Population Flows and the Speed of History

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Population decline as a global priority

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Recent work suggests this may be a threat to long-term human welfare

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Put simply, there will be **fewer people** and/or these people will have **worse lives**

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There’s *something* perverse about stuffing people into technologically immature states to speed up progress

Population sizes govern the *speed of history*

This project:

1. Shows that standard models imply that increasing the size of the population (only) serves to **speed up history**
   - Technologies and people are "brought forward" at the same speed
   - So no individual is made better off: same quality of life, but they occur earlier
2. Uses this framing to sort out concerns about population decline
   - The key issue is how the model ends (Ord, Forthcoming)
     - If a deadly asteroid is coming in 1000 years, speeding up history has value
     - If extinction is endogenous, that is (presumably) brought forward just as fast as population and technology

Takeaway: This 'speeding up history' framing is greedy—it neutralizes the stagnation concern *and* eats away at the totalist benefits

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   - New reading of standard semi-endogenous growth model
3. More speculative, sci-fi considerations (these are necessary!)
   - If population size considerations are equivalent to speeding things up, it matters what is happening at the end of history

Discrete Endogenous Growth Setting

Growth theory á la Romer (1990), Jones (1995) implies that research effort determines the level of innovation in a period

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For concreteness, let's say it takes 100,000 people-years

Is it good to increase population sizes?

Suppose a benevolent planner could pick the population, N

- Should she pick a large population, to speed up progress?

Let's focus on choosing between $N = 100$ or $N = 500$

- So it takes either 1000 years or 200 years to get to H, respectively

Is it better to get there faster?

From the perspective of each individual, **no**

Individuals can be identified by their order of birth, i; assume they live for one period

- $i = 5$ is the 5th person ever born
- They likely share the planet with their friends $i = 4, 6$

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We've stipulated that it takes 100,000 people-years to get to H

- So the first $i \leq 100000$ **don't care** that you've sped up technological progress in this way
- (They have more contemporaries, but I'll set that aside as second-order)

Do people $i > 100000$ care?

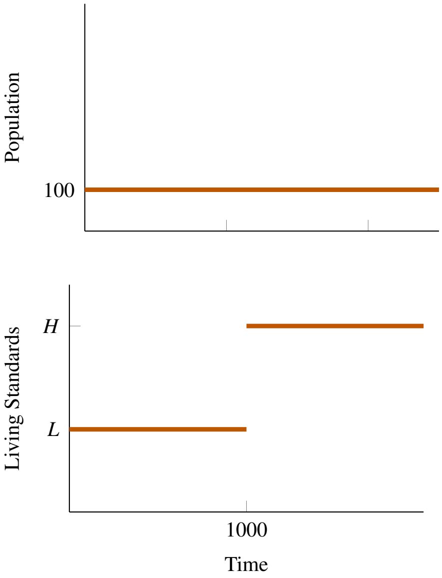
What changes for the people who come afterwards?

Suppose for the moment that person $i = 100001$ will come into existence with certainty

- She lives in the H-state, *no matter what*
- The only thing on the line for her is *when* she comes into existence

So, any individual who comes into existence with certainty is made no better off by increasing population sizes

Larger populations speed up technological progress...



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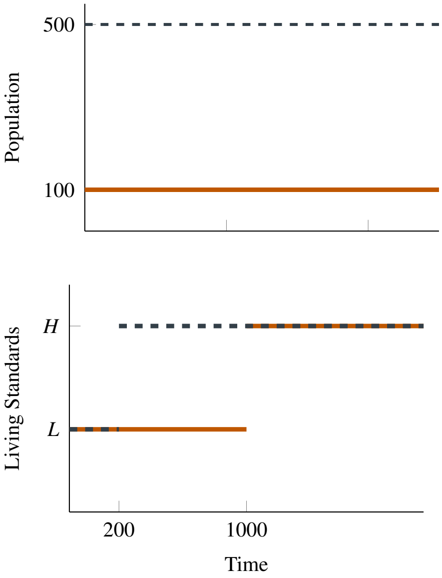
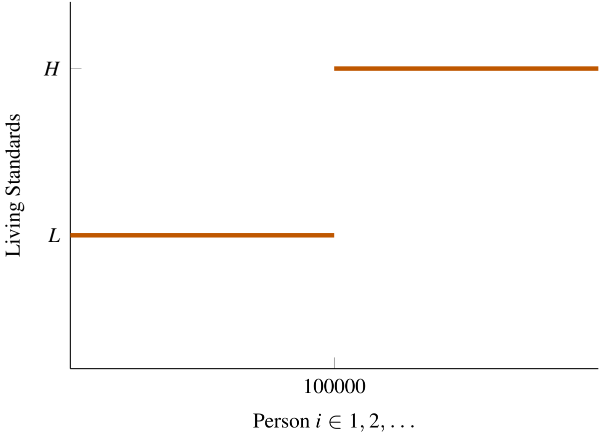


...but no one's living standards are improved



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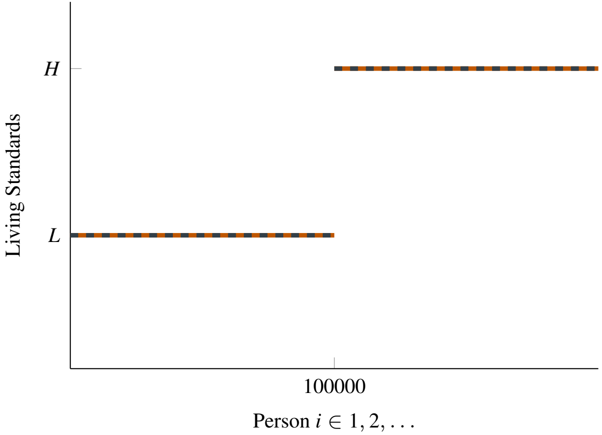

Result: Being in a larger population world, with faster technological progress, has not made anyone's life better

What’s on the line is existence, not individual living standards!

Corollary: If there is a pre-determined number of people who will ever live, then the population size in any given period is normatively irrelevant, even if we accept that it speeds up progress

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- We need to think about exinction risks

Case I: Exogenous extinction

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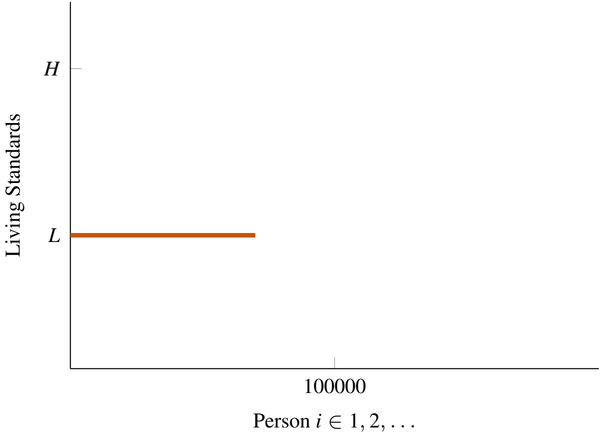
Trivial solution: total (and average) utility is increasing in the size of the flow population

- For $N = 100$ we get to the first 50,000 life-years; for $N = 500$ we get to the first 250,000

Larger populations are valuable in this case



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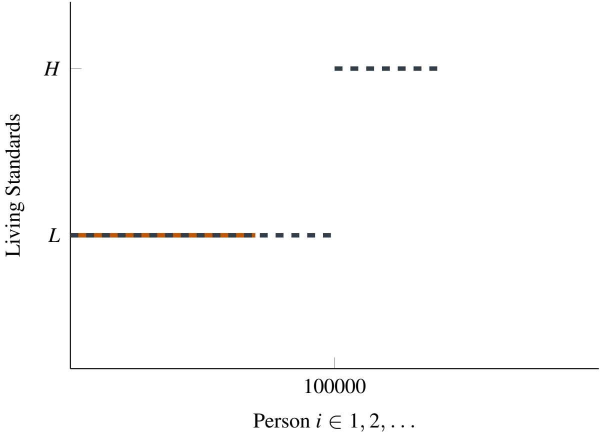

The larger population gets through more of this shared, potential history

Case II: Endogenous extinction

Two ways we might intuitively model existential risk:

1. We invent something that leads to our extinction
   - This is the AGI case: suppose H comes with a technology that kills everyone soon after its reached
2. We invent something that makes it possible for a rogue individual or group to kill everyone
   - In H, maybe we now face a 1:100,000 chance of drawing an individual evil enough to produce an existential bioweapon

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In each case: the number of individuals who ever live is **invariant** to flow population sizes

i. With AGI we get the first 100,000 life-years (until H is reached)

ii. With bioweapons we get 100,000 i's after H is reached

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With endogenous extinction of these sorts, we **bring forward extinction** at the same rate we bring forward people and innovations

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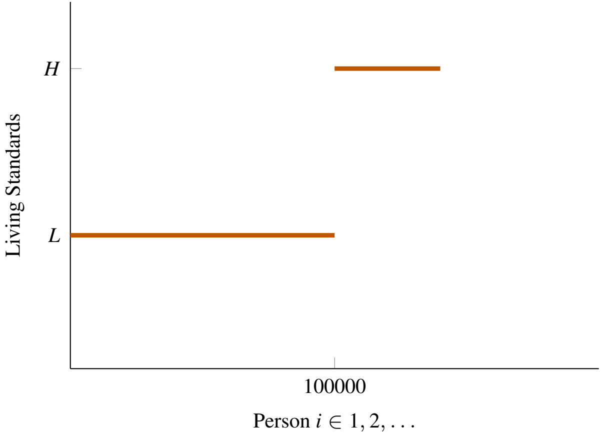

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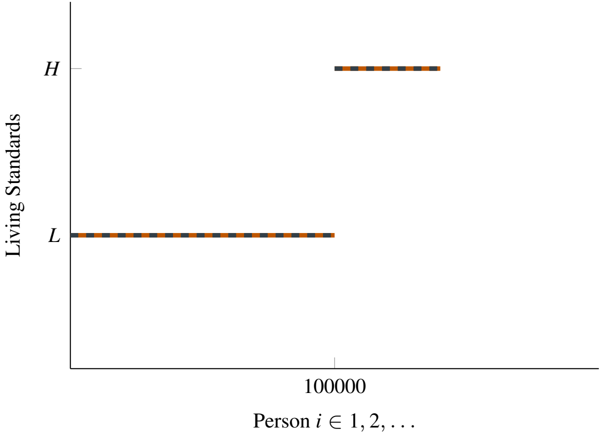

The only difference is that the small population exists for longer, but time is not on this graph

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However, the *value* of speeding up history is **decreasing in the share of risk that's endogenous**

- This should influence priorities
- EV of adding a person is $p_{exo} \times u_I$
  - p_{exo} is probability of exogenous extinction (ever)
  - u_I is utility of last individual

This idea holds more generally, and in leading models

Semi-endogenous growth model: Percent growth in TFP (A) is increasing in N, but suffers from dynamic diminishing returns (β)

$$\frac{\dot{A}}{A} = \alpha N(t)^{\lambda} A(t)^{-\beta}$$

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"Simplified model" sets $\lambda = 1$

- $\lambda < 1$ (duplication) implies that to maximize innovation that M people create, spread them out into M non-overlapping lives
- $\lambda > 1$ (collaboration) implies that to maximize innovation that M people create, stack them all in one year

Neither seems plausible in limits, so I'll assume that these offset ($\lambda = 1$)

Cumulative people-years by t pins down A_t

Integrate with respect to time:

$$A(t) = \left(\beta\alpha \underbrace{\int_0^t N(\tau)d\tau}_{\textbf{People-years} \text{ by } t} + A_0^\beta\right)^{\frac{1}{\beta}}$$

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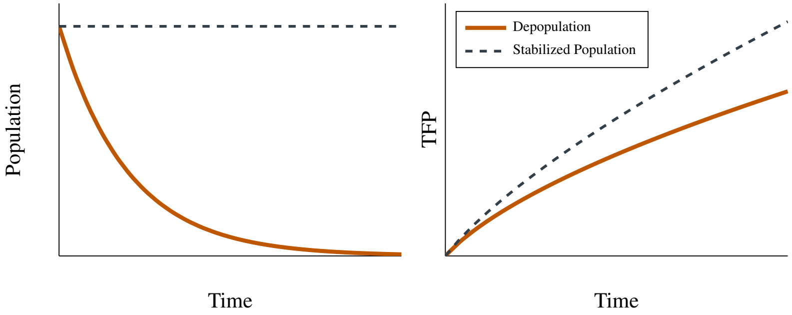
Implication: by the time the ith person lives, the level of technology they experience is **invariant** to *when* they live

- And the path of population could have taken any arbitrary path to deliver that integrated value

So everything from that simple model will be the same here, except that living standards now take continuous values

Larger populations speed up technological progress



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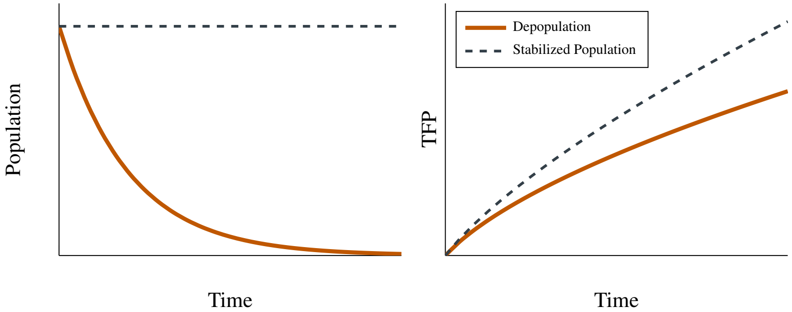
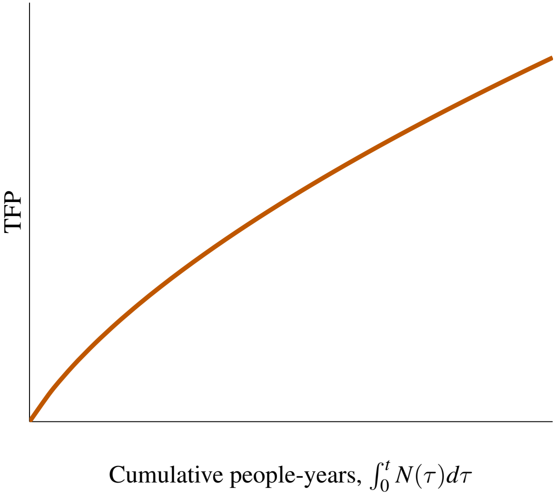


All **time periods** have a higher average living standard

- But we care about living standards for **people**, not time periods

ith person has same technology available



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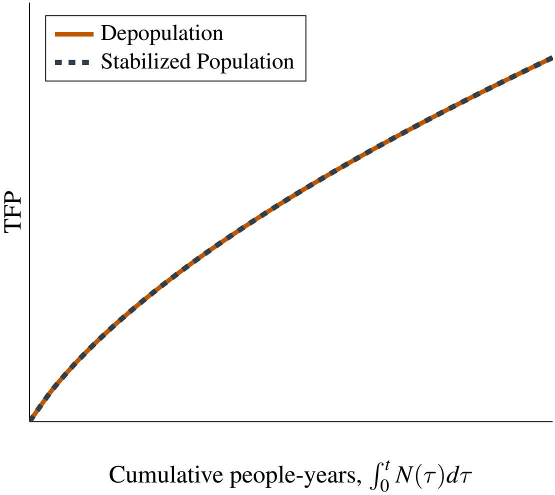

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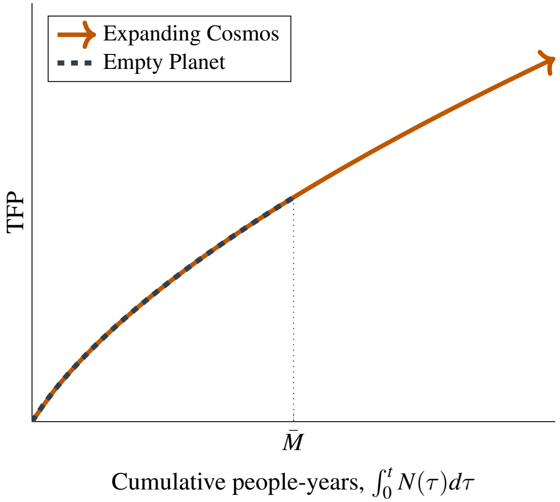
In endogenous growth models, $g \geq 0$ is good *because we never go extinct*

Again: *i*th person has same technology available



"Empty Planet" **cuts short** the same trajectory by voluntary extinction

Endogenous, continuous, existential risk can be formalized

Consider two simple versions of a relationship between x-risk and A

$$P(survive(t)|alive) = \frac{1}{1 + \theta N(t) \times A(t)^{\phi}}$$

$$P(survive(t)|alive) = \frac{1}{1 + \theta N(t) \times e^{-\phi A(t)}}$$

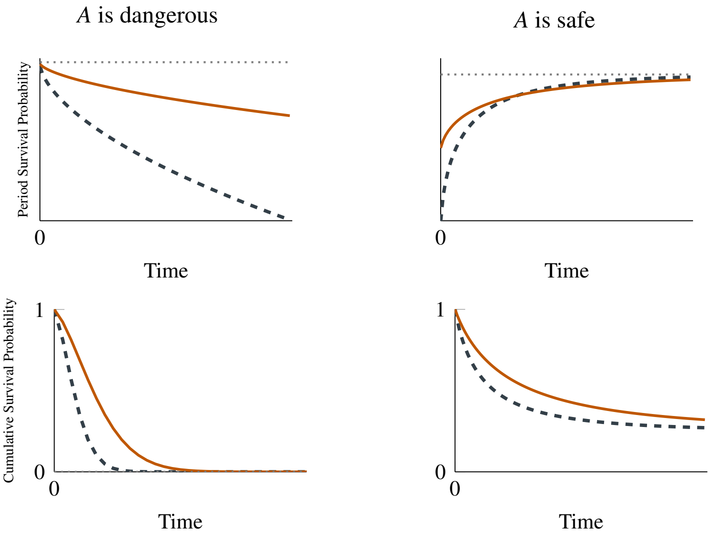
Increasing in N: you need the technology *and the bad actor* for extinction

- If there are only 10 people alive, seems unlikely one will engineer a pandemic

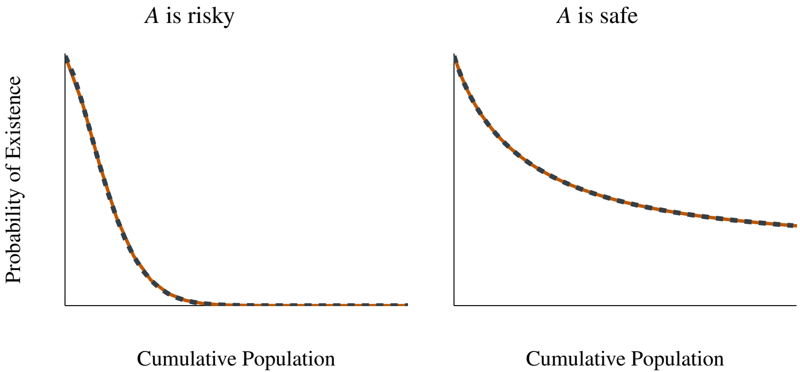
What's the probability of getting to the i'th person in this framework?

Humanity survives longer with smaller populations

Blue dotted population is twice as large in each period



No surprise: Probability of getting to *i*th person is constant



In simple specifications, we can't use population to grow us to safety

- This relies on x-risk increasing proportionately with N
- Result differs from Aschenbrennar (2020)

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I remain confused about all of this!

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