Scale effects and speeding up history

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Normative aspects of semi-endogenous growth models

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But increasing population sizes **stacks more people in the less mature state**

- Does this offset the benefits of faster technological progress?

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Probably! It depends on how you specify the end of history (i.e, x-risk)

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4. Relax some simplifying assumptions in knowledge production
   - Diminishing returns to knowledge production gives rise to **competing forces**

Semi-Endogenous Growth Model

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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, so I'll assume that these offset ($\lambda = 1$)

Main Result: 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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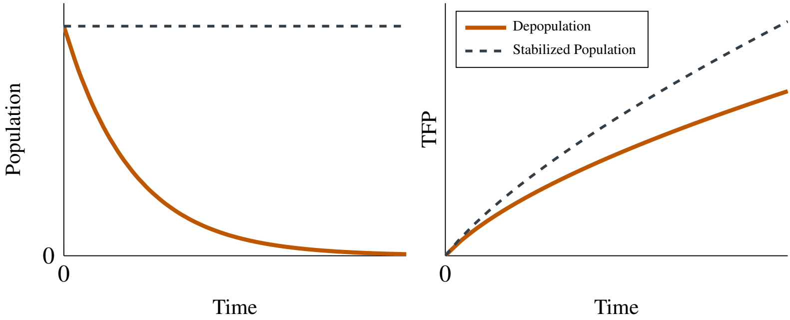
Implication: by the time the *i*th person lives, the level of technology they experience is **invariant** to *when* they live

- Therefore, **increasing population sizes makes no one's life better**
- Alternatively, the same number of people will live before factory farming ends, regardless of population sizes
  - So there's no "meat-eater problem," on the population margin

(Of course, increasing or decreasing per capita intensity of these activities will still matter, this is all on the population-growth margin)

Larger populations speed up technological progress



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

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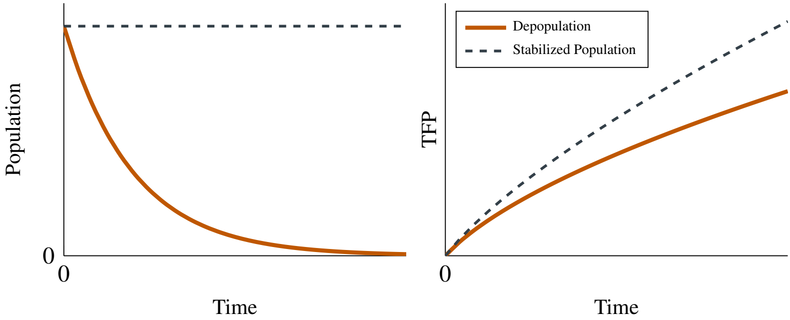
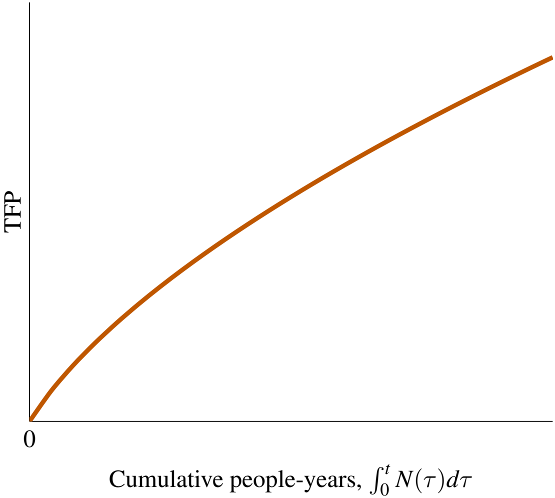


All **time periods** have a higher average living standard

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

ith person has same technology available



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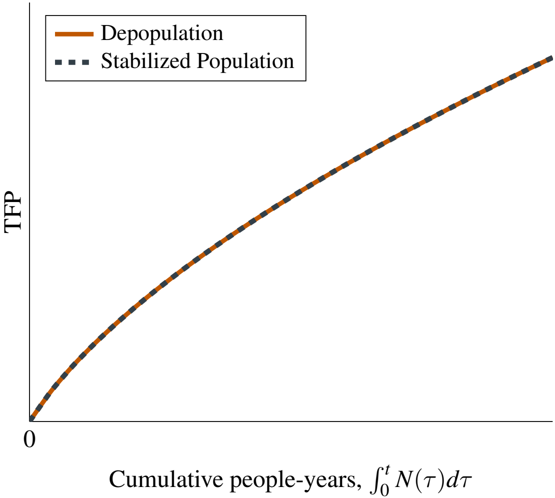

History has been **sped up**: people and innovations brought forward **proportionately**

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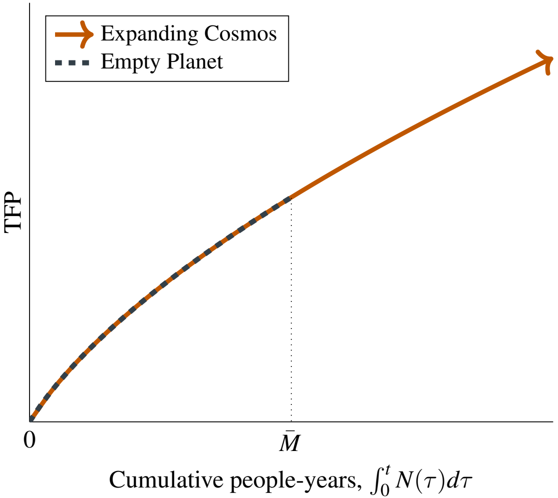
Population growth is good *because more people exist*

Again: *i*th person has same technology available



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

How you close the model is crucial

Exponential decay ends history in Jones (2022)

- That's just one of many ways to "close the model"

Consider two alternative assumptions:

(i.) Asteroid: Humanity ends at some date T, exogenously
   - Speeding up history is **very valuable**: we get more of it
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If events in **chronological time** contribute to x-risk, speeding up history has value

- Exactly how valuable will depend on the "share" of x-risk that's exogenous

What about stagnating in a time of perils?

McAskill (2022) worries about **stagnating when x-risk is high**

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Here I'll consider two simple versions of x-risk

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

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

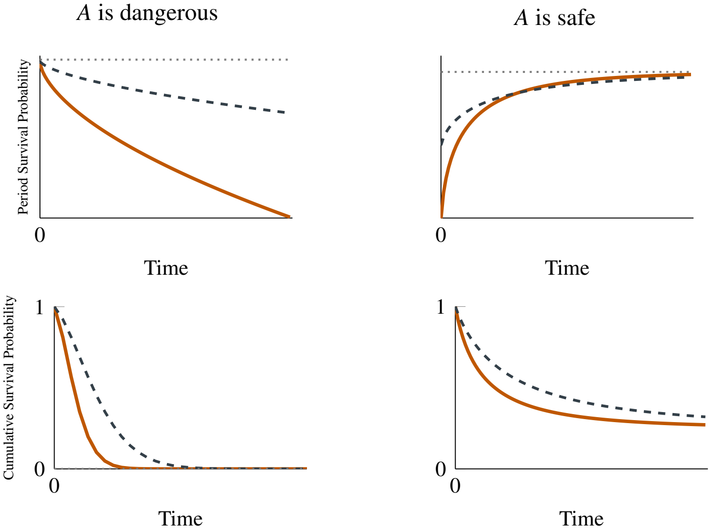
Increasing in N: you need the technology *and the bad actor* for extinction

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

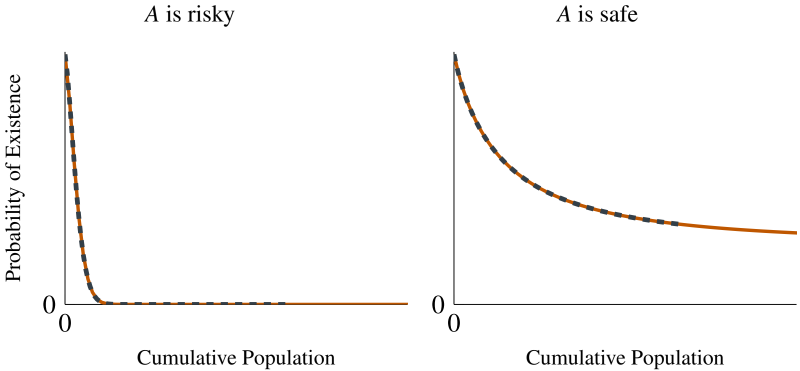
What's the probability of getting to the i'th person in this framework?

Humanity survives longer with smaller populations

Blue dotted population is half the size in each period



You guessed it: probability of getting to *i*th person is constant



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

- This of course relies on x-risk increasing proportionately with N

What if we relax linearity?

There are a few linearity restrictions which help generate the exact neutrality

- If doubling the number of people doubles economic growth $\Rightarrow$ proportional results

Let's relax $\lambda < 1$

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It's **no longer true** that the timing of people doesn't matter

$\lambda < 1$ implies ambiguous effects of increasing populations

If there are diminishing returns, **less knowledge** is available to the *i*th person **if populations were large**

- 10 people in one year now generates less A than 1 person per year
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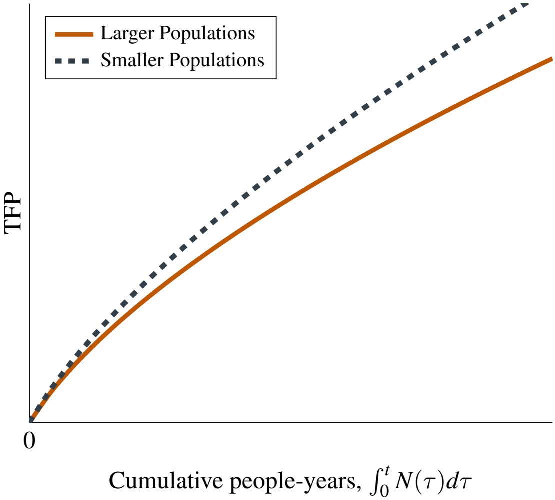
So—if i gets to exist—they do so with a **lower living standard**

- They still have a higher probability of existing for exogenous reasons
  - They come **earlier** in time
- They also may have a higher chance of existing for endogenous reasons
  - Technology is **less mature** before their existince

Whether this is ex-ante valuable depends on quantitative trade-offs between the chances of existing and the quality of life conditional on existing

Smaller populations increase average living standards...

...when returns to knowledge production diminish in population



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