## Intergenerational Discounting and Inequality

Frikk Nesje and Paolo G. Piacquadio

Stockholm School of Economics November 28, 2025











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## Motivation

- ▶ Policies today affect present and future generations:
  - Typically, some gain, other lose from the policy.
- **Examples**:
  - Mitigation of climate change;
  - Public debt reduction:
  - Research and development for technological change;
  - Pension reform.

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## Motivation

- ▶ What policies are better? The answers depend on two aspects of intergenerational justice:
  - ► The attitude toward earlier vs. later generations—discounting;
  - ▶ The attitude toward better-off vs. worse-off generations—inequality.

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## Motivation

- ▶ What policies are better? The answers depend on two aspects of intergenerational justice:
  - ► The attitude toward earlier vs. later generations—discounting;
  - ▶ The attitude toward better-off vs. worse-off generations—inequality.
- ▶ But: The set of attitudes we typically adopt for economic policy evaluation and analysis is quite narrow.

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Motivation

- ▶ We develop a new, large family of theories of intergenerational justice.
- ► We show that **discounting and inequality** attitudes are generally independent of each other and **can be disentangled**.

## Discounting and Inequality

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- ▶ We develop a new, large family of theories of intergenerational justice.
- We show that discounting and inequality attitudes are generally independent of each other and can be disentangled.
- ► This **orthogonality property** holds across a wide variety of cases, and provides significantly more general (tractable) criteria.

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▶ A feature of the most common criteria is that they rely on exponentially-discounted utilitarianism or other additively separable formulations.

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- ▶ A feature of the most common criteria is that they rely on exponentiallydiscounted utilitarianism or other additively separable formulations.
- ▶ The advantage of our separation is that we can present a wide variety of cases that go beyond exponential discounting and additive separability.
- Examples:
  - Non-constant social impatience:
  - Positional attitudes to inequality between generations.

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Contribution

## Our contribution

## 1. We develop "modular" theories of intergenerational justice:

- 1.1 *Module 1* exclusively deals with **discounting**;
- 1.2 Module 2 exclusively deals with **inequality**;
- 1.3 Any theory is fully described by these two modules;
- 1.4 Many new theories emerge;
- 1.5 The most common theories fit our approach.
  - Exponentially-discounted utilitarianism as special case.

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## Our contribution

- 1. We develop **"modular" theories of intergenerational justice**:
  - 1.1 Module 1 exclusively deals with discounting;
  - 1.2 *Module 2* exclusively deals with **inequality**;
  - 1.3 Any theory is fully described by these two modules;
  - 1.4 Many new theories emerge;
  - 1.5 The most common theories fit our approach.
- 2. We axiomatically characterize the class of modular theories of intergenerational justice.

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## Our contribution

- 3 We provide a transparent framework to understand and choose from a large class of social welfare functions.
- 4 We relate the social welfare function to measures of (in)equality and their trade-off with efficiency and the generalized Ramsey rule.
- 5 We offer **new definitions** of social impatience and inequality aversion.

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## Literature

- ► The relationship between discounting and inequality remains understudied (Stern, 2007; Nordhaus, 2007; Dasgupta, 2008).
- ► The literature has focused on **discounting attitudes**:
  - Pareto efficiency implies some sort of discounting (Diamond, 1965).
- ➤ Our perspective on **inequality attitudes** is borrowed from the leaky bucket experiment popularized by Okun (1975).

Technical remarks

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## Agenda

- Disentanglement;
- Characterization:
- Implications;
- Discounting and inequality;
- Conclusion.

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## A consumption stream

▶ We study the problem of ranking bounded consumption streams

$$c: T \to \mathbb{R}_+$$

in infinite continuous time  $T\equiv [0,\infty).$  The set of all consumption streams is C.

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## A consumption stream

▶ We study the problem of ranking bounded consumption streams

$$c: T \to \mathbb{R}_+$$

in infinite continuous time  $T \equiv [0, \infty)$ . The set of all consumption streams is C.

► A theory of intergenerational justice is represented by a **social welfare function** 

$$W: C \to \mathbb{R}$$
.

We assume that the social welfare function is continuous.

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▶ The central step of our analysis is to *transform* consumption streams in "calendar time" T to consumption streams in "equivalent time"  $I \equiv [0, 1)$ .

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- ▶ The central step of our analysis is to transform consumption streams in "calendar time" T to consumption streams in "equivalent time"  $I \equiv [0, 1)$ .
  - ▶ The duration of each generation is expanded / compressed up to the point where all consumption has the same value.

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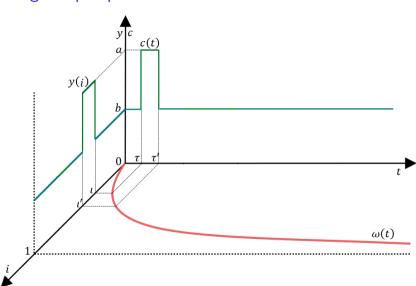


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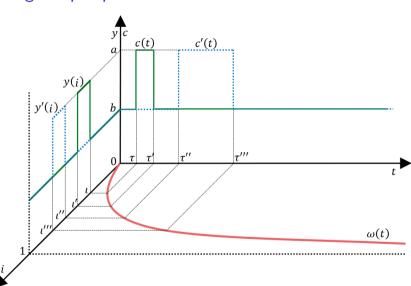
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#### Discounting and Inequality

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- The central step of our analysis is to *transform* consumption streams in "calendar time" T to consumption streams in "equivalent time"  $I \equiv [0, 1)$ .
  - ► The duration of each generation is *expanded/compressed* up to the point where all consumption has the **same value**.
- ► Anticipating the results: since each instant of consumption in equivalent time has the same value, we can apply any law invariant inequality averse aggregation of consumption.

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# The time-discounting function

• We say that consumption streams admit a representation in **equivalent time**, if there exists a strictly increasing function  $\omega: T \to I$ , such that permuting the transformed consumption is a matter of social indifference.

$$W(c) = W(c')$$
 whenever  $c = y(\omega)$ ,  $c' = y'(\omega)$ ,  $y = \Pi y'$ .

In other words, all intervals in equivalent time have the same value.

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## The time-discounting function

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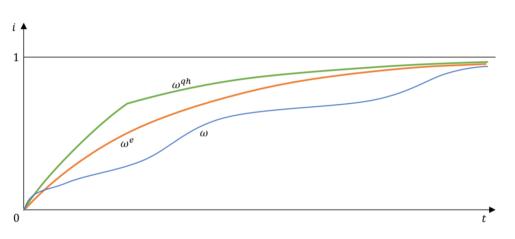
- In other words, all intervals in equivalent time have the same value.
- $\triangleright$  We call  $\omega$  the **time-discounting function**.

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Discounting and equivalent time representation

# The time-discounting function



$$\omega^e(t) = 1 - e^{-\rho t}$$

$$\omega^{qh}(t) = \begin{cases} \beta \kappa (1 - e^{-\rho t}), & \text{for } t \in [0, \tau] \\ 1 - \kappa e^{-\rho t}, & \text{for } t > \tau. \end{cases} \text{ with } \kappa = 1/(\beta + (1 - \beta)e^{-\rho t})$$

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## The aggregator

- ▶ How to aggregate consumption streams in equivalent time?
- ▶ Given the social welfare function W and the time-discounting function  $\omega$ , the **aggregator**  $V: Y \to \mathbb{R}$  immediately follows by setting

$$V(y) = W(y(\omega)).$$

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## The aggregator

- How to aggregate consumption streams in equivalent time?
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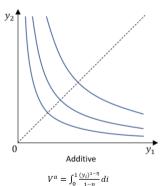
- Note that the aggregator is *law invariant* in equivalent time by definition.
- Thus, V could be any standard (atemporal) social welfare function.

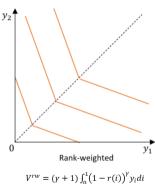
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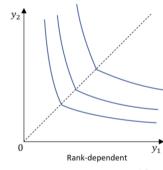
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The aggregator

# The aggregator







# $V^{rd} = (\gamma + 1) \int_0^1 (1 - r(i))^{\gamma} \frac{(y_i)^{1-\eta}}{1-\eta} di$

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## The modular social welfare function

- We say that W is **modular** if consumption streams can be represented in equivalent time and, thus, there exist an  $\omega$  and V induced by W.
- ▶ Importantly, the most common welfare criteria adopted in the literature are modular.

Example formulas

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# **Implications**

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# Some modular theories of intergenerational justice

w	v	Additive $V^a$	Rank-weighted $V^{rw}$	Rank-dependent $V^{rd}$
ω		$\int_{0}^{1} f(y_{i})di$	$\int_{0}^{1} g(r(i))y_{i}di$	$\int_{0}^{1} g(r(i))f(y_i)di$
Exponential $\omega^e$	$1 - e^{-\rho t}$	EDU		
Quasi- hyperbolic $\omega^{qh}$	$\begin{cases} \beta k (1 - e^{-\rho t}) \ t \le \tau \\ 1 - k e^{-\rho t}  t > \tau \end{cases}$		NE	W
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## Efficiency-equity representation

**Proposition 1.** Assume W is modular, Paretian and scale invariant. Then, the following decomposition emerges:

$$W = \overline{y} \cdot E(y)$$
.

Here,  $\overline{y}$  is the mean,  $y(\omega) = c$ , and E is a measure of equity (or 1 minus inequality), building on Atkinson (1970).

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## Efficiency-equity representation

**Proposition 1.** Assume W is modular, Paretian and scale invariant. Then, the following decomposition emerges:

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- ► Here,  $\overline{y}$  is the mean,  $y(\omega) = c$ , and E is a measure of equity (or 1 minus inequality), building on Atkinson (1970).
- ▶ Thus, social welfare can be decomposed in two main aspects:
  - ightharpoonup the time attitude  $(\omega)$ ,
  - ▶ the efficiency-equity trade-off  $(\overline{y} \cdot E)$ .

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## Generalized Ramsey rule

**Proposition 2.** Assume W is modular and Paretian, and  $\omega$ , V are "differentiable". Then, the social discount rate follows:

$$SDR_t = \frac{1}{t} \ln(\omega'(0)/\omega'(t)) + \frac{1}{t} \ln(\mu(0;y)/\mu(\omega(t);y)).$$

- ► The first term captures the "pure time preference", embodied by the time-discounting function.
- The second term captures inequality adjustment  $(\mu(i; y))$  is the marginal of V at i given y).

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- lacktriangle As a special case, the standard Ramsey rule obtains:  $SDR_t = \rho + \eta g_t^c$ .

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## Generalized Ramsey rule

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- lacktriangle As a special case, the standard Ramsey rule obtains:  $SDR_t = \rho + \eta g_t^c$ .
- ► For parametric rank-dependent families:  $SDR_t^{erd} = \rho + \eta g_t^c + \gamma g_t^r$ .

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## Conclusion

- ▶ We propose modular theories of intergenerational justice.
- Distinctive features:
  - It builds on and highlights a variety of attitudes towards discounting and inequality;
  - ▶ It is very general and flexible, and enriches the toolbox of economic analysis. At the same time, the parametric specifications of these theories remain suitable for investigation of optimal policies.
- Estimation, application, and generalization of the modular theories also open many avenues for future research.

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