Bringing Present Bias Back to the Present

Alexis Direr *

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Abstract

This paper introduces a narrow, preference-based definition of present bias. A decision maker is present biased when immediate outcomes are strictly preferred to all sufficiently small delays of the same outcome. This definition separates present bias from other behaviors often associated with it, including decreasing impatience, choice reversal, and short-term impatience. It leads to simple behavioral criteria for identifying present bias and to a nonparametric, choice-based measure of its intensity. The definition is consistent with standard representations such as the quasi-hyperbolic model and fixed-cost formulations, which appear as particular cases within this framework.

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*Univ. Orléans, LEO. E-mail : alexis.direr@univ-orleans.fr. Phone: 33 (0)1 49 55 68 64. Address: rue de Blois - BP 26739, 45067 Orléans Cedex 02. ORCiD: 0000-0002-4459-7780. I thank for useful comments Arnaud Goussebaïle and Nicolas Drouhin.

1 Introduction

The last two decades have witnessed a rapid growth of theoretical and empirical works on present bias. It is now considered an important determinant of many intertemporal decisions related to saving or borrowing [Meier and Sprenger, 2010], retirement timing [Diamond and Koszegi, 2003], addiction [Laibson, 2001, Bernheim and Rangel, 2004], health [Loewenstein et al., 2012], bargaining [Schweighofer-Kodritsch, 2018], or job search [DellaVigna and Paserman, 2005]. It helps explain why individuals have self-control problems, procrastinate, or do not stick to the plans they have made earlier [O'Donoghue and Rabin, 2015, Bisin and Hyndman, 2014].

However, it is fair to recognize that the very idea of present bias still lacks a formal definition. It has been used so far as a label for addressing various behavioral properties like short-term impatience, decreasing impatience, choice reversal toward early outcomes, and more generally, procrastination, self-control problems, demand for commitment, high required rates of return and naiveté (when people underestimate their own procrastination or present bias). The profusion of concepts surrounding the term raises questions, given the importance ascribed to the concept in the behavioral literature.

The aim of this article is to propose a simple and narrow definition of present bias, which closely relates to, but remains distinct from choice reversal, decreasing or increasing impatience and short-term impatience. A present biased individual values an immediate outcome more than one postponed in the near future, where the near future can be arbitrarily close to the present. The definition makes a natural distinction between present bias, present neutrality and future bias. Two well known models of present bias, the quasi-hyperbolic model of Laibson [1997] and the fixed cost model of Benhabib et al. [2010] conform in an intuitive way to the definition.

The expression "present bias" can be traced back to the article by O'Donoghue and Rabin [1999] who present it as "a more descriptive term for the underlying human characteristic that hyperbolic discounting represents". Hyperbolic discounting is taken as an equivalent expression for decreasing impatience, which means that when considering trade-offs between two future periods, individuals give stronger relative weight to

the earlier moment as it gets closer. Decreasing impatience has since then served as a testable implication of present bias [e.g. Andreoni and Sprenger, 2012]. Subsequent studies [Hayashi, 2003, Benhabib et al., 2010] have extended the meaning to time preference reversal, which is the tendency of reversing one's choice from late to early outcome once a trade-off is moved closer to the present [Thaler, 1981, Read and van Leeuwen, 1998]. More recently, O'Donoghue and Rabin [2015] proposed as an alternative test the detection of non negligible impatience over short delays.

Many studies referring to present bias have worked with functional representations, usually the quasi-hyperbolic model of Laibson [1997], also called the $(\beta - \delta)$ model. compared to the exponential model of Samuelson [1937], an extra weight $1/\beta$ is added to present utility. In his seminal article, Laibson did not propose a specific theory of present bias, whose expression appeared later in his work [Laibson et al., 2003]. His objective was rather to propose a time inconsistent discounting model which exhibits decreasing impatience while being closer to the canonical model of Samuelson [1937] than the hyperbolic formulation used by psychologists [Ainslie, 1992]. Since then, the model has served as a workhorse to investigate the consequences of many behaviors like decreasing impatience, choice reversal, naiveté or short-term impatience. Although functional forms offer tractable ways for analyzing a wide range of issues, they may lack scope and generality [Spiegler, 2019].

A few articles give a conceptual or axiomatic definition of present bias. Chakraborty [2021] weakens the stationarity axiom in a way that permits choice reversals without contradicting a preference for the present. Montiel Olea and Strzalecki [2014] provide an axiomatic characterization of quasi-hyperbolic discounting and a more general class of semi-hyperbolic preferences. Both articles elaborate on present bias defined as a deviation from stationarity and constant impatience.

A closely related revealed-preference approach is developed by Takeuchi [2011], who proposes a nonparametric test of present and future bias based on the modularity properties of the equivalent delay function. In his framework, present bias corresponds to submodularity of this function, while future bias corresponds to supermodularity. Our approach is complementary. Whereas Takeuchi's test identifies the *direction* of time in-

consistency from finite comparisons across outcomes, we characterize present bias as a *local* discontinuity at the present boundary and provide a choice-based measure of its *magnitude*. In particular, our present-bias intensity index can be interpreted as the size of the jump in present valuation revealed by choices as the delay shrinks to zero.

The remainder of the paper is organized as follows. Section 2 proposes a non-parametric definition of present bias. Section 3 derives the class of utility consistent with present bias. Section 4 classifies the main models of present bias according to the definition. Section 5 relates the definition to alternative measures of present bias. Section 6 concludes.

2 Present bias: Definition

2.1 Preliminaries

Let us consider a decision maker (henceforth DM) whose time preferences are defined over a set of dated outcomes $X \subseteq \mathbb{R} \setminus \{0\}$. The time domain is $T \subseteq \mathbb{R}_+ = [0, \infty)$, with $t = 0$ denoting the present. A dated outcome (x, t) delivers payoff $x \in X$ at date $t \in T$. The binary relations $\succ$, $\prec$, and $\sim$ denote a complete and transitive preference ordering on $X \times T$ expressed at date 0. For positive outcomes (gains, broadly interpreted as consumption), preferences are increasing in x: $(x, t) \succ (y, t)$ for all $x > y$ and all $t \in T$. For negative outcomes (losses or unpleasant tasks), the preference ordering is reversed. In what follows, attention is restricted to one domain at a time. For simplicity, all definitions and propositions are stated for gains; for losses, the preference symbols should be reversed accordingly.

2.2 Axioms of present bias

To formalize the concept of present bias, the discontinuity in preferences at the present moment is characterized.

Axiom 1 *(present bias) The DM is present biased if, for each $x \in X$ and for every sequence $\{t_n\}$ with $t_n > 0$ and $t_n \to 0$, $(x, t_n) \prec (x, 0)$ for all n sufficiently large.*

This axiom captures the key intuition that a present-biased individual exhibits a discontinuity in preferences at the present moment: for any outcome x, receiving it immediately ($t = 0$) is strictly preferred to receiving it after any positive delay, no matter how small.

Future bias can be symmetrically defined as a preference for the late outcome, a special case of patience:

Axiom 2 *(future bias) The DM is future biased if for each $x \in X$ and every sequence $\{t_n\}$ with $t_n > 0$ and $t_n \to 0$, $(x, 0) \prec (x, t_n)$ for all n sufficiently large.*

Future bias may occur when individuals derive a positive utility of anticipating a pleasant consumption experience [Loewenstein, 1987, Shu and Gneezy, 2010]. The DM may also be willing to postpone a positive outcome to create an improving sequence [Loewenstein and Prelec, 1991].

Last, a DM is present neutral if preferences are continuous at the present moment:

Axiom 3 *(present neutrality) The DM is present neutral if, for each $x \in X$ and every sequence $\{t_n\}$ with $t_n > 0$ and $t_n \to 0$, $(x, 0) \sim (x, t_n)$ for all n sufficiently large.*

All individuals are characterized by one of the three attitudes toward immediate outcomes. As we will see, they can be used to classify usual models of discounting as present biased or time neutral, and to provide axiomatic foundations to present biased models.

2.3 Present bias intensity

Building on these three attitudes toward the present, we introduce a choice-based measure that quantifies the intensity of present bias.

Definition 1 ***(Present-Bias Intensity).*** *For any outcome $x > 0$ and for every $t > 0$, let $m(x,t)$ denote the* present equivalent *of (x,t), defined by the indifference relation $(m(x,t),0) \sim (x,t)$. The present-bias intensity of the DM at outcome x is*

$$\mathrm{PBI}(x) = 1 - \limsup_{t \to 0^+} \frac{m(x,t)}{x}.$$

This ratio measures the fractional discontinuity in present valuation: $\mathrm{PBI}(x) = 0$ corresponds to present neutrality, $\mathrm{PBI}(x) > 0$ to present bias, and $\mathrm{PBI}(x) < 0$ to future bias.

3 Utility representation

Present bias is defined in a narrow sense by focusing on some minimal assumptions. Although it does not impose a complete preference ordering of intertemporal plans, the definition allows us to discriminate between a variety of full-fledged models of intertemporal choices.

Proposition 1 *Suppose preferences admit a utility representation u with $(x,t) \succeq (y,s)$ if and only if $u(x,t) \geq u(y,s)$, and assume u is continuous in t for $t > 0$. Then, for each $x \in X$, the DM satisfies:*

- *Axiom 1 (present bias) if* $\forall x \in X, \limsup_{t \to 0^+} u(x,t) < u(x,0)$
- *Axiom 2 (future bias) if* $\forall x \in X, \liminf_{t \to 0^+} u(x,t) > u(x,0)$.
- *Axiom 3 (present neutrality) if* $\forall x \in X, \limsup_{t \to 0^+} u(x,t) = \liminf_{t \to 0^+} u(x,t) = u(x,0)$.

Proof Fix $x \in X$. Suppose first that Axiom 1 holds. Then for every sequence $\{t_n\}$ with $t_n > 0$ and $t_n \to 0$, we have $(x,t_n) \prec (x,0)$ for all n large enough, hence $u(x,t_n) < u(x,0)$ eventually. Therefore $\limsup_{t \to 0^+} u(x,t) \leq u(x,0) - \eta$ for some $\eta > 0$, and thus $\limsup_{t \to 0^+} u(x,t) < u(x,0)$. Conversely, suppose $\limsup_{t \to 0^+} u(x,t) < u(x,0)$. Then

there exists $\delta > 0$ such that $\limsup_{t\to 0^+} u(x,t) \le u(x,0) - \delta$. By the definition of lim sup, there exists $\varepsilon > 0$ with $u(x,t) \le u(x,0) - \delta/2$ for all $t \in (0,\varepsilon)$. Hence $(x,t) \prec (x,0)$ for all such t, and therefore for any sequence $t_n \to 0^+$ we have $(x,t_n) \prec (x,0)$ eventually. This is precisely Axiom 1. The argument for future bias follows by reversing the inequalities. The case for present neutrality follows immediately, since equality of the upper and lower limits implies eventual indifference. □

4 Relation to other present bias models

Most models belonging to the present bias family, but not all, exhibit a time discontinuity between the present and future and satisfy our definition. A prominent example is given by the quasi-hyperbolic model of Laibson [1997]. Long-term impatience is driven by an exponential discounting function: $d(t) = (1+\rho)^{-t}$, $t > 0$. Short-term impatience is affected by an extra weight on present utility $d(0) = 1/\beta > 1$. The discounting function is present biased according to Proposition 1

$$u(x,0) - \limsup_{t\to 0^+} u(x,t) = u(x)\Big(1/\beta - \limsup_{t\to 0^+}(1+\rho)^{-t}\Big) = (1/\beta - 1)u(x) > 0$$

Moreover, indifference between $(m(x,t),0)$ and (x,t) implies $m(x,t) = \beta(1+t\rho)^{-1}x$. Hence,

$$\mathrm{PBI}(x) \;=\; 1 - \limsup_{t\to 0^+} \frac{m(x,t)}{x} \;=\; 1-\beta.$$

Thus the parameter $1-\beta$ provides a direct, choice-based measure of the intensity of present bias.

The same analysis applies to the continuous version of the quasi-hyperbolic model investigated by Harris and Laibson [2013]. They assume that the length of the present is stochastic and distributed exponentially with hazard rate λ. The discount is exponential during the present and drops discontinuously afterward in proportion $\beta \in (0,1)$. The limit case in which the hazard rate tends to infinity and the duration of the present period tends to zero is the exact continuous equivalent of Laibson [1997] and is therefore present biased according to Proposition 1.

Another example is provided by the discounting model of Benhabib et al. [2010], where $u(x,0) = u(x)$ and, for all $t > 0$, $u(x,t) = e^{-rt}u(x) - \tau$, with $\tau > 0$ interpreted as a "psychological restraint" cost associated with choosing the immediate reward. This specification generates a jump discontinuity at the present:

$$u(x,0) - \limsup_{t\to 0^+} u(x,t) = u(x) - \limsup_{t\to 0^+} e^{-rt}u(x) + \tau = \tau > 0$$

which makes preferences present biased according to Proposition 1. Moreover, indifference between $(m(x,t),0)$ and (x,t) implies $m(x,t) = e^{-rt}x - \tau$. Hence,

$$\mathrm{PBI}(x) \;=\; 1 - \limsup_{t\to 0^+} \frac{m(x,t)}{x} \;=\; \frac{\tau}{x}$$

Thus the present-bias intensity is proportional to τ, with τ/x providing a direct, choice-based measure of its magnitude.

All discounting models which do not give an extra weight to the immediate outcome are present neutral. The exponential discount function [Samuelson, 1937] $d(t) = (1+\rho)^{-t}$ with $\rho \in (0,1)$ a subjective discount rate defined over a unit period of time, is present neutral:

$$u(x,0) - \limsup_{t\to 0^+} u(x,t) = u(x)\Big(1 - \limsup_{t\to 0^+}(1+\rho)^{-t}\Big) = 0$$

While the result is well known in the literature, the interpretation is novel. Exponential discounting is present neutral because it is continuous in the neighborhood of the present.

The same analysis applies to the generalized model of hyperbolic discounting of Loewenstein and Prelec [1992]: $d(t) = (1+ht)^{-r/h}$ with $h \geq 0$ and $r > 0$, which nests as special cases proportional discounting [Mazur, 1987] if $h = r$ and power discounting [Harvey, 1986] if $h = 1$. Although those models satisfy the property of decreasing impatience, they are still present neutral since the discounting functions are smooth around the present. Discount functions in Bleichrodt et al. [2009]: $d(t) = \exp(\exp(-ct) - 1)$, and Ebert and Prelec [2007]: $d(t) = \exp(-(at)^b)$ are also present neutral for the same reason. In all those models, DMs may be strongly impatient but not present biased.

5 Relation to other measures of present bias

5.1 Decreasing impatience

Present bias as defined in our framework is conceptually distinct from decreasing impatience, another property commonly discussed in the literature.

Definition 2 *(decreasing impatience)* $\forall x, y \in X, \forall s, t \in T, s < t$, *such that* $(x, s) \sim (y, t)$, *impatience is decreasing if* $(x, s + \Delta) \prec (y, t + \Delta)$, *for all* $\Delta > 0$ *and* $t + \Delta \in T$.

Impatience is decreasing (or discounting is hyperbolic) if for any couple of equivalent dated outcomes, the DM prefers the delayed option when the two dates are shifted forward by the same time interval. Increasing impatience is defined the same way with a reversed preference relation between the early and late outcomes.

Most experimental studies have found decreasing impatience [Thaler, 1981, Benzion et al., 1989, Green et al., 1997, Kirby, 1997, Kirby et al., 1999, Kable and Glimcher, 2007, Benhabib et al., 2010, Bleichrodt et al., 2016]. However, some studies have found increasing impatience for money [Attema et al., 2010, Sayman and Öncüler, 2009, Scholten and Read, 2006, Loewenstein, 1987, Takeuchi, 2011].

Many articles assimilate present bias and decreasing impatience [O'Donoghue and Rabin, 1999, Halevy, 2008, Benhabib et al., 2010, Andreoni and Sprenger, 2012]. Yet, decreasing impatience, which characterizes the evolution of impatience at every date, does not stress what is special about the present. Present bias (Axiom 1) characterizes a discontinuity at $t = 0$, focusing exclusively on the difference between immediate and delayed outcomes.

Importantly, a DM may exhibit present bias without decreasing impatience. For example, a DM with quasi-hyperbolic preferences [Laibson, 1997] shows present bias through parameter β, but exhibits constant impatience for all future trade-offs. Conversely, a DM may exhibit decreasing impatience without present bias. The generalized hyperbolic discounting model of Loewenstein and Prelec [1992] exhibits decreasing impatience yet remains present neutral because its discount function is continuous at $t = 0$.

Behaviors previously attributed to present bias in the literature may in fact be manifestations of decreasing impatience, or vice versa. Our definition provides conceptual clarity by separating these distinct properties of intertemporal preferences.

5.2 Choice reversal

Decreasing impatience is a cause of time inconsistency and choice reversal. For this reason, present bias is also sometimes assimilated to choice reversal [Manzini and Mariotti, 2009, Chakraborty, 2021]. Several experimental studies use it as a test of present bias [Read and van Leeuwen, 1998, Takeuchi, 2011, Andreoni and Sprenger, 2012, Augenblick et al., 2015]. As a future trade-off gets closer to the present, preferences are increasingly biased toward the early option.

Definition 3 *(choice reversal)* $\forall x, y \in X$ *and* $\forall s, t \in T$, $t < s$, *such that* $(x, t) \sim (y, s)$, *the choice is reversed in favor of the early outcome if,* t *periods later,* $(x, 0) \succ (y, s - t)$, *and of the late outcome if* $(x, 0) \prec (y, s - t)$.

Experiments usually find that choices are reversed in favor of the present option for positive outcomes. Since choice reversal toward the present option often reveals self-control problems and toward the late outcome suggests procrastination, present bias is also sometimes inferred from demand for precommitment devices that restrict the set of future consumptions or actions [Bryan et al., 2010]. The test relies on the joint assumption of sophistication according to which the DM is sufficiently aware of her self control problem.

The definition of choice reversal toward the early outcome is close to the definition of decreasing impatience but requires the passage of time and additional assumptions. Decreasing impatience entails choice reversal towards the present outcome if preferences are stable across periods [Halevy, 2015]. A large class of additive intertemporal utility functionals are both non stationary and time consistent [Drouhin, 2020].

Present bias (Axiom 1) does not necessarily imply choice reversal toward the immediate outcome, even if preferences are stationary. Following Definition 3 of choice reversal,

suppose the outcomes (x,t) and (y,s), $t<s$, are equivalent from date 0 perspective, or $u(x,t)=u(y,s)$. t periods later, when the early outcome is eventually available, the DM choice is tilted toward the immediate option if $u(x,0)-u(y,s-t)>0$ or if: $u(x,0)-u(y,s-t)=\Big(u(x,0)-\limsup_{\tau\to 0^+}u(x,\tau)\Big)+\Big(\limsup_{\tau\to 0^+}u(x,\tau)-u(y,s-t)\Big)$.

Here, $\limsup_{t\to 0^+}u(x,t)$ represents the utility of outcome x occurring in the immediate future (as t approaches 0 from above). The first term captures the pure present bias effect (the discontinuity at $t=0$), while the second term reflects the impatience effect.

The choice is reversed if the DM preferences satisfy both present bias (the first difference is positive) and decreasing impatience (the second difference is positive). However, if time preferences are characterized by increasing impatience (the second difference is negative), present bias could well be associated with preference reversal toward the late outcome.

5.3 Short-term impatience

Impatience over short-term trade-offs, a property commonly observed in experiments, is also interpreted as signaling present bias [Rabin, 2002, Shapiro, 2005, O'Donoghue and Rabin, 2006]. O'Donoghue and Rabin [2015] argue that short-term discounting is a test of present bias, even better than choice reversal. To see why, consider exponential discounters whose discount rate over a short period of time is $\rho\geq 0$ and short term discount factor is $d(1)=(1+\rho)^{-1}$. Their utility in one year is discounted by $d(m)=(1+\rho)^{-m}$, with m the number of unit periods within a year. Their annualized discount factor ρ_a is equal to $1+\rho_a=(1+\rho)^m$.

Even a small departure from perfect short-term patience may translate into a potentially extreme degree of impatience once compounded over many periods of time. For instance, a tiny discount rate of $\rho=0.1$ percent over one day leads to a significant annualized discount rate of 44 percent. Such value seems incompatible with individuals engaging in profitable long-term investments like saving for their long term standard of living. More reasonable long-term impatience is consistent with short-term impatience once a bias for the present is accounted for. This can be done with the two-parameter $(\beta-\delta)$ model of

Laibson [1997] where future utility is discounted exponentially ($d(t) = (1+\rho)^{-t}$) and an extra weight $d(0) = 1/\beta > 1$ applies to present utility.

This interpretation of present bias directly connects to our axiomatic definition. Short-term impatience becomes a natural consequence when the discount rate is discontinuous. "Short" means any durations which, once exponentially compounded over longer time intervals imply implausible impatience. Present bias defined as impatience over arbitrarily small time intervals, is close in spirit to theirs.

However, our approach makes an important distinction. While significant short-term impatience may suggest present bias, our definition specifically isolates the discontinuity between present and future, rather than conflating it with the general rate of time preference over short periods. The definition can be formally stated and does not rely on assumptions about what are acceptable short periods, nor on model-dependent consequences for long-run impatience.

6 Conclusion

How concepts are defined influences the way researchers frame their reasoning and produce new knowledge. By providing a narrow definition of present bias, this article fills a gap in the literature in which important theoretical and empirical results abound but conceptual clarity lags behind.

The definition of present bias as a discontinuity in preferences at the present moment has affinities with, yet is distinct from behaviors previously associated with the concept. Individuals may be present biased and not decreasingly impatient with regards to immediate or future trade-offs. As time elapses, they may not necessarily reverse their choice toward the immediate outcome, even if their preferences are stationary. The definition takes an intuitive form and clearly distinguishes between leading models of present bias. The $(\beta - \delta)$ model of Laibson [1997] and the fixed cost model of Benhabib et al. [2010] meet the definition, while the generalized model of hyperbolic discounting of Loewenstein and Prelec [1992] or the discount functions of Bleichrodt et al. [2009] and Ebert and

Prelec [2007] do not.

The paper proposes an intuitive axiomatic framework in which the elicitation of present bias is agnostic about preferences over extended or delayed trade-offs, and as a result is not tied to a specific functional form. The definition suggests new ways of measuring present bias. Most experiments estimate a $(\beta - \delta)$ model by collecting data on multiple types of choices, some involving trade-offs between immediate utility and future utility, and others involving trade-offs between future utilities at different dates. A simpler measure consistent with the present definition would elicit the present bias intensity between the present and an extremely short period ahead, avoiding the need for multiple temporal trade-offs, an empirical strategy similar to Augenblick [2018] for unpleasant tasks.

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