsch [44] assumes that players are sophisticated about their own and the other player's present-bias. Players agree to a bargain immediately and the equilibrium solution is unique. All payoffs are received immediately which reduces the problem to a standard discounting scenario with some players having a greater degree of impatience. We, on the other hand, keep to the sharp distinction in the quasi-hyperbolic discounting literature between regular long-term impatience and present-bias-induced short-term impatience [53,54].

Additionally, unlike the four papers above, the current paper allows players to determine the timing of bargaining payoffs. In particular, the players can decide whether to distribute all or part of the bargaining surplus immediately, and players have some leeway to determine when they incur bargaining costs. The paper most similar to this one regarding the relative timing of payoffs is Lu [46]. The author models time-inconsistent players in an alternating-offers Rubinstein game in which the players bargain over a stream of bargaining surplus and make offers that would pay some of the bargaining surplus immediately and some in future periods. The author argues that the timing of bargaining payoffs plays a role in real-world bargains between firms and consumers, and employers and employees—e.g., payday loans, credit card agreements, signing bonuses and non-compete agreements. In the model, the players are sophisticated and have different levels of present-bias. The author shows that the player with the higher present-bias will demand more of the present surplus and can suffer welfare losses. Under certain conditions, players will reach the Rubinstein bargaining solution, but the equilibrium is not unique, given that the actual tradeoffs between current and future payoffs may vary. However, under other conditions the number of equilibrium payoffs increases as does the possibility of inefficient delays.

Our paper differs in an important respect: we explicitly distinguish between two types of immediate payoffs—immediate rewards and immediate costs. Standard quasi-hyperbolic discounting models show that the timing of receiving rewards and incurring costs are the main drivers of time-inconsistent behavior [16]. Additionally, we show that models that assume that both players are sophisticated about each other's present-biased preferences will reach a different result if one extends those bargaining games to allow for pre-play commitments. Finally, the paper also adds to the literature by examining spillover welfare losses from time-inconsistent bargaining and the use of cross-commitment devices to reduce those losses.

Section 2 sets forth the time-inconsistent bargaining model. Section 3 discusses the role of self-awareness in time-inconsistent bargaining scenarios. Section 4 introduces the concepts of counterparty-naïve, counterparty-sophisticated, and counterparty-partially naïve players and describes the role of counterparty awareness in creating and deterring spillover welfare losses. The section also shows how counterparties can design efficient cross-commitment devices as well as rent-extracting cross-commitments. Section 5 develops the implications of the time-inconsistent bargaining model set forth in Section 1 through Section 4. It extends the model to the Rubinstein bargaining scenario and discusses how time-inconsistent bargaining can help explain inefficient delays in agreeing to a bargain and exiting bargaining relationships.

2. Time-Inconsistent Bargaining

We assume that two players bargain over the division of a bargaining surplus. We allow for take-it-or-leave-it offers as well as sequential bargaining involving offers and counteroffers. The bargaining surplus depends both on (1) the magnitude of positive and negative bargaining payoffs (bargaining "rewards" and "costs", respectively) and (2) when those payoffs materialize. Players can make bargaining proposals that both allocate the net surplus and determine the timing of receiving bargaining rewards and incurring bargaining costs.

Players maximize their intertemporal utility function: the sum of the instantaneous utility [7] in each period, discounted to account for their level of impatience [8]. In each period, players make "bargaining decisions" by choosing the course of action that will maximize their intertemporal utility, given their beliefs of how they will act in future periods [9]. Bargaining decisions include making and rejecting bargaining proposals, entering and exiting bargaining situations, searching for counterparties and outside options, and acquiring transactional information.

We adopt the $\beta\delta$ quasi-hyperbolic approach to modeling present-biased preferences. In the $\beta\delta$-model, agents discount delayed payoffs by both a long-term discount factor, $\delta \leq 1$, and a short-term discount factor, $\beta < 1$, that captures present-bias [16,53,55,56]. Setting the players' $\beta = 1$ converts the bargaining game into the standard one with time-consistent players. Otherwise identical time-consistent and time-inconsistent players make identical long-term plans, and while time-consistent players always keep to them [2], their present-biased counterparts may override them one or more times. To isolate the intertemporal conflicts faced by players with present-biased preferences, we distinguish between long-term and short-term bargaining decisions.

Definition 1. *A long-term decision in period t is one in which a player compares two or more future payoffs and chooses the optimal course of action for period t + 1.*

Definition 2. *A short-term decision in period t + 1 is one in which a player compares both immediate and future payoffs and determines whether to reverse a period-t long-term decision.*

We will assume that a player in a bargaining game makes both long-term and short-term bargaining decisions, and that the only difference between them is the relative timing of payoffs [10]. A player's commitment to a long-term decision will depend on the costs of reversing that decision. The relevant costs are those faced by a player when she makes a short-term decision. When a player can reverse a long-term decision at zero-cost we will say that the player is not committed to the planned course of action. When reversing the decision produces a net loss (taking into account present-biased preferences), the player will be deemed to be pre-committed to the planned course of action.

Definition 3. *Players exhibit time-consistent ("TC") preferences if in period t they make a long-term decision to do A in period t + 1, and in period t + 1, they make a short-term decision to do A.*

Definition 4. *Players exhibit time-inconsistent ("TI") preferences if in period t they make a long-term decision to do A in period t + 1, and in period t + 1, they make a short-term decision not to do A, and they do so solely due to their present-biased preferences.*

2.1. Time-Inconsistent Bargaining Requires Existence of Tradeoffs between Immediate and Delayed Payoffs

Standard bargaining models posit exponential discounters who exhibit TC preferences. Exponential discounters discount future payoffs using a discount factor $\delta < 1$ and choose the course of action that will maximize the discounted sum of their instantaneous utility:

$$U_t = (u_t + \delta u_{t+1} + \delta^2 u_{t+2} + \delta^3 u_{t+3} + \ldots\ \delta^n u_{t+n}, \ldots)$$

It can be easily checked that exponential discounters discount in the same manner in period t and all subsequent periods—i.e., they always discount a one-period delay by δ, a two-period delay by δ^2, and so on.

However, the evidence on present-biased preferences suggests both that agents have declining discount rates and that they discount most heavily when making decisions involving immediate payoffs. For example, when asked to choose between USD 1 a year from today and USD 2 in a year and a day, people routinely chose the USD 2. However, when asked to choose between USD 1 today and USD 2 tomorrow, people choose the immediate USD 1. An exponential discounter would discount the one-day delay in both instances by the same discount factor δ.

One way to capture declining discount rates is to use a hyperbolic discount function [1]. However, given the observed added weight agents give to immediate payoffs as compared to any delayed payoffs, present-bias models routinely use a simpler quasi-hyperbolic discount function, with $\delta \leq 1$ capturing long-term impatience and a second discount factor, $\beta < 1$, capturing short-term impatience. A quasi-hyperbolic discounter maximizes the following intertemporal utility function:

$$U_t = (u_t + \beta\delta u_{t+1} + \beta\delta^2 u_{t+2} + \beta\delta^3 u_{t+3} + \ldots\ \beta\delta^n u_{t+n}, \ldots)$$

We will refer to the quasi-hyperbolic discounting model as *$\beta\delta$-discounting*. Because β is constant over time, it only affects bargaining decisions involving tradeoffs between immediate and delayed payoffs. In period t, a TI player compares the immediate payoffs captured by u_t with the $\beta\delta$-discounted payoffs in the following period: $\beta\delta u_{t+1}$. Because $\beta < 1$, it follows that $\beta\delta < \delta$. The added weight given to immediate gratification can also be represented by using an *immediacy multiplier* $1/\beta > 1$. For example, in period t, a TI player with a $\beta = 0.5$ and thus an immediacy multiplier of 2 gives twice as much weight to payoffs received immediately in that period as compared to those same payoffs received in any future period. Using the immediacy multiplier $1/\beta$ (as opposed to discounting all future payoffs by β) helps highlight the difference between exponential and quasi-hyperbolic discounting. TI players are not just more impatient than their TC counterparts—they are more impatient only when they are making bargaining decisions involving immediate and delayed payoffs. To highlight the qualitative difference between short-term and long-term impatience, $\beta\delta$-discounting models often set $\delta = 1$ [11].

Proposition 1. *Identical TC and TI players will act in the same manner in all periods involving only delayed payoffs. However, in periods involving immediate and delayed payoffs, TI players will give 1/β greater weight to the immediate payoffs than do TC players.*

Suppose that both types of players are in period $t-1$ considering the following delayed payoffs: TC: $U_{t-1} = (\delta u_t + \delta^2 u_{t+1} + \delta^3 u_{t+2} + \ldots\ \delta^{n+1} u_{t+n}, \ldots)$ and TI: $U_{t-1} = (\beta\delta u_t + \beta\delta^2 u_{t+1} + \beta\delta^3 u_{t+2} + \ldots\ \beta\delta^{n+1} u_{t+n}, \ldots)$. Since β remains constant, one can divide it out and show that when payoffs are all delayed both the TC and TI players reach the same long-term decision. But in period t, the TC player still discounts period $t+1$ payoffs by δ: $U_{\mathrm{t}} = (u_t + \delta u_{t+1} + \delta^2 u_{t+2} + \ldots\ \delta^n u_{t+\mathrm{n}}, \ldots)$; while the TI player discounts period $t+1$ payoffs more severely, by $\beta\delta$: $U_t = (u_t + \beta\delta u_{t+1} + \beta\delta^2 u_{t+2} + \ldots\ \beta\delta^n u_{t+n}, \ldots)$. Dividing by β shows that the TI player gives $1/\beta$ greater weight to u_t over u_{t+1} than does the TC player. Moreover, from the perspective of period t, both players discount delayed payoffs from period $t+1$ onward identically. TC: $U_t = (\delta u_{t+1} + \delta^2 u_{t+2} + \ldots\ \delta^n u_{t+n}, \ldots)$; and TI: $U_t = (\beta\delta u_{t+1} + \beta\delta^2 u_{t+2} + \ldots\ \beta\delta^n u_{t+n}, \ldots)$. One can again divide out the constant β and show that when payoffs are all delayed both the TC and TI players reach the same decision. Since by assumption, both the TC and TI players are otherwise identical, it follows that the only time in which their behavior will differ is when they are making decisions involving a tradeoff between immediate and delayed payoffs.

Proposition 1 shows that not all bargaining contexts involving TI players will lead to TI bargaining behavior. In bargaining games in which players reach a bargain in period t and all payoffs materialize in period $t+1$ or later, both TC and TI players will make the same long-term and short-term bargaining decisions. Recall that a TI player with a $\beta = 0.5$ (i.e., an immediacy multiplier of 2) gives twice as much weight to immediate period t payoffs, u_t, as compared to delayed period $t+1$ payoffs, u_{t+1}. However, when players reach a bargain in period t and all bargaining payoffs materialize in period $t+1$, both TC and TI players experience the same instantaneous utility of 0 in period t. Moreover, both the TC and TI player discount the delayed period $t+1$ payoffs by the same δ and reach the same decision.

With a minor modification, one can also extend the basic intuition of Proposition 1 to bargaining contexts in which all payoffs are received immediately. Suppose that players are in a take-it-or-leave-it bargaining game. In period $t-1$, the players make a long-term decision whether to accept or reject a bargain in period t. Assume two possible scenarios. In the first, if the players agree to a bargain in period t, all bargaining payoffs will materialize in period $t+1$. Proposition 1 applies directly to this first scenario. Suppose, however, that if the players reach a bargain in period t, all payoffs materialize immediately [12]. In this second scenario, the TC and TI players make the same long-term and short-term decisions and both act in a TC manner. Moreover, the TI player's incentive to follow through with the planned bargain in period t will be greater than that of the TC player. In fact, the TI player will give $1/\beta$ greater weight to the immediate period t payoffs than does the TC player.

2.2. Immediate Costs and Immediate Rewards of Bargains: Procrastination, Preconsumption, and Overconsumption

We saw in the previous section that TI bargaining can only arise in contexts in which bargaining payoffs materialize in different periods. Payoffs can either be positive—bargaining rewards—or negative—bargaining costs. Bargaining rewards include the tangible and intangible benefits produced by a bargain, including actual monetary payoffs. Bargaining costs include a player's investment in time, effort, and money, as well as intangible costs such as anxiety and other negative emotions. As part of an overall bargain, players may also incur other types of transaction costs, including the costs of writing and enforcing contracts that accurately memorialize what the parties agreed to in their bargain [57,58] [13].

We must therefore distinguish between two types of TI bargaining scenarios. In the first type, TI players incur immediate costs to produce delayed bargaining rewards. This can lead to inefficient bargaining delays: bargaining procrastination.

Definition 5. *A TI player procrastinates when she makes a long-term bargaining decision in period t to do A in period $t + 1$ given that doing so would maximize her intertemporal utility, but when period $t + 1$ arrives, she makes a short-term decision to delay doing A solely due to the added weight that she gives to the immediate costs of doing A [16,62]. Since TC players do not have present-biased preferences, they will never engage in bargaining procrastination.*

In the second type of scenario, TI players receive immediate rewards and incur delayed bargaining costs. Under this second scenario, TI players may agree to bargains sooner than optimal and may agree to one or more bargains that TC players would reject: bargaining preconsumption and overconsumption, respectively.

Definition 6. *A TI player preconsumes when she makes a long-term decision in period t to do A in period $t + 2$ given that doing so would maximize her intertemporal utility, but when period $t + 1$ arrives, she makes a short-term decision to do A immediately solely due to the added weight that she gives to the immediate rewards of doing A. Relatedly, a TI player overconsumes when she makes a long-term decision in period t not to do A more than n times (where n may be 0) in periods $t + 1$ through T given that doing so would maximize her intertemporal utility, but she makes one or more short-term decisions to do A more than n times solely due to the added weight that she gives to the immediate rewards of doing A. TC players will never preconsume or overconsume.*

Example 1. *Suppose that a TC and a TI player each has a $\delta = 1$, and the TI player, a $\beta = 0.5$. Suppose further that from the long-term perspective of period 0, both players decide to do an onerous bargaining task, A, in period 1. The task would require them to incur immediate costs—e.g., effort—with negative utility of 100 to produce delayed bargaining rewards of 150 in period 2. In period 1, the TC player does A, but the TI player procrastinates. She applies her immediacy multiplier, $1/\beta = 2$, to the immediate costs of 100 and overrides her long-term decision, given that $200 > 150$. Alternatively, suppose that the same two players can receive immediate bargaining rewards of 100 in period 1 and that partaking of the bargaining rewards will produce delayed bargaining costs of 150 in period 2. In period 0, both players decide to abstain from partaking of the period-1 bargaining rewards. In period 1, the TC player abstains, but the TI player overconsumes, given that she now perceives the immediate rewards as 200 and the delayed costs as 150.*

2.3. One-Shot Bargaining Procrastination, Preconsumption, and Overconsumption and Maximum Welfare Loss

We have seen that TI players will reach different bargaining outcomes than their TC counterparts only in contexts in which bargaining payoffs materialize in different periods. We have also seen that the effects of a player's present-biased preferences on bargaining outcomes will differ depending on the relative timing of bargaining costs and rewards. But these two conditions by themselves are not sufficient for TI bargaining to occur. As we will now show, TI players will reverse their long-term bargaining decisions only when their present-bias, captured by their immediacy multiplier, is sufficiently great to lead them to conclude that the immediate gains from reversing their long-term decisions are greater than the delayed losses from doing so. We will also see that TI players who override their long-term decisions just once will have a maximum welfare loss that is bounded by their immediacy premium.

2.3.1. The Incentive to Override a Long-Term Optimal Plan

Suppose that player A and player B are involved in a bargaining game in which they will make one or more bargaining decisions. We will model that decision-making process as occurring over three periods. In period 0, players make long-term decisions about their bargaining strategies, and each adopts an optimal long-term plan (a *period-0 plan*). Each player makes two decisions about potential future actions: which actions to take; and the optimal period to complete those actions [14]. For example, players may form a long-term plan to *do* x in period 1; to *not do* y in period 2; and so on. Possible actions include making a bargaining proposal; accepting or rejecting a proposal; investing in information; exercising an outside option; and so on. Given the two-level strategic setting, a player's actions may be conditioned on the expected actions of the other player and of her own future selves.

In period 1, players make short-term decisions about planned actions and non-actions. Players may (1) follow through with their period-0 plans, (2) override them, or (3) update them. TI players override their period-0 plans whenever they conclude that the immediate gains from doing so exceed the delayed losses. Players who override their optimal period-0 plans solely due to their present-bias incur welfare losses.

Period-1 Immediate Gains of Overriding Optimal Plan—The Immediacy Premium:

The immediate gains depend on both the immediate payoffs and the TI player's immediacy multiplier $1/\beta > 1$. In the case of immediate costs, a player's *immediacy premium*, $(1/\beta \times c_t) - c_t$, captures her perceived immediate gains from delaying incurring immediate costs, c_t, until period 2. For example, if a player with a $\beta = 0.75$ and immediacy multiplier $1/\beta = 1.33$ must incur immediate bargaining costs of 100, she perceives those costs as 133. She thus has an immediacy premium of $(1.33 \times 100) - 100 = 33$. In the case of immediate bargaining rewards of 100, the immediacy premium is again 33.

Period-2 Delayed Losses of Overriding Optimal Plan:

The TI player will override her long-term plan only if the immediacy premium she experiences in period 1 is greater than the period-2 delayed losses. Delayed losses in the case of procrastination include the player's added costs (or reduced rewards) of acting later than the optimal period. Delayed losses from preconsumption and overconsumption include the player's added costs (or reduced rewards) from having acted too soon or consumed too much [15].

2.3.2. Welfare Losses from TI Bargaining Behavior

TI players deviate from their period-0 optimal plans intentionally, knowing that doing so will reduce their intertemporal utility and make them worse off in the long run [16]. Nonetheless, one can generally assume that TI players have a meta-preference to act in a time-consistent manner and thus that they incur welfare losses each time that they override their optimal long-term plans. Of course, players may sometimes want to let their current selves yield to temptation. However, it is unlikely that they want to go through life yielding repeatedly to whatever desires they happen to be feeling at the time. Such free-wheeling "wantons" [64] will find it difficult to coordinate, cooperate, and compete with more self-aware agents.

2.3.3. Bounded Welfare Loss in One-Shot Preference Reversals

The maximum welfare loss from yielding to immediate gratification just once is bounded by a TI player's immediacy premium. The TI player in Example 1 has an immediacy premium of 33 and will procrastinate, preconsume, or overconsume only if the delayed losses from doing so are less than 33 (assuming the player adheres to her long-term decision when indifferent). On the other hand, repeated time-inconsistent behavior can lead to very large aggregate welfare losses. Moreover, even a relatively small immediacy premium can lead to repeated procrastination, preconsumption, and overconsumption.

Example 2. *Suppose that a TI player has a relatively small present-bias captured by an immediacy multiplier $1/\beta = 1.11$ (and without loss of generality, she has no long-term impatience: $\delta = 1$). Suppose that every day she can choose to either exercise an outside option—at an immediate cost of 100—or delay until the following day, where each one-day delay reduces the option's future rewards by 10. Moreover, assume that the player has made a long-term decision that exercising the outside option immediately will maximize her net bargaining surplus. Nonetheless, each day the TI player has an incentive to procrastinate: the delayed loss of 10 is less than the immediacy premium of $11 = (1.1 \times 100) - 100$.*

2.4. Conditions for Repeated Preference Reversals and Large Welfare Losses

Whether a TI player procrastinates, preconsumes, or overconsumes repeatedly and incurs large aggregate welfare losses will depend on four factors. The first is the player's ability to accurately predict the immediacy multiplier that her future selves will use in making short-term decisions. The second is the availability of commitment devices that she can use to deter her future selves from reversing optimal long-term bargaining decisions. The third factor is the ability of the other player in the bargaining game—the counterparty—to accurately predict the immediacy multiplier that the TI player will apply during the bargaining game. The fourth factor is the availability of cross-commitment devices that the counterparty can deploy to either deter or encourage the TI player's repeated TI bargaining behavior. In other words, cross-commitment devices can be used for either benevolent or rent-seeking purposes. Section 3 focuses on the first two factors and Section 4 on the last two.

3. Self-Awareness and Self-Commitment

Recall that TC players have a $\beta = 1$ and thus when making short-term decisions they have an immediacy multiplier of 1 and an immediacy premium of 0. Given that people value flexibility, autonomy, and free will, in a world of TC players, commitment devices would not exist [65]. In the real world, however, people routinely adopt them. They pay for health club memberships [12], open savings accounts, purchase certificates of deposits that charge for early withdrawals, adopt deadlines, put retirement funds in illiquid assets, such as defined pension plans, and cut-up their credit cards [11,66]. The existence of commitment devices provides some evidence that TI players are aware of their potential self-control problems. What ultimately matters, however, is a TI player's ability to accurately predict the magnitude of the immediacy multiplier that she will apply in the future when faced with immediate payoffs. TI players who are sufficiently unaware of their actual immediacy multiplier will have an incentive to repeatedly procrastinate, preconsume, and overconsume. We consider three levels of awareness: naiveté, sophistication, and partial naiveté.

3.1. Naïve TI Players

Naïve TI players have a $\beta < 1$ and thus an immediacy multiplier $1/\beta > 1$. However, in each period, they believe incorrectly that in the following period their future selves will exhibit a $\beta = 1$ and act in a TC fashion. They reach this conclusion even while they are yielding to temptation in the current period. Naïve players will never see the need to adopt commitment devices.

Thus, naïve players may repeatedly procrastinate agreeing to worthwhile bargains, ending fruitless bargaining relationships, and exercising outside options. Repeated procrastination by naïve TI players may explain, at least in part, observed inefficient delays in bargaining. Additionally, naïve bargainers faced with the prospect of immediate bargaining rewards may repeatedly preconsume and overconsume. For example, a naïve TI player in a long-term contract may engage in *nibbling opportunism*, repeatedly grabbing small immediate rewards—e.g., cutting corners and shirking—each time thinking incorrectly that it is the last time. Over time, repeated nibbling opportunism can lead to contract breaches and erosion of reputation.

3.2. Sophisticated TI Players

Sophisticated TI players correctly predict their future immediacy multiplier $1/\beta > 1$ and immediacy premium. They know that their future selves will override optimal long-term bargaining decisions whenever the immediacy premium from doing so exceeds the delayed losses. They also have rational expectations, which will help them in cases of potential procrastination, but may hurt them in cases of potential preconsumption.

Suppose a sophisticated player must complete an onerous bargaining task in periods 1, 2, 3, or 4, and has made a long-term decision to complete the task in period 1. However, the sophisticated player also knows that each period she will compare an immediacy premium of 15 with a delayed procrastination loss of 10 and will have an incentive to procrastinate. She has rational expectations and thus knows that if she procrastinates until period 3, she will procrastinate until period 4. This means that if she procrastinates in period 2, she will end up procrastinating until period 4. Procrastinating for two periods produces an aggregate welfare loss of 20, which exceeds the period 2 immediacy premium of 15. Knowing that she will definitely complete the task in period 2, the sophisticated player concludes that she can safely procrastinate in period 1. The sophisticated player will suffer a relatively small welfare loss of 10 from procrastinating just once.

Suppose instead that a sophisticated player is in a bargaining game in which she will receive an immediate reward at the time of the bargain. Suppose also that she can agree to a bargain in periods 1, 2, 3, or 4, and that she has made a long-term decision that waiting until period 4 would maximize her bargaining surplus. Moreover, the sophisticated player knows that in each period she will compare an immediacy premium of 15 with a delayed loss of 10. The sophisticated player now reasons that if she reaches period 3, she will agree to the bargain then and not wait until period 4. She also reasons that if she reaches period 2, she will agree to the bargain then instead of waiting until period 3. As a result, she knows that she will have an incentive to agree to the bargain in period 1 given her immediacy premium of 15 and delayed loss of 10.

These two examples illustrate why it is important to draw a distinction between bargaining decisions involving immediate bargaining costs and those involving immediate bargaining rewards. In immediate-costs scenarios, sophistication helps, while in immediate-rewards scenarios, sophistication hurts. Knowing this, a sophisticated player will have an incentive to engage in pre-play commitment whenever she knows that she will be making short-term bargaining decisions involving immediate rewards.

3.3. Partially Naïve TI Players

Partially naïve TI players know that their future selves will apply an immediacy multiplier $1/\beta > 1$, but they underappreciate its true magnitude. For example, a partially naïve player may have a $\beta = 0.5$ and immediacy multiplier of 2 but believe incorrectly that she has a $\beta = 0.9$ and an immediacy multiplier of 1.1. Since it is the actual immediacy multiplier that will determine the immediacy premium, a partially naïve player who sufficiently underappreciates her true present-bias will act in the same manner as a fully naïve player, and one whose misprediction is less severe will act as a fully sophisticated player.

3.4. The Paucity of Learning

One would expect TI players will, after a while, learn their true immediacy multiplier $1/\beta$ and adopt commitment devices when they are needed. However, the evidence on learning by TI players suggests that learning is slow and, in many instances, does not occur. People spend whole lifetimes overconsuming and procrastinating, even when they convince themselves each day that this is—for sure—the last time. One reason for the paucity of learning by TI players is that learning about one's akratic propensities and self-control problems can call into question one's virtue and character [17]. For example, learning about one's propensity to procrastinate can impose immediate psychic costs and lead to learning-meta-procrastination.

4. Counterparty Awareness and Cross-Commitments

4.1. Counterparty-Sophisticated, Counterparty-Naïve, and Counterparty-Partially-Naïve Players

TI players can both incur welfare losses and impose them on other players. As we will see below, these counterparty spillover welfare losses may exceed those incurred by the TI player. As a result, players in a bargaining game must try to predict the present-biased preferences of other players. If player B has a β = 0.5 and player A believes incorrectly that B has a $\beta > 0.5$, player A's decisions can lead to bargaining breakdowns or inefficient delays.

Let β_{CP} be player A's beliefs of player B's actual β.

Definition 7. *Player A is counterparty-sophisticated if player B has a $\beta < 1$ and player A correctly predicts it: $\beta_{CP} = \beta$.*

Definition 8. *Player A is counterparty-naive if player B has a $\beta < 1$ but player A believes incorrectly that B has TC preferences: $\beta_{CP} = 1$.*

Definition 9. *Player A is counterparty-partially-naïve if she believes correctly that player B has a $\beta < 1$ but she mispredicts the true magnitude of player B's present-bias: $\beta < \beta_{CP} < 1$.*

Counterparty-sophisticated players (and counterparty-partially-naïve ones who are sufficiently sophisticated) will have an incentive to impose cross-commitment devices on their TI counterparties. Cross-commitments target either immediate or delayed payoffs. As we will see, all other things being equal, targeting immediate payoffs will produce the more efficient result. Additionally, cross-commitment devices can be used either benevolently to reduce welfare losses incurred by TI players or non-benevolently to extract rents from TI players.

4.2. Welfare Losses Faced by Counterparty-Naïve Players

4.2.1. Ultimatum Game—Naïve TI Responder and Counterparty-Naïve Proposer

Suppose that TC player A is the proposer and player B the responder in an ultimatum game to divide π. Both players have δ = 1, but naïve player B has a $\beta < 1$. Player A is counterparty-naïve and thus believes incorrectly that she is bargaining with a TC player (i.e., $\beta_{CP} = 1$). Additionally, it is common knowledge that player B must incur immediate bargaining costs, c_{B1}, in period 1 to fully evaluate player A's offer. If player B accepts the offer, he receives his portion of the surplus, v_{B2} (the delayed bargaining rewards) in period 2, and if he rejects, both players receive 0.

In periods 0 and 1, player A believes incorrectly that player B will accept any offer with a net bargaining surplus:

$$v_{B2} - c_{B1} \geq 0$$

In period 0, player B decides to accept any period 1 offer with a net bargaining surplus:

$$\beta v_{B2} - \beta c_{B1} \geq 0 \equiv v_{B2} - c_{B1} \geq 0 \text{ (given } \beta \text{ is constant).}$$

However, in period 1, player B gives added weight to the immediate bargaining costs and will accept an offer only if:

$$\beta v_{B2} - c_{B1} \geq 0 \equiv v_{B2} \geq c_{B1}/\beta$$

In period 1, counterparty-naïve player A offers player B:

$$v_{B2} - c_{B1} = 0$$

However, player B rejects the offer given his participation constraint:

$$v_{B2} \geq c_{B1}/\beta > c_{B1}$$

4.2.2. Spillover Welfare Losses Suffered by Counterparty-Naïve Player

Suppose that π = 1000, and v_{B2}, c_{B1} = 100, and that player B accepts the bargain when he is indifferent. Also suppose that player B has a β = 0.8. From a long-term perspective player B is indifferent, but from a short-term perspective, he requires a delayed reward of at least: c_{B1}/β = 125.

Importantly, while it is player B's time-inconsistency that leads him to reject the offer, he is made no worse off when he does so, since his share of the surplus is 0 whether he accepts or rejects. It is counterparty-naïve player A who suffers the full welfare loss from the bargaining breakdown.

4.2.3. Other Implications

As we have seen, even a slight preference for immediate gratification can lead a TI player to reject offers that TC players would accept. This can be important when bargaining solutions rely on offers that give the responder just enough to make him indifferent—e.g., in the Rubinstein bargaining game. Moreover, present-biased preferences may help explain some of the observed results in ultimatum games. Laboratory experiments find that responders in ultimatum games often reject offers in which the proposer keeps all or most of the surplus. A common explanation is that responders reject offers to retaliate against "unfair" proposers [68]. Retaliation can provide TI responders with immediate positive utility. As a result, all other things being equal, TI responders are more likely to retaliate in ultimatum games [18].

4.3. Designing Optimal Cross-Commitment Devices

In the previous section we showed that TI players can impose welfare losses on a counterparty-naïve player, even in cases in which the TI players suffer no welfare losses. A counterparty-sophisticated player accurately predicts those welfare losses and may thus adopt cross-commitment devices to change the TI player's incentives. Cross-commitment devices work by reallocating bargaining payoffs to offset the added weight that TI players give to immediate payoffs. This reallocation can be done either by targeting a TI player's delayed payoffs or by targeting that player's immediate payoffs. This section shows that targeting the TI player's immediate payoffs always dominates targeting the player's delayed payoffs. This result has important implications for the design of optimal cross-commitment devices.

4.3.1. Cross-Commitment 1: Targeting Delayed Payoffs

Recall that TI player B rejects any offer that fails to meet his participation constraint:

$$v_{B2} \geq c_{B1}/\beta > c_{B1}$$

Suppose that player A is counterparty-sophisticated and thus holds correct beliefs about player B's present-bias: $\beta_{CP} = \beta$. Player A can meet B's participation constraint by offering him a greater cut of the delayed bargaining rewards: $v_{B2} = c_{B1}/\beta$. As in Section 4.2.2, suppose that the bargaining surplus is π = 1000, v_{B2}, c_{B1} = 100, and β = 0.8. The cross-commitment would require player A to give B a delayed reward of c_{B1}/β = 125. If player A adopts this cross-commitment, CC_1, she keeps: $\pi - (v_{B2} + CC_1) = 1000 - (100 + 25) = 875 < 900$.

Naiveté, it seems, gives bargaining power to naïve TI players. Some commentators have reached such a conclusion when modeling bargaining games between a counterparty-sophisticated proposer and a naïve responder [19]. While at first glance targeting delayed payoffs appears to be a useful cross-commitment strategy, we will now show that this approach is always dominated by cross-commitments that target immediate payoffs.

4.3.2. Cross-Commitment 2: Targeting Immediate Payoffs

Player A can design a cross-commitment device that targets B's immediate payoffs by either increasing B's immediate bargaining rewards and/or reducing his immediate bargaining costs. It is easy to see that cross-commitments that target B's delayed payoffs are always more costly to implement than those that target immediate payoffs.

Proposition 2. *All other things being equal, cross-commitment devices that target a TI player's delayed payoffs are always dominated by cross-commitments that target the TI player's immediate payoffs.*

To see this, assume without loss of generality that $\delta = 1$. A TI player perceives an immediate USD 1 as USD $1/\beta$ and a delayed USD 1 at face value. Since $1/\beta > 1$, it will always be the case that a TI player will perceive the immediate USD 1 as providing higher utility than the delayed USD 1. The player creating the cross-commitment device must therefore pay $1/\beta$ more when she targets the TI player's delayed payoffs.

Player A can target player B's immediate payoffs by using a cross-commitment device that gives B an immediate share of his portion of the bargaining surplus. Player B gives added weight both to immediate rewards and immediate costs in period 1 and would accept any bargain that provides him:

$$v_{B1}/\beta - c_{B1}/\beta + v_{B2} \geq 0, \text{ or equivalently, } (v_{B1} - c_{B1})/\beta + v_{B2} \geq 0 = v_{B2} - c_{B1} \geq 0.$$

Alternatively, the cross-commitment can target player B's immediate bargaining costs. Player A will have some control over the timing in which player B incurs bargaining costs. To the extent that she can, she will have an incentive to shift some or all those bargaining costs to period 2, such that: $(v_{B2} - c_{B2}) \geq c_{B1}/\beta$. Player A can also take steps to reduce overall bargaining costs.

Suppose that to consummate a bargain, player B must review and sign a contract. Player A can choose to deliver a complex contract that would require B to incur immediate bargaining costs of c_{B1} to comprehend it. Alternatively, A can deliver an easier to comprehend standard form contract with a lower c_{B1}. Player A can also make an interest-free loan to player B to pay for some or all his immediate bargaining costs. This is just another way to transform immediate costs into delayed ones. This sort of cross-commitment device is much more common than it may first appear. For example, trade credit is commonly used in commercial transactions—one reason is that it reduces the immediate costs of purchasing goods. Additionally, retailers pay credit card processing fees so they can offer consumers immediate utility from a purchase while avoiding the disutility from having to pay immediately in cash.

Cross-commitment devices are useful in other contexts. Suppose that two naïve TI players can produce a good together or separately—in both cases they will each produce $\frac{1}{2}$ of the good and assemble it afterwards, but in the first instance they do it as part of a collaborative process [20]. Let the costs of both types of production be identical and assume that working alone both TI players would procrastinate. Suppose however that both players are counterparty-sophisticated and can provide each other with cross-commitments. Then internalizing production can create a cross-commitment surplus.

4.4. Cross-Commitment Rents

As we will now see, having control over the relative timing of payoffs allows not only for benevolent cross-commitment devices, but also for non-benevolent rent-extractions. Assume that a counterparty-sophisticated player A and a naïve TI player B are dividing $\pi = 1000$. Without loss of generality, we continue to assume that $\delta = 1$. Player B has an immediacy multiplier $1/\beta = 2$. Let player B have immediate bargaining costs, $c_{B1} = 50$, and an outside option with a delayed, period-2 reward of 75. In period 0, the naïve player B makes a long-term decision to reject any proposal unless he gets bargaining rewards

$v_B \geq 125$, so that he receives a net bargaining surplus of at least $125 - 50 = 75$ (the value of his outside option).

Suppose that in period 1, a non-benevolent player A offers player B an immediate bargaining reward, $v_{B1} = 87.50$. Player B will accept the bargain, which he perceives as $(2 \times 87.50) - (2 \times 50) = 175 - 100 = 75$. In period 0, the naïve player B believed incorrectly that in period 1 he would have a $\beta = 1$ and would thus reject an offer of $87.50 - 50 = 37.50 < 75$. Player A uses her counterparty-sophistication to extract a sophistication-rent of 37.50 from the naïve player B. This is an example of overconsumption by player B. From a long-term perspective, he had decided not to accept such a bargain, but when faced with the prospect of immediate gratification he gave in.

4.5. Sophisticated TI Players and Pre-Play Commitment

Recall that sophisticated TI players are more likely to suffer large welfare losses in instances involving immediate bargaining rewards, such as the ones in the previous sub-section. Given the potential that a non-benevolent counterparty will try to extract cross-commitment rents, one would expect that sophisticated TI players will take prophylactic actions—such as engaging in pre-play commitment. More generally, if one allows for a first round of play before the bargaining game proper, two sophisticated TI players will have an incentive to engage in pre-play commitment (alone, with third parties, or with their counterparty). It follows that these sophisticated TI players enter the bargaining game proper with TC preferences. They can thus be modeled using standard bargaining models.

4.6. Doubled Commitment: Targeting Self-Control and Bargaining Power

Commitment devices that commit a player to a path of play can increase the player's bargaining power. In certain cases, bargaining and self-control commitment devices may act as complements, but they may also create externalities. For example, a commitment device that forces a player to keep to her long-term TC plan can also indirectly increase her bargaining power. Additionally, one player's bargaining commitment can act as a cross-commitment for the other player. On the other hand, a bargaining commitment device may exacerbate self-control problems. For example, a bargaining commitment that would require a TI player to incur an immediate cost may exacerbate the player's incentive to procrastinate. Thus, all other things being equal, bargaining commitments of TI players are less credible than those of their TC counterparts.

5. Extending the TI Bargaining Model

5.1. Rubinstein Bargaining with Time-Inconsistent Players

So far, we have focused on relatively straightforward bargaining scenarios and seen that incorporating TI players into bargaining models designed for TC players is neither an easy nor a straightforward task. Incorporating TI players into the more complex Rubinstein bargaining model creates additional complications. Given that the growing literature on TI bargaining has given great attention to the Rubinstein model, this section extends some of the arguments developed above to the context of sequential bargaining. The goal is not to develop a full-fledged model, but to identify a set of key factors that any such model needs to address.

Rubinstein [43] sets forth a sequential, alternating offers model with a unique subgame-perfect Nash equilibrium in which in period 1 the proposer offers a split of the surplus that the responder immediately accepts. Both players have complete information, and they bargain over an infinite number of periods. Suppose that player A and player B are to divide a surplus = 1 and that they both have the same discount factor $\delta < 1$. Each one-period delay in agreeing to a bargain reduces the bargaining surplus by: $1, \delta, \delta^2, \delta^3, \ldots$ In period 1, player A offers a split in which player B receives x and player A keeps $(1 - x)$. Player B can either accept or reject. If player B rejects, he will make a proposal in period 2 to split the smaller pie: player B offers to keep δx and give player A, $\delta(1 - x)$. Under the Rubinstein bargaining solution, in period 1 player A offers to keep $1/(1+\delta)$ and give player B $\delta/(1+\delta)$, and player B accepts [21].

Let the proposer and responder have TI preferences with identical immediacy multipliers $1/\beta$. The players make a long-term decision in period 0 about their planned course of action in periods 1 through n. From the perspective of period 0, all bargaining payoffs are in the future and thus both players make long-term plans to agree to a bargain in period 1. In period 1, however, the TI proposer and responder give added weight to any immediate costs and immediate rewards and will have an incentive to override their long-term plans if doing so would yield an immediacy premium that is greater than the delayed loss. We first analyze two contexts in which TI preferences would play no role and in which the standard bargaining model would apply. In the first context, the players can agree to a bargain in period 1, at zero cost, and all bargaining costs and bargaining rewards are received in period 2. We can apply Proposition 1 and conclude that the two TI players would reach the same bargaining result as two TC players. In the second context, both players are sophisticated (or partially naïve, but sufficiently sophisticated) about their future immediacy multiplier and engage in pre-play commitment in period 0 to assure TC behavior. One possibility is for the players to agree to a contract about how they would bargain in period 1. However, players may choose to engage in pre-play commitment with a third party instead, particularly if they are concerned that the other player is counterparty-sophisticated and may try to extract cross-commitment rents.

Suppose now that the players are both naïve about their own immediacy multiplier and counterparty naïve about the other player's multiplier. Suppose first that to enter a bargain the proposer must incur immediate bargaining costs in period 1 in order to produce delayed bargaining rewards in the following period. In period 1, the TI proposer overrides her long-term plan. She makes a proposal that will give her a greater portion of the delayed rewards to make up for the added weight that she now gives to the immediate bargaining costs. The TI responder would reject this bargain. From the perspective of period 1 looking at period 2, the TI responder would be making the same long-term decision as she did in period 0 (albeit vis-à-vis a smaller pie). She thus believes that in period 2 she would make a proposal that would give her the standard share of the surplus predicted by the Rubinstein model and that the other player would accept. However, in period 2, she faces the same immediate bargaining costs and delayed rewards. She thus makes an offer that gives her a larger share of the surplus (for the same reasons as the initial proposer in period 1), and again the responder rejects. Assuming no learning, the players repeat the same set of offers period after period and never agree to a bargain.

Suppose instead that if the players reach a bargain in period 1, they get immediate bargaining rewards and incur delayed costs in period 2. For example, in period 2, the players must pay lawyers to draft a contract to memorialize the period-1 bargain. Again, both players are naïve about themselves and counterparty naïve about each other. Now both players reach a bargain in period 1. In period 1, both players give added weight to the immediate bargaining rewards and not only would accept the initial proposed bargain, but each would be willing to accept less. The same result would hold if both players were sophisticated about their own immediacy multiplier. Even though this is a case in which sophisticated players face immediate rewards, the players correctly predict that in period 1 they will have an enhanced incentive to follow through with their long-term decisions.

These results underline the importance of drawing a clear distinction between immediate-costs and immediate-rewards bargaining scenarios. TI bargaining models that fail to fully account for the relative timing of payoffs predict that players would reach the same bargain in both immediate-costs and immediate-rewards scenarios. However, bargaining delays and bargaining breakdowns do not arise when bargaining rewards are received immediately and bargaining costs are delayed. Moreover, even in contexts in which all payoffs are received immediately, if the net surplus is sufficiently high or the immediacy multipliers are not too great, TI players would reach a bargain immediately.

5.2. Exogenous Cross-Commitments

TI bargaining delays and breakdowns can produce welfare losses for the bargainers and third parties. Both types of losses are important from a social welfare maximizing perspective. For example, a TI bargaining breakdown that results in a strike can produce welfare losses for the employer, employees, customers, suppliers, and other third parties. Third parties who face large losses from bargaining delays and breakdowns will have an incentive to adopt cross-commitment devices to cause TI players to internalize the negative externalities.

For example, governments may provide bargainers with default and mandatory commitment devices [22]. Default commitments allow sufficiently sophisticated TI players to opt out. However, this ease of exit comes at a cost: optimistic naïve players, those most likely to need commitment devices, will also opt out. Mandatory commitment devices can help resolve this problem, but at the expense of imposing potential costs on sophisticated players. Consumer protection laws and criminal statutes both provide mandatory precommitments. If governments have sufficiently accurate information about the β of TI players, they can create default commitments with immediate exit costs—either in effort or fees. Sophisticated players can opt out if they want, but sufficiently naïve players may repeatedly procrastinate exiting [23].

5.3. Repeated, Time-Inconsistent Bargaining Delays

In real-world bargaining, inefficient delays are commonplace. One way to explain these delays is to allow for incomplete information and signaling by players [73].

But delays can also be explained through the lens of repeated procrastination by TI players. The likelihood of repeated procrastination will depend on the self-awareness and counterparty-awareness of players and the availability of commitment devices. All other things being equal, the greater the immediate costs of bargaining, the greater the incentive to procrastinate. Immediate bargaining costs increase with bargaining complexity. The latter will increase with the number of bargaining parties, actions available, bargaining issues, and with the way that each of these interact [74]. Bargaining complexity can also increase with the amount of information needed to make informed bargaining decisions [24]. TI preferences may thus help explain why in real-world contexts we often observe less complex and more intuitive bargaining solutions, such as a 50-50 split.

Deadlines can act as commitment devices to deter repeated procrastination [77]. Thus, the deadline effect observed in bargaining contexts can be explained in part through the lens of TI bargaining. For example, the term of collective bargaining agreements provide natural deadlines for TI players and may help explain why quick settlements before a strike are more likely than afterwards, [78,79] when there are fewer natural deadlines [25].

5.4. Entry and Exit into Bargaining Relationships

Studies in labor and employment have found that TI agents tend to procrastinate investing in human capital, switching jobs, and exiting unemployment and welfare rolls [84–87]. Other studies suggest that higher impatience can lead to a higher likelihood of divorce and may lead individuals to delay exiting gangs [78,88]. One can apply these insights to entry and exit decisions in bargaining. As the costs of entry and exit increase so does the likelihood that TI players will procrastinate. Moreover, all other things being equal, as the immediate rewards of entry and exit increase, so does the likelihood that TI players will enter and exit too soon, compared to their TC counterparts. TI players may exit a worthwhile bargaining relationship too soon to enter into a non-worthwhile one (compared to the original one) if the new relationship provides immediate rewards. One would also expect that the greater the number of outside options, the greater the likelihood that a TI bargainer will procrastinate settling on one of them [26]. For example, workers who are provided with a greater number of investment options in retirement accounts are more likely to procrastinate signing up for retirement benefits [90].

5.5. Time Interval between Bargaining Periods

TI bargainers are more likely to engage in TI behavior the shorter the delay between offers. All other things being equal, shorter delays will lead to lower delayed losses from procrastination and overconsumption. Suppose that two TI players are procrastinating completing an onerous bargaining task. One player can choose to complete the task each day for 365 days and the other player must complete the task either today or a year from now. The latter player faces a greater delayed loss from not completing the task today—a one year delay—and thus has a greater incentive not to procrastinate. TC players will complete the task on the first day and will not procrastinate.

6. Conclusions

This paper develops a general model of time-inconsistent bargaining that highlights the critical role played by the relative timing of bargaining costs and bargaining rewards. Immediate-costs scenarios can lead players to engage in bargaining procrastination, while immediate-rewards scenarios can lead to bargaining preconsumption and overconsumption. In the model, players can choose both the allocation of the net bargaining surplus and the timing of the two components of the surplus—the gross bargaining rewards and the bargaining costs that players incur to produce the net surplus. By determining the timing of bargaining payoffs, sophisticated players can engage in pre-play commitment and counterparty-sophisticated players can create cross-commitment devices. Cross-commitments can be used to deter other players from engaging in TI bargaining that produces spillover welfare losses. They can also be used to extract rents from naïve TI players. When players can deploy sufficiently robust self-commitment and cross-commitment devices, they will behave in the same manner as TC players and will not incur welfare losses. In those instances, standard bargaining models apply without modification. The paper also shows that present-biased preferences can affect bargaining outcomes only in contexts involving immediate and delayed bargaining payoffs, and that, all other things being equal, commitment devices that target immediate payoffs dominate those that target delayed payoffs. The model developed in the paper applies to bargaining decisions generally. Under the model, present-biased preferences can lead players to repeatedly procrastinate reaching worthwhile bargains and to overconsume inefficient bargains. They can also have material effects on other bargaining decisions, such as entry and exit decisions.

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Notes

1 From a long-term perspective, people discount the future as if they were exponential discounters. However, they become increasingly impatient the closer they get to receiving immediate rewards or incurring immediate costs [3–5]. People, in short, value immediate gratification [6]. The evidence from brain imaging studies seems to suggest that our preference for immediate gratification is hard-wired [7,8]. Field studies have also found that people routinely adopt commitment devices to tie the hand of their future selves, revealing at least some awareness of their present-biased preferences [9–13].

2 Mandatory and default commitment devices are prevalent in consumer protection law, criminal law, and employment law [18–25].

3 There is a large literature examining how time-consistent firms often structure contracts to extract rents from sufficiently naïve time-inconsistent consumers [12,27–29]. Heidhues and Kőszegi analyze credit contracts designed to exploit sufficiently naive time-inconsistent borrowers who enter into contracts believing incorrectly that they will adhere to a cheaper front-loaded payment schedule, but end up switching to a more costly delayed payment option [30]. Gottlieb and Zhang show that long-term contracts can be used both to exploit partially naïve consumers and to delay their welfare losses until the last period. Importantly, they show that consumers' welfare losses vanish over sufficiently long contracting periods [31]. The contracting literature focuses on one-sided self-control problems: only consumers exhibit present-biased preferences. Our paper focuses on the pre-contract

bargaining phase in which one or both players have time-inconsistent preferences. Section 4 shows that counterparties, such as firms, can incur spillover welfare losses and thus will have an incentive to create cross-commitment devices for time-inconsistent agents. We show that counterparty-sophisticated players may use cross-commitments not just to extract rents, but to reduce their exposure to spillover welfare losses.

4 Commitment devices already play a large role in bargaining models [32–35], in general present-biased preference models [36–38], and in real-world solutions for present-biased preferences [39–42].

5 The time-inconsistent bargaining literature has focused primarily on Rubinstein [43] bargaining games with naïve and sophisticated time-inconsistent players [44–47]. More recently, commentators have resorted to laboratory experiments to better isolate the relative impact of the players' general impatience, present-bias, and awareness of their time-preferences [48,49].

6 Fahn and Seibel show a similar result in the context of employment contracts between firms and naïve time-inconsistent employees [51].

7 The instantaneous utility in a period depends on the rewards received and costs incurred in that period.

8 Impatience plays a big role in many bargaining contexts, particularly those in which players can bargain over long periods. For example, the relative impatience of players in sequential bargaining games can give a bargaining advantage to the more patient player, and impatience, generally, can lead players to reach a bargain quickly or even immediately, as in the case of the Rubinstein bargaining solution. Rubinstein [43] allows for two types of friction, impatience, capture by δ and fixed bargaining costs. But the literature focuses primarily on the discounting interpretation.

9 As we will see, players may have correct or incorrect beliefs about how their future selves will behave in subsequent periods.

10 Of course, players may reverse their long-term decisions when they have acquired new information showing that the expected payoffs have changed. In other words, had they known that information when making their long-term decisions, their long-term and short-term decisions would have coincided.

11 More generally, one can without loss of generality set $\delta = 1$. A TI player then maximizes: $U_t = (u_t + \beta u_{t+1} + \beta u_{t+2} + \beta u_{t+3} + \ldots \beta u_{t+n}, \ldots)$ and the TC player maximizes: $U_t = (u_t + u_{t+1} + u_{t+2} + u_{t+3} + \ldots u_{t+n}, \ldots)$. Since $\beta < 1$, the TI player gives $1/\beta$ greater weight to u_t than to payoffs in any future period.

12 If they do not reach a bargain, they each get their breakdown payoff of 0 in period $t + 1$.

13 Transaction costs play a large role in the literature on incomplete contracts and the theory of the firm [59,60]. One can suppose that there is an analogue between an incomplete contract and an incomplete bargain − i.e., a bargaining situation in which agents would have been better off by agreeing to n different items, but they were only able to agree to $k < n$ items due to bargaining transaction costs. The parties then set out to collaborate on those k items. Some parties exhibit a bias for entering into a series of small bargains as opposed to a large global one [61].

14 More generally, each player determines the set of actions available to both players; forms beliefs about their own and the other player's expected future actions; determines the current state and expected evolution of the bargaining environment; weighs the expected costs and expected benefits associated with each action; and chooses strategies that are best responses to the expected actions of the other player.

15 Note that in this model all losses are incurred in period 2, but more generally the losses may be experienced in one or more future periods. We can assume that in period 2, players experience a disutility equal to the discounted present value of the stream of future losses.

16 In other words, their self-control problem is not due to temporary visceral psychological states that highjack their ability to fully deliberate [63].

17 Aristotle drew a distinction between the more morally reprehensible weak-willed agents who "after deliberating fail, owing to their passion, to stand by the conclusions of their deliberation," and the more morally forgivable "keen and excitable people" who "because of the violence of their passions do not wait on reason" [67].

18 One way to test this hypothesis is to offer the following two bargains:
(1) Delayed Ultimatum Game: Let us split USD 10 to be paid a year from today. I will keep USD 9 and will give you USD 1. If you reject, you and I will receive USD 0.
(2) Immediate Ultimatum Game: Let us split USD 10 to be paid immediately. I will keep USD 9 and will give you USD 1. If you reject, you and I will receive USD 0.
Even if one assumes that both the disutility from perceived unfairness and the utility from receiving bargaining rewards are felt immediately, one expects that TI responders will react differently to the immediate and delayed ultimatum games. In other words, the TI responder will give greater relative weight to the immediate disutility of accepting an unfair bargain today than to the same but delayed disutility, a year from now. TC responders would make the same decision in both the immediate and delayed ultimatum games.

19 For example, Sarafidis [50], Akin [45], and Lu [46].

20 Note that this is analogous to the general question of whether a firm should produce a good internally or through the market [69]. Fahn and Hakenes [70] develop a model of team production in which teamwork acts as a commitment device for TI team members.

21 Following Shaked and Sutton [71], suppose that the players are in period 3 and A is considering whether to accept or reject a proposed offer. Player A will choose the course of action that will maximize her intertemporal utility. She thus considers whether the period 3 offer is at least as great as her continuation payoffs if she rejects. The continuation payoff, V, is the amount she would receive if both players played their subgame perfect strategies in all future periods. As a result, the best that she can do if she rejects in period 3 is $\delta^2 V$. Knowing this, in period 2, player B know that A will accept any offer that is greater than $\delta^2 V$ and reject any offer that is less than that amount. B thus would choose to offer A the minimum amount that she would accept: $\delta^2 V$. In period 1, player A knows then that the minimum that player B will accept in period 2 is $\delta - \delta^2 V$. Player A concludes that if she offers him at least that amount she would be able to keep $1 - \delta - \delta^2 V$. From the perspective of period 1, player A determines the continuation value $V = 1 - \delta - \delta^2 V$, which reduces to $V = 1/(1 + \delta)$. Given the symmetry of the arguments in period 1 and 3 and all other odd number future periods, player A concludes that to be indifferent, she must keep at least $1/(1 + \delta)$ and that player B will not accept any offer lower than $1 - 1/(1 + \delta) = \delta/(1 + \delta)$.

22 In other words, the state can provide Ulysses with the rope and information about the Sirens without necessarily tying him to the mast [25].

23 Non-benevolent governments can use the same approach to engage in stealth governance. A non-benevolent government can increase the costs of A and thus deter an ancillary activity B, in cases in which a direct prohibition of B would not garner democratic support [72].

24 In theory, bargaining parties should use all available information, but may not do so due to bounded rationality constraints [75,76].

25 More generally, delays ending strikes are difficult to explain as rational bargaining behavior [80]. It is also difficult to rationalize observed delays by referring to the terms of final settlements [81]. The same is true for observed delays in litigation settlements and treaty negotiations [82,83].

26 A similar result can occur in contracting contexts. Parties with too many outside options may procrastinate switching from one contract to a better one [89].

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