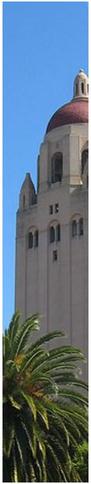

Population and Welfare:

The Greatest Good for the Greatest Number

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Motivation

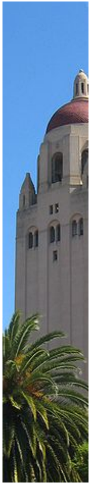
- Economic growth is typically measured in per capita terms
  - Puts **zero** weight on having more people – extreme!
- *Hypothetical:* Two countries with the same TFP path. One has constant N but rising c, the other has constant c but rising N.
  - Example: Japan is 6x richer p.c. than in 1960, while Mexico is 3x richer
    But Mexico's population is 3x larger than in 1960 vs. 1.3x for Japan
- **Key Question:**
  How much has population growth contributed to aggregate welfare growth?

Examples of how this could be useful

- The Black Death, HIV/AIDS (Young “Gift of the Dying”), or Covid-19
- China’s one-child policy
- Population growth over thousands of years
- What fraction of GDP should we spend to mitigate climate change in 2100?
    - How many people are alive today versus in the year 2100?

Outline

- **Part I.** Baseline calculation with only population and consumption
- **Part II.** Robustness
- **Part III.** Incorporating parental altruism and endogenous fertility



Part I. Baseline calculation
with only population and consumption

Flow Aggregate Welfare

- Setup
  - c_t consumption per person
  - $u(c_t) \geq 0$ is flow of utility enjoyed by each person
  - N_t identical people
- Summing over people $\Rightarrow$ aggregate utility flow

$$W(N_t, c_t) = N_t \cdot u(c_t)$$

  - Exist $\Rightarrow u(c)$, not exist $\Rightarrow$ 0 (the 0 is a free normalization)

Philosophy and Social Welfare

- Longstanding debate: both "average" and "total" views considered valuable
  - Critique of average utilitarian approach: Sadistic conclusion
- Total utilitarian welfare
  - Critique — Repugnant conclusion (Parfit, 1984)

    Zuber et al (2020): 29 philosophers argue this critique is not decisive
  - Axiomatic justification (e.g. Kuruc, Budolfson, and Spears, 2022)

    Example: For $N^{\alpha}u(c)$, rejects $\alpha < 1$ in favor of $\alpha = 1$
- *Our contribution:* measure how the "average" and "total" views differ

Growth in consumption-equivalent aggregate welfare

$$\frac{dW_t}{W_t} = \frac{dN_t}{N_t} + \frac{u'(c_t)c_t}{u(c_t)} \cdot \frac{dc_t}{c_t}$$

$$\underbrace{\frac{u(c_t)}{u'(c_t)c_t} \cdot \frac{dW_t}{W_t}}_{\text{CE-Welfare growth}} = \underbrace{\frac{u(c_t)}{u'(c_t)c_t}}_{\equiv v(c_t)} \cdot \frac{dN_t}{N_t} + \frac{dc_t}{c_t}$$

- $v(c)$ = value of having one more person live for a year
  - expressed relative to one year of per capita consumption
- 1 pp of population growth is worth $v(c)$ pp of consumption growth

Calibrating $v(c)$ in the U.S. in 2006

- Using the EPA's VSL of $7.4m in 2006:

$$v(c) \equiv \frac{u(c)}{u'(c) \cdot c} = \frac{\text{VSLY}}{c} \approx \frac{\text{VSL}/e_{40}}{c} \approx \frac{\$7,400,000/40}{\$38,000} = \frac{\$185,000}{\$38,000} \approx 4.87$$

  - 1 pp population growth is worth ∼5 pp consumption growth

Measuring $v(c)$ in other years and countries

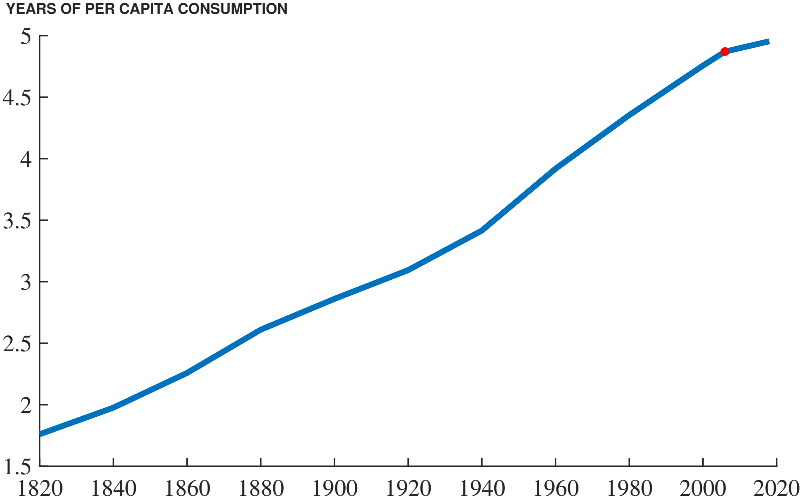
- Baseline: Assume $u(c) = \bar{u} + \log c$

$$v(c) \equiv \frac{u(c)}{u'(c) \cdot c} = u(c) = \bar{u} + \log c$$

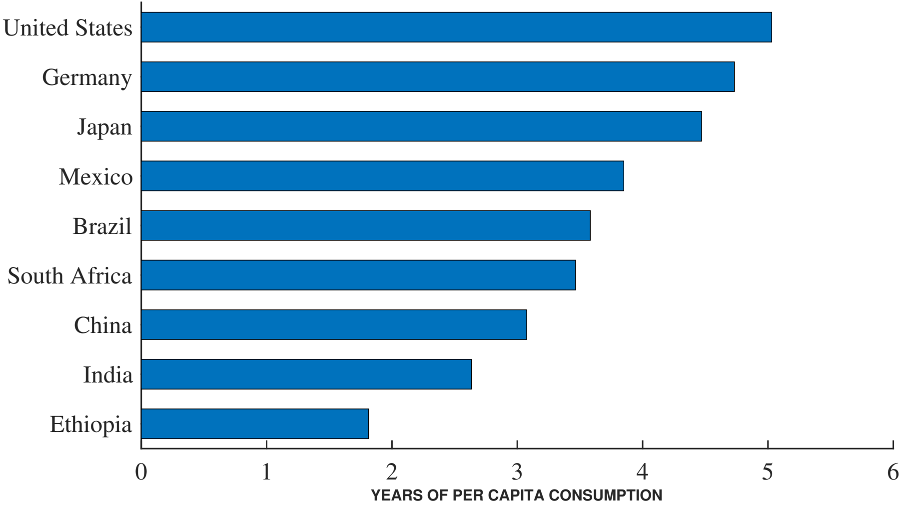
  Higher consumption raises the value of a year of life

- Calibration:
  - Normalize units so that $c_{2006,US} = 1$
  - Then $v(c_{2006,US}) = 4.87$ implies $\bar{u} = 4.87$

$v(c)$ over time in the U.S.



$v(c)$ across countries in 2019



Valuing Death vs. Life

- VSLY: willing to give up $v(c)\%$ of c to reduce mortality by 1pp
- Population growth reflects longevity but also fertility
- What fraction of c would you give up each year to avoid a 1% chance of never having been born?
  - Baseline treats symmetrically: $v(c)\%$
  - Dying one hour after birth similar to never having been born
  - Future research could survey people? (But not revealed preference.)
- Robustness checks are informative (e.g. half VSLY)

Recap

$$g_\lambda = v(c)\, g_N + g_c$$

λ is consumption-equivalent welfare

g_c is the growth rate of per capita consumption

g_N is population growth

$v(c)$ values lives the way people themselves do

- $v(c) = 0 \;\Rightarrow\; g_\lambda = g_c$ is an extreme corner
- $v(c) = 1 \;\Rightarrow$ CE-welfare growth is just aggregate consumption growth
- $v(c) = 3$ or $5 \;\Rightarrow$ much larger weight on population growth

Results for 101 countries from 1960 to 2019 (PWT 10.0)

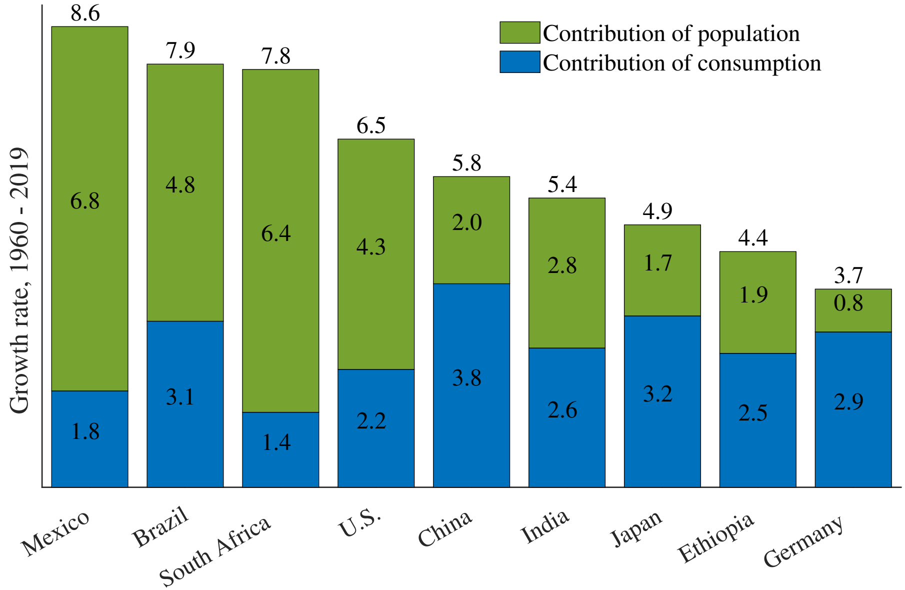
	Unweighted	Pop Weighted
CE-welfare growth, g_λ	6.2%	5.9%
Population term, $v(c)g_N$	4.1%	3.1%
Consumption term, g_c	2.1%	2.8%
Population growth, g_N	1.8%	1.6%
Value of life, $v(c)$	2.7	2.3
Pop share of CE-welfare growth	66%	51%

In 77 of the 101 countries, Pop Share of CE-Welfare Growth $\geq 50\%$

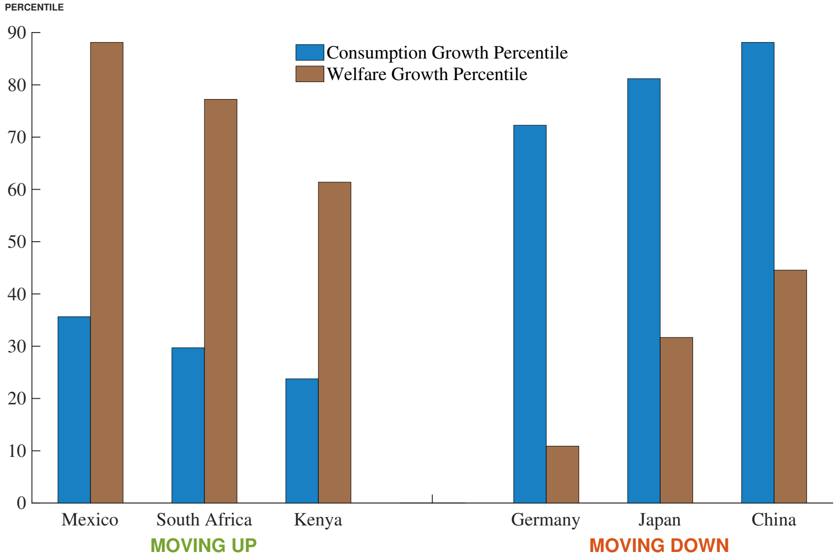
Decomposing welfare growth in select countries, 1960–2019

	g_λ	g_c	g_N	$v(c)$	$v(c) \cdot g_N$	Pop Share
Mexico	8.6	1.8	2.1	3.4	6.8	79%
Brazil	7.9	3.1	1.8	2.8	4.8	61%
South Africa	7.8	1.4	2.1	3.1	6.4	82%
United States	6.5	2.2	1.0	4.4	4.3	66%
China	5.8	3.8	1.3	1.8	2.0	34%
India	5.4	2.6	1.9	1.6	2.8	52%
Japan	4.9	3.2	0.5	3.8	1.7	34%
Ethiopia	4.4	2.5	2.7	0.7	1.9	44%
Germany	3.7	2.9	0.2	4.0	0.8	22%

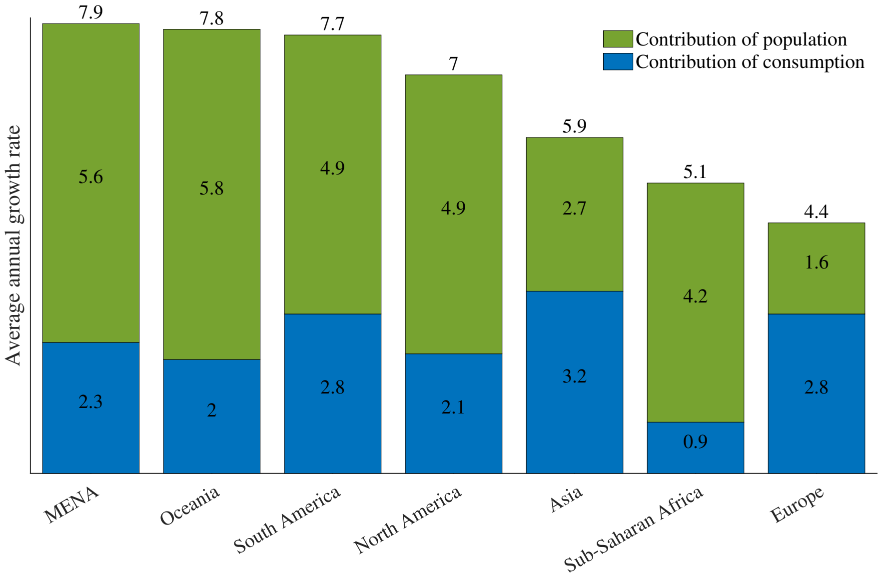
Average CE welfare growth for select countries, 1960–2019



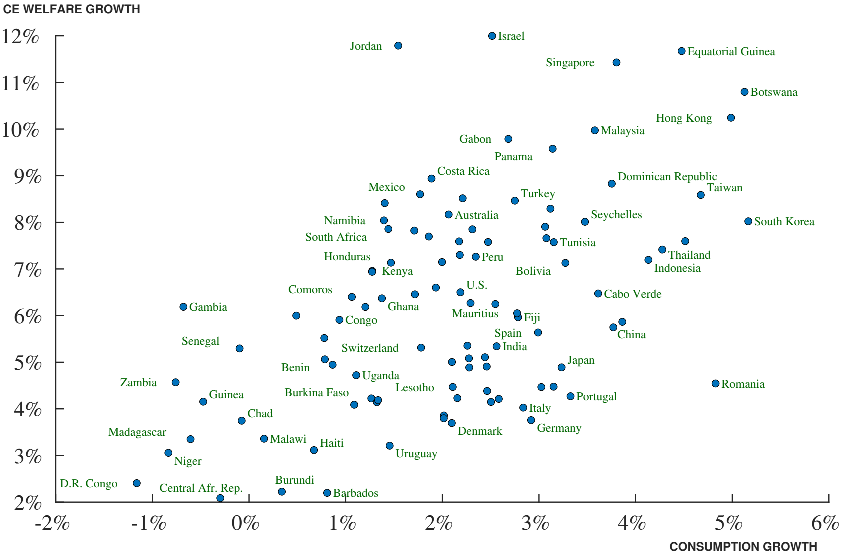
Some big differences in percentiles, 1960–2019 growth



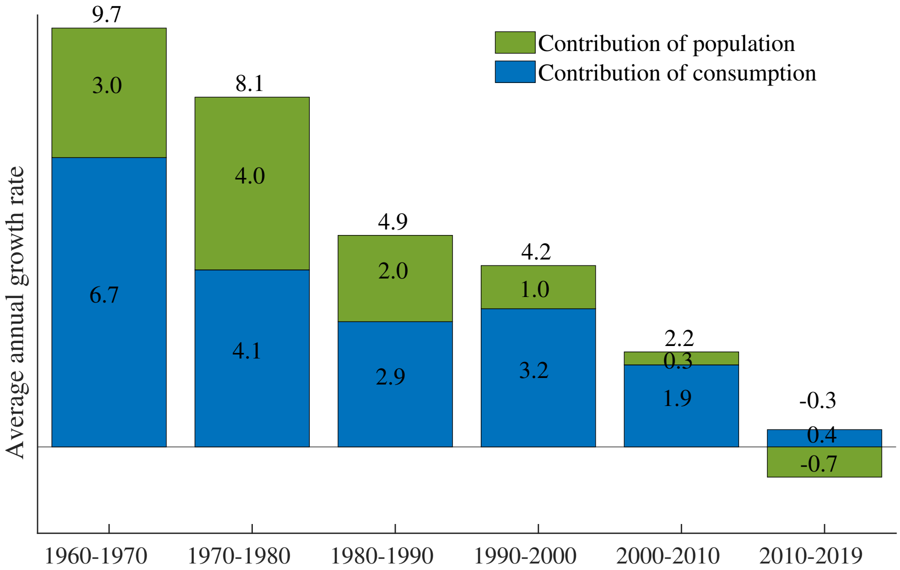
Average CE welfare growth by region, 1960–2019



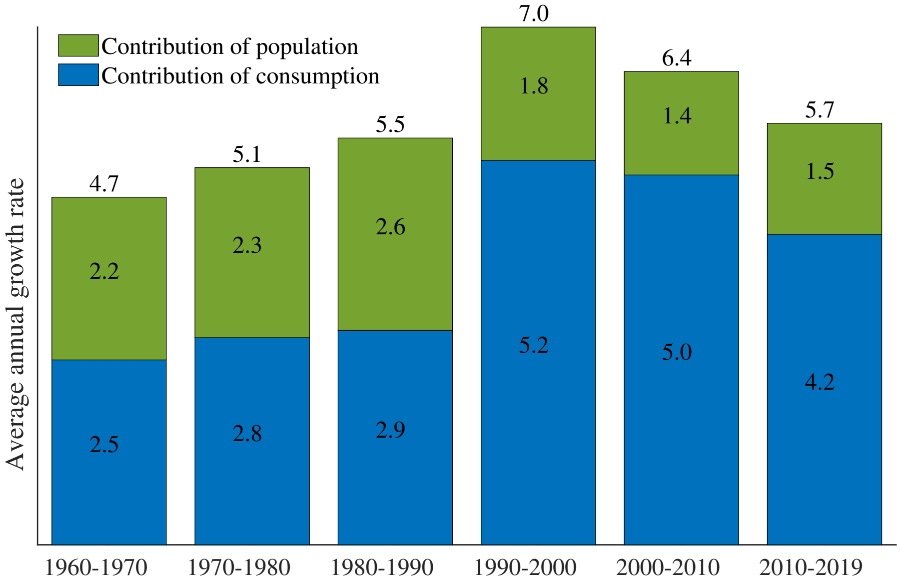
Plot of CE-Welfare growth against consumption growth, 1960-2019



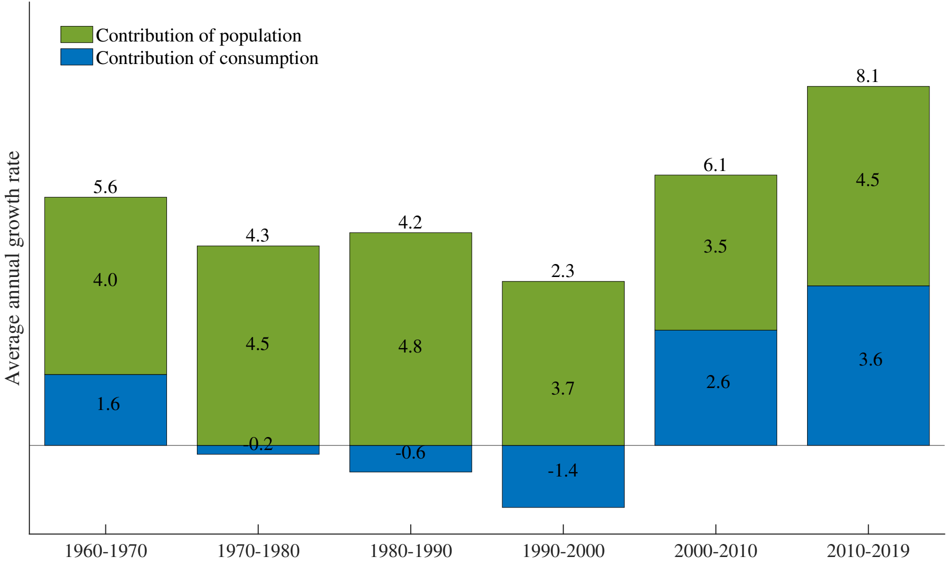
Average annual growth in Japan



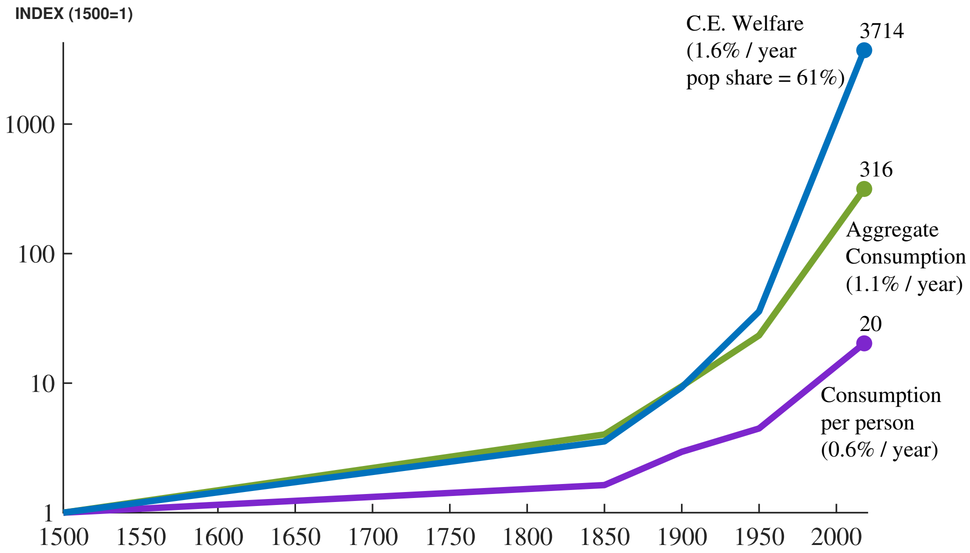
Average annual growth in China



Average annual growth in Sub-Saharan Africa

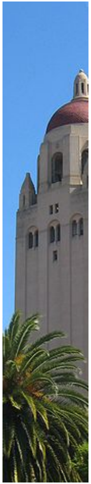


World cumulative growth, 1500-2018



What we are and *are not* doing

- We study the MB of people, not the MC
- Answering many interesting questions requires the production side (externalities from ideas, human capital, pollution, costs of fertility)
  - Optimal fertility?
  - Was the demographic transition good or bad?
- This paper cannot say that people in Japan should have more or fewer kids
  - Beyond the scope...



Part II. Robustness

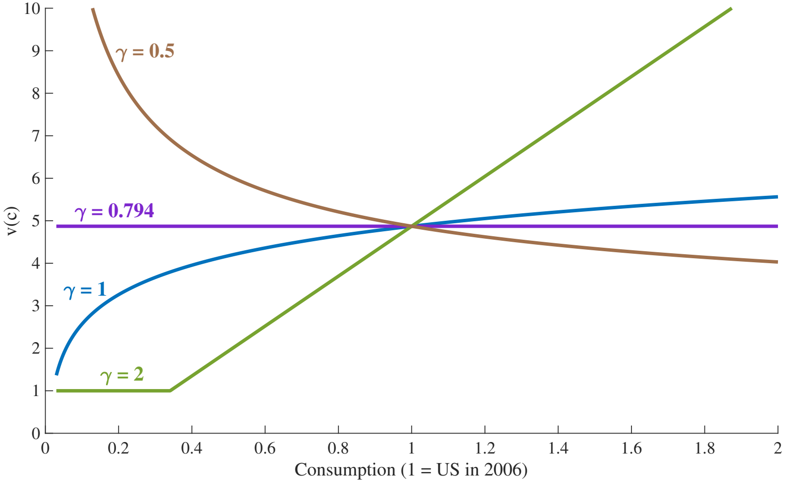
Robustness

- Double or halve the value of life (VSL)
- Alternative values for the CRRA γ
- Relaxing the representative agent assumption
- No decline in mortality rates
- Adjusting for migration

Robustness to values for $\overline{u}$

- Baseline assumes $\bar{u} = v(c_{US,2006}) = 4.87$
- Consider cutting by half, or increasing by 50%
  - Imply U.S. VSL_{2006} of $3.7 mil and $11.1 mil, vs. $7.7 mil for baseline
- U.S. Dept. of Transp. (2013) states $4 to $10 mil as plausible for VSL_{2001}
  - Encompasses nine studies they consider reliable
  - Range we consider implies values for VSL_{2001} of $2.8 to $8.6 mil

$v(c)$ for different values of γ



Weight on population growth is very high, either in past or future or both!

Robustness: CEW growth

	Mean	U.S.	Japan	Mexico	Ethiopia
1. Per capita consumption	2.8%	2.2%	3.2%	1.8%	2.5%
2. Baseline	5.9%	6.5%	4.9%	8.6%	4.4%
3. Baseline ($v \geq 1$)	6.0%	6.5%	4.9%	8.6%	5.2%
4. VSL $_{US,\ 2006}$ 50% lower ($v \geq 1$)	4.5%	4.1%	3.8%	4.0%	5.1%
5. VSL $_{US,\ 2006}$ 50% higher ($v \geq 1$)	9.8%	8.9%	6.1%	13.6%	10.9%
6. $\gamma = 2$ ($v \geq 1$)	4.6%	5.1%	3.7%	3.8%	5.1%
7. Constant $v = 4.87$ ($\gamma = 0.79$)	10.6%	7.0%	5.7%	11.8%	15.4%
8. Constant $v = 2.7$ ($\gamma = 0.63$)	7.1%	4.8%	4.6%	7.4%	9.7%
9. Constant $v = 1$ ($\gamma = 0$)	4.4%	3.2%	3.7%	3.8%	5.1%

Note: $v(c_{us,2006}) = \bar{u}$ in all cases.

Moving Beyond the Representative Agent

- N_t individuals indexed by $i \in \{1, \ldots, N_t\}$
- Individual i consumes c_{it} and gets flow utility $u(c_{it})$

Aggregate Flow Welfare

$$W_t = \sum_{i=1}^{N_t} u(c_{it})$$

Assumptions:

1. Log utility from consumption: $u(c_{it}) = \widetilde{u} + \log(c_{it})$
2. Consumption lognormally distributed across individuals with mean c_t and a variance of log consumption of σ_t^2

CEW Growth

$$g_\lambda = \left(v(c_t) - \frac{1}{2} \cdot \left(\sigma_t^2 - \sigma_{\text{US, 2006}}^2\right) \right) \cdot \frac{dN_t}{N_t} + \frac{dc_t}{c_t} - \sigma_t^2 \cdot \frac{d\sigma_t}{\sigma_t}$$

Introducing heterogeneity affects the calculation in two ways:

1. Due to the concavity of v, the weight on pop growth is
   - Lower for country-years with more inequality than the US in 2006
   - Higher for country-years with less inequality than the US in 2006
2. Due to concavity of u, there is a term reflecting changes in inequality
   - Faster CEW growth for countries with falling inequality
   - Slower CEW growth for countries with rising inequality

Results

	Baseline	Inequality Adjusted	Adjustment
Ethiopia	2.1%	2.4%	0.27%
Brazil	7.1%	7.3%	0.15%
Japan	4.1%	4.1%	-0.05%
Mexico	7.0%	6.9%	-0.09%
United States	7.1%	7.0%	-0.13%
Germany	2.4%	2.2%	-0.13%
China	6.7%	6.6%	-0.15%
India	5.8%	5.7%	-0.16%
South Africa	7.7%	6.8%	-0.83%
All countries – pop. weighted	6.1%	6.0%	- 0.10%
Mean absolute deviation			0.18%

The role of birth and death rates

- Our VSL estimates value longevity, but not being born *per se*
- How much of our population term is fertility versus longevity?
  - Consider thought experiment of no decline in death rates
- For 24 countries with the requisite data, we find that fertility contributes three-quarters of population growth
  - Human Mortality Database for $N_a(t)$, $D_a(t)$ and $B(t)$

Contribution of fertility+migration to population growth

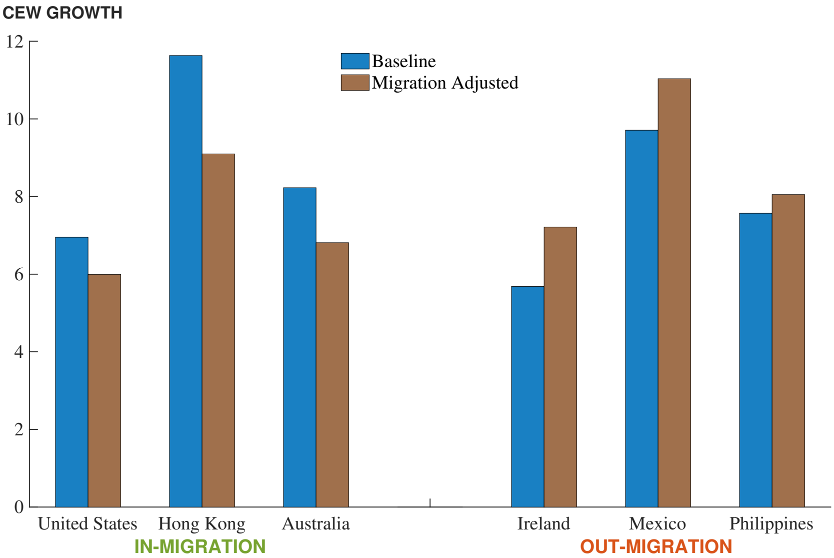
5 select countries	g_N	Counterfactual g_N
France	0.61%	0.42%
UK	0.41%	0.25%
Italy	0.33%	0.08%
Japan	0.51%	0.15%
USA	1.03%	0.89%
24 countries – pop. weighted	0.72%	0.53%

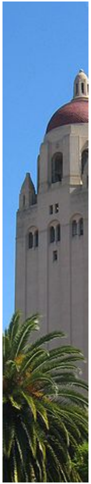
- Jones and Klenow (2016): rising LE adds $\approx 1\%$ to CE-welfare growth outside of Sub-Saharan Africa

Growth in country welfare adjusted for migration

- Who should receive “credit” for population growth from immigration?
- Our baseline credits all immigrants to **destination** country
- Migration adjustment credits them to **source** country instead

Countries with Large Migration Adjustments





Parental altruism and endogenous fertility

Parental altruism and fertility

- Parents have kids because they love them – missing in our baseline
  - Account for reduced fertility on parental welfare (Cordoba, 2015)
- But falling fertility may be compensated by higher per capita utility:
  - Quantity / quality trade-off $\Longrightarrow$ fewer but "better" kids
- Accordingly, extend framework to incorporate:
  - Broader measure of flow utility, including quantity/quality of kids
  - *Privately* optimal fertility, consumption, and time use by parents

Flow aggregate welfare

$$W(N_t^p, N_t^k, c_t, l_t, c_t^k, h_t^k, b_t) \; = \; N_t^p \cdot u(c_t, l_t, c_t^k, h_t^k, b_t) + N_t^k \cdot \widetilde{u}(c_t^k)$$

- N^p = number of adults
- N^k = number of children
- b = number of children per adult

$\implies N = N^p + N^k = (1+b) \cdot N^p$

- c = adult consumption
- l = adult leisure
- c^k = child consumption
- h^k = child human capital

Double counting kids' consumption downweights all non-consumption terms

Parental utility maximization problem

$$\max_{c,\ l,\ c^k,\ h^k,\ b} u(c_t,\ l_t,\ c_t^k,\ h_t^k,\ b_t)$$

subject to: $c_t + b_t \cdot c_t^k \leq w_t \cdot h_t \cdot l_{ct}$

$h_t^k = f_t(h_t \cdot e_t)$ and $l_{ct} + l_t + b_t \cdot e_t \leq 1$

- w = wage per unit of human capital
- h = parental human capital, equals inherited h^k
- l_c = parental hours worked
- e = parental time investment per child

Data to implement generalized growth accounting

- Childcare from time use is main data constraint, restrict to 6 countries:
  - US (2003–2019)
  - Netherlands (1975–2006)
  - Japan (1991–2016)
  - South Korea (1999–2019)
  - Mexico (2006–2019)
  - South Africa (2000-2010)

- Additional data sources: PWT for per capita consumption and average market hours worked for ages 20-64, World Bank for population by age group
  - # Children = 0-19 years old
  - # Adults = 20+ years old
  - b_t = Children / Adults
  - l_{ct} = paid work
  - $b_t e_t$ = total child care
  - l_t = 16 hrs $- l_{ct} - b_t \cdot e_t$

CEW Growth: Macro vs Micro

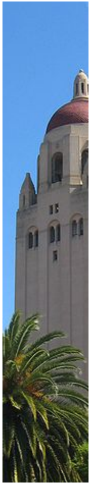
	MACRO			MICRO					
	CEW growth	pop term	cons term	CEW growth	pop term	cons term	leisure term	quality term	quantity term
USA	5.4	3.9	1.5	4.8	3.2	1.5	0.1	0.2	−0.3
NLD	4.5	2.5	2.1	3.9	2.0	2.1	0.0	0.4	−0.4
JPN	2.3	0.4	1.9	1.9	0.1	1.9	0.0	0.2	−0.4
KOR	4.4	1.7	2.6	3.8	1.0	2.6	0.6	0.4	−0.8
MEX	6.5	4.9	1.6	3.7	3.3	1.5	−0.3	0.1	−0.8
ZAF	6.8	4.3	2.6	5.6	2.8	2.4	1.0	0.3	−1.0

Share of population in CEW growth: Macro vs Micro

		MICRO				
			Robustness			
	MACRO	Baseline	Larger θ	Smaller θ	Larger v_k	Smaller v_k
USA	72%	68%	69%	66%	68%	67%
NLD	54%	50%	52%	48%	48%	52%
JPN	16%	8%	10%	6%	-6%	18%
KOR	40%	27%	30%	24%	19%	34%
MEX	76%	87%	90%	85%	87%	88%
ZAF	63%	51%	53%	48%	49%	52%

Conclusions

- Each additional point of population growth is worth:
  - 5pp of consumption growth in rich countries today
  - an average of 2.7pp for the world as a whole
- Population growth:
  - Contributes more than per-capita cons. growth in 77 of 101 countries
  - Weighting by population, contributes comparably to cons. growth
  - Shuffles countries perceived as growth miracles
- Results are robust to adjusting for migration and parental altruism

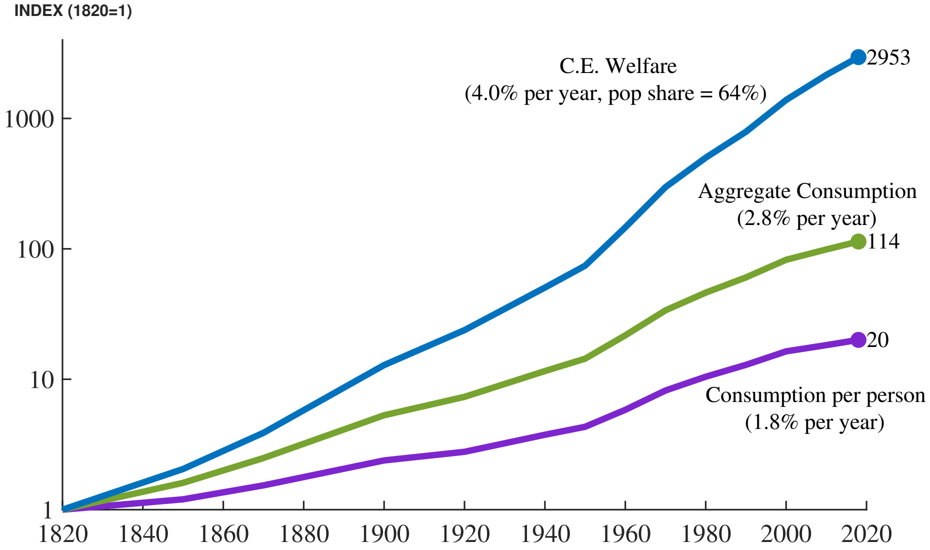


Extra Slides

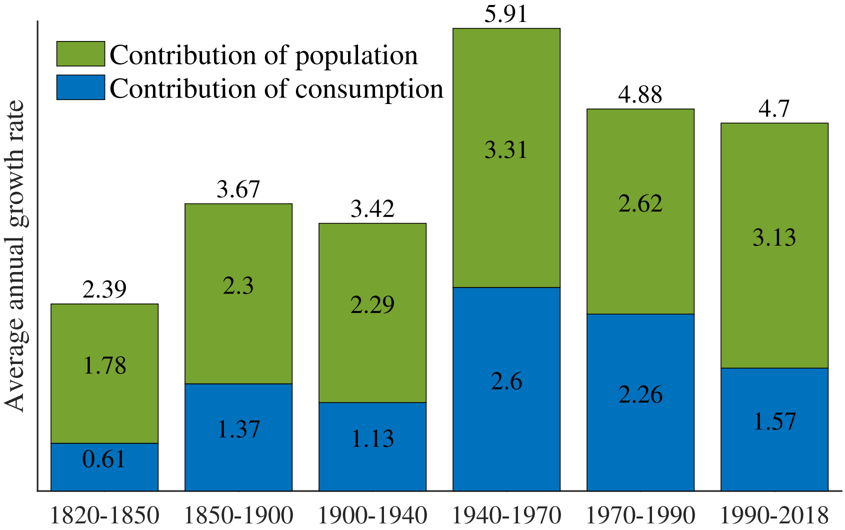
More on Assumptions

- Write: $W_t \;=\; \text{Unborn}_t \cdot A + N_t \cdot u(c_t) + \text{Deceased}_t \cdot \Omega$
- Gives: $dW_t \;=\; N_t \cdot u'(c_t) dc_t + \text{Births}_t \cdot \Big(u(c_t) - A\Big) - \text{Deaths}_t \cdot \Big(u(c_t) - \Omega\Big)$
- Use economic choices/prices to get: $u(c_t) - \Omega$
  - Choice of A is a normalization (irrelevant)
- Need one other assumption. For us: $A = \Omega$
  - Nonexistence is nonexistence, whether 100 years before birth or 100 years after death and decay
  - $A < \Omega$ means we *underestimate* the value of people
  - $A > \Omega$ means we *overestimate*. But why would people have kids if they believed this?

Cumulative growth in “The West”, 1820–2018



West CE-Welfare growth over the long run, 1820-2018



World CE-Welfare growth over the long run, 1500-2018