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 same TFP_t. 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

  ○ Example: Population growth over thousands of years

- **Key Question:**
  How much has population growth contributed to aggregate welfare growth?

Examples of how this could be useful

- The Black Death, HIV/AIDS, or Covid-19

- China's one-child policy

- What fraction of GDP should we spend to mitigate climate change in 2100?
  - How many people today versus in the year 2100?

- How much to spend to avoid existential risks (asteroids, nuclear war)?
  - Many billions of people-years in the future

What we're *not* doing

- We use the MRS in aggregate welfare between people N and per capita c

- Answering other key questions would require the social MRT from the production side (externalities from ideas, human capital, pollution)

  ○ Optimal fertility?

  ○ Was the demographic transition good or bad?

- Our approach is just accounting with total welfare – need fewer assumptions

- **Part I.** Baseline calculation with only population and consumption

- **Part II.** Adjusting for migration (who gets credit?)

- **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

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

    ○ Non-existence is valued at zero

    ○ Assumes "utility when not born" = "utility when dead"

Total utilitarianism

- Critiques
  - Repugnant conclusion (Parfit, 1984)
  - Inalienable rights

- Versus per capita utilitarianism
  - e.g. Jones and Klenow (2016)
  - Sadistic conclusion

- Zuber et al. (2020), De la Croix and Doepke (2021), MacAskill (2022)

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:

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

  ○ 1 pp population growth is worth $\sim$5 pp consumption growth

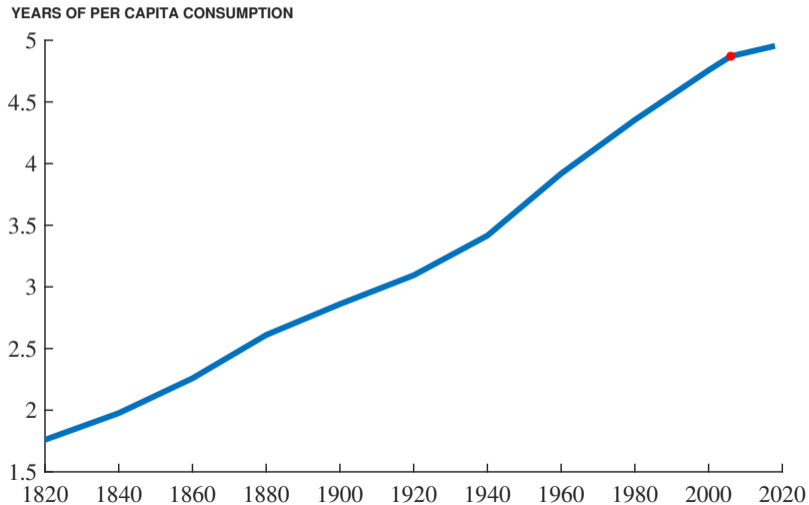**Measuring $v(c)$ in other years and countries**

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

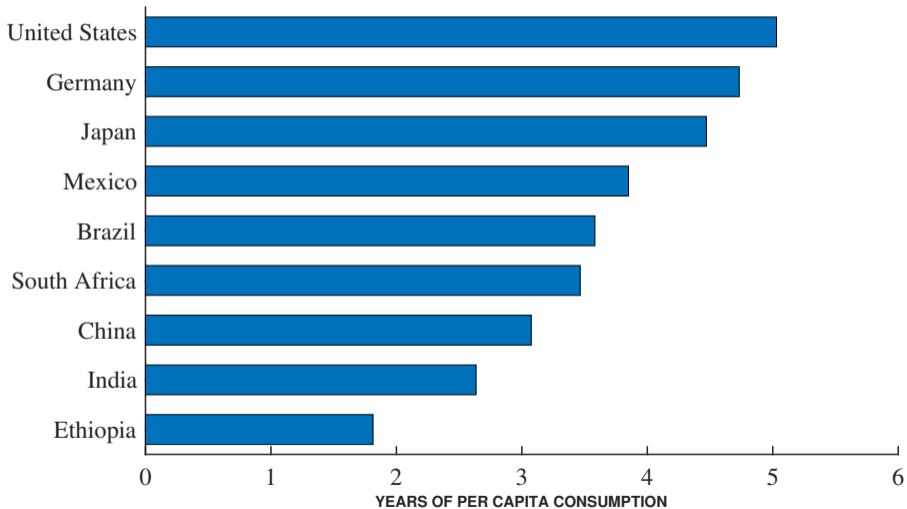$$v(c) \equiv \frac{u(c)}{u'(c) \cdot c} = u(c) = \bar{u} + \log c$$

  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.**

YEARS OF PER CAPITA CONSUMPTION

$v(c)$ **across countries in 2019**

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

λ is consumption-equivalent welfare

g_N is population growth

g_c is the growth rate of per capita consumption

○ If $v(c) = 1$, then CE-Welfare growth is just aggregate consumption growth

○ But $v(c) = 3$ or 5 implies much larger weight on population growth

Baseline samples

Penn World Tables 10.0

Years	# of OECD countries	# of non-OECD countries
1960-2019	38	63

Maddison (2020), BEA, Barro and Ursua (2008)

Years	Sample
1840-2018	United States
1850-2018	The "West"
1500-2018	The World

Overview of baseline results for 101 countries from 1960 to 2019

Average $g_c = 2.1\%$ and average $g_N = 1.8\%$ across the 101 countries

|	Baseline	— Robustness —	
	$\bar{u} = 4.87$	$\bar{u} = 4.44$	$\bar{u} = 6.16$
CE-Welfare Growth	6.2%	5.4%	8.5%
Contribution of population	4.1%	3.3%	6.4%
Average value of life $v(c)$	2.7	2.3	4.0
Pop Share of CE-Welfare Growth	66%	63%	73%
Pop Share (if weight by population)	51%	46%	62%
# of countries with pop share $\geq 50\%$	78	69	89

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	7.9	1.4	2.1	3.1	6.4	82%
United States	6.5	2.2	1.0	4.4	4.3	66%
China	5.7	3.8	1.3	1.8	2.0	34%
India	5.3	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	3.8	2.9	0.2	4.0	0.8	22%

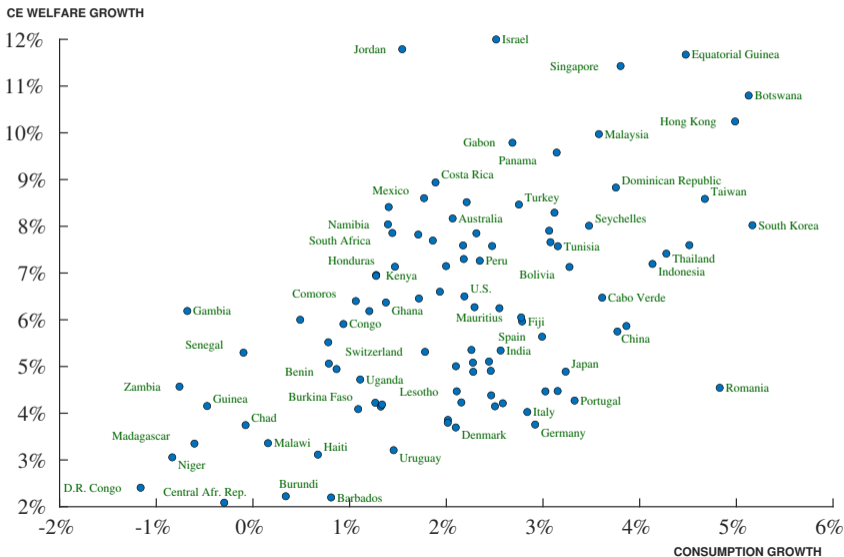**Average CE welfare growth for select countries, 1960–2019**
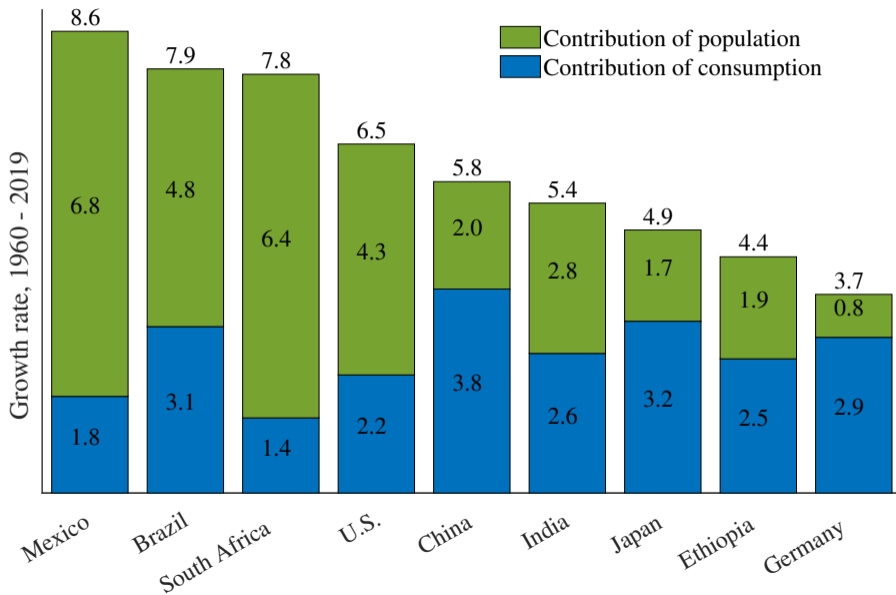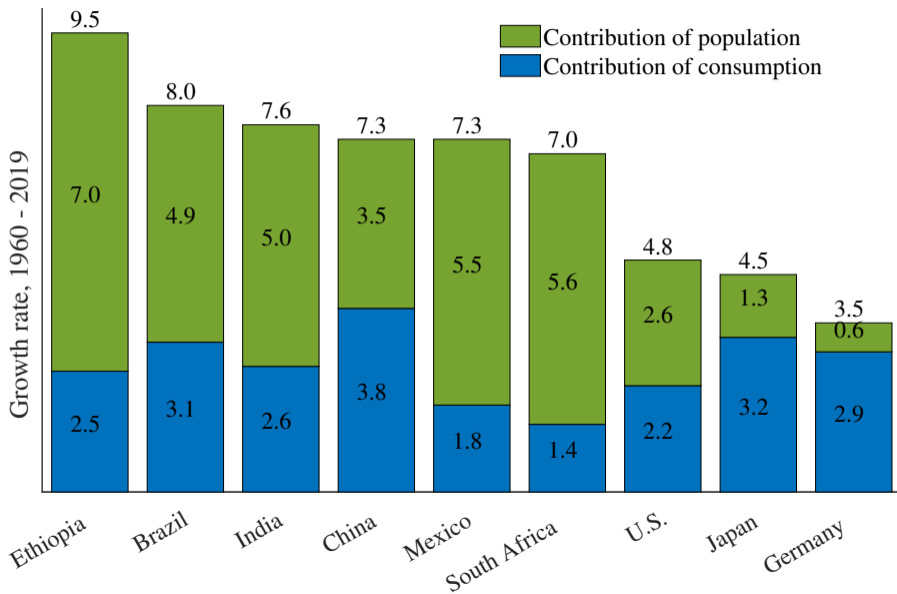
Some big differences in percentiles, 1960–2019 growth
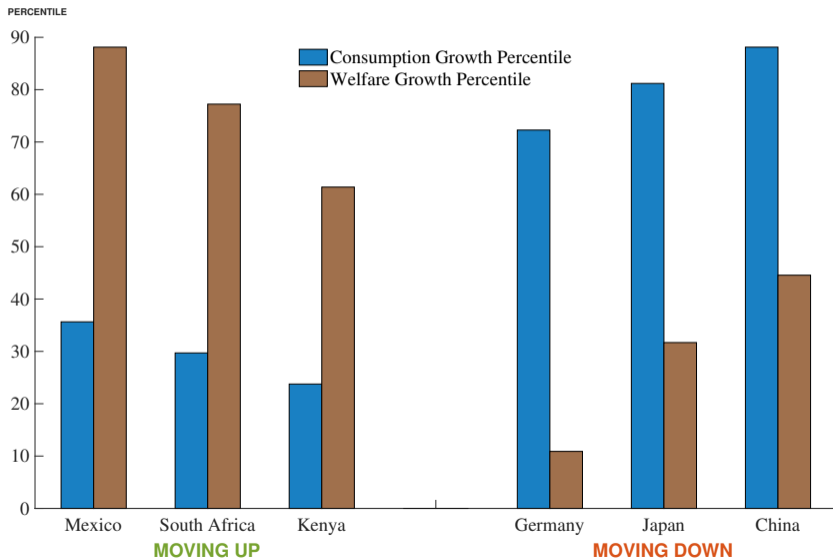
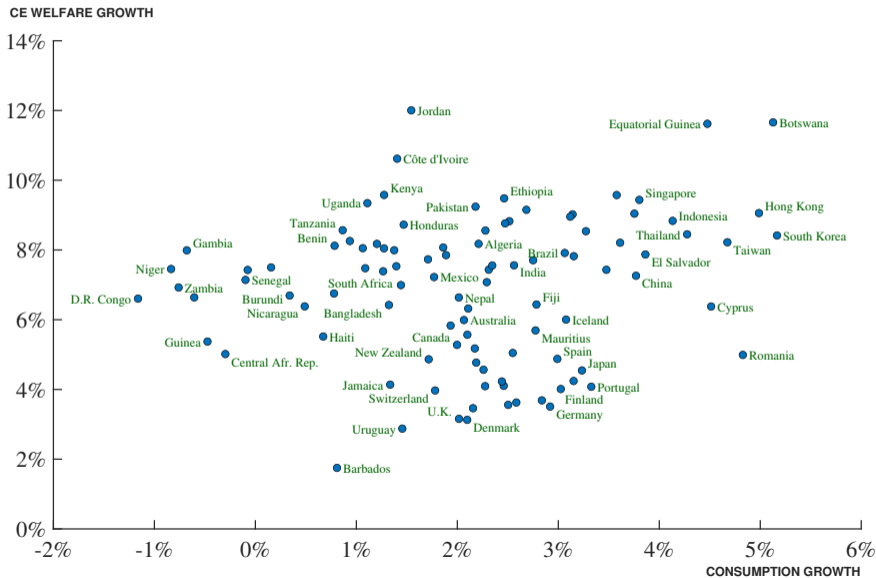**Average CE welfare growth by region, 1960–2019**
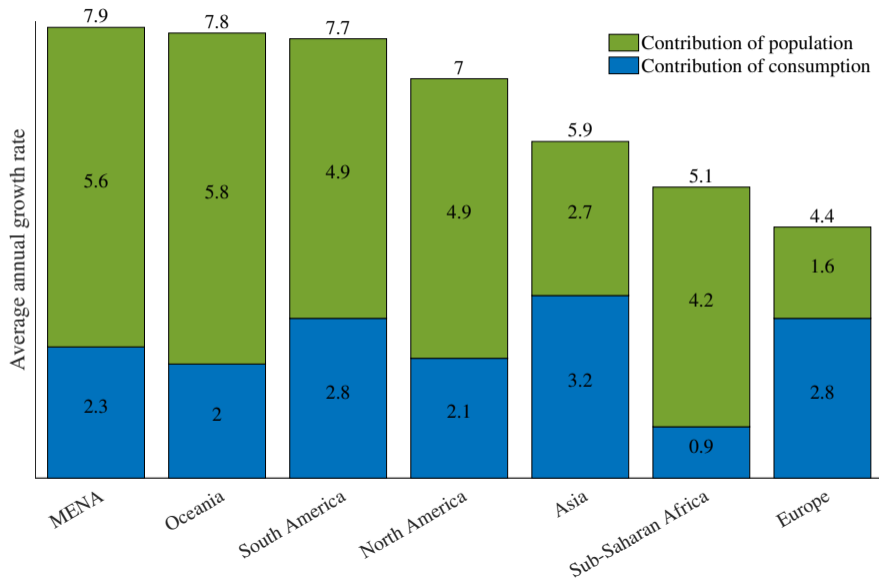
# Plot of CE-Welfare growth against consumption growth, 1960-2019

CE WELFARE GROWTH

Plot showing CE Welfare Growth (y-axis, 2% to 12%) against Consumption Growth (x-axis, -2% to 6%) for various countries including: D.R. Congo, Central Afr. Rep., Burundi, Barbados, Madagascar, Niger, Malawi, Haiti, Uruguay, Zambia, Guinea, Chad, Burkina Faso, Uganda, Lesotho, Denmark, Germany, Italy, Portugal, Japan, Senegal, Benin, Switzerland, Spain, India, Fiji, China, Romania, Gambia, Comoros, Congo, Ghana, Mauritius, U.S., Bolivia, Cabo Verde, Kenya, Honduras, South Africa, Namibia, Peru, Tunisia, Indonesia, Thailand, Mexico, Costa Rica, Australia, Turkey, Seychelles, Taiwan, South Korea, Gabon, Panama, Dominican Republic, Malaysia, Hong Kong, Jordan, Israel, Singapore, Equatorial Guinea, Botswana.

CONSUMPTION GROWTH

21

Robustness to constant $v(c) = 2.7$, 1960–2019

Growth rate, 1960 - 2019

Legend:
- Contribution of population (green)
- Contribution of consumption (blue)

Country	Total	Population	Consumption
Ethiopia	9.5	7.0	2.5
Brazil	8.0	4.9	3.1
India	7.6	5.0	2.6
China	7.3	3.5	3.8
Mexico	7.3	5.5	1.8
South Africa	7.0	5.6	1.4
U.S.	4.8	2.6	2.2
Japan	4.5	1.3	3.2
Germany	3.5	0.6	2.9

Scatterplot with constant $v(c) = 2.7$, **1960-2019**
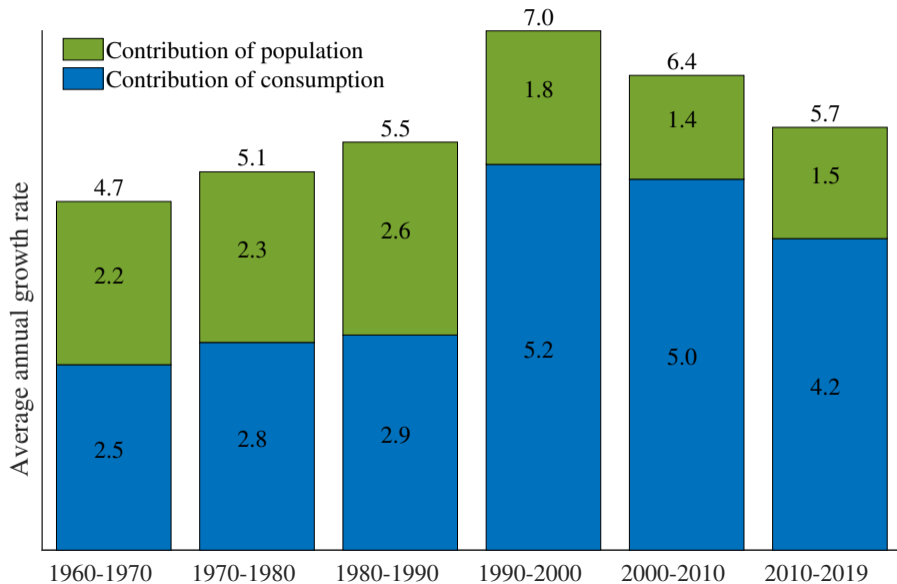

CE WELFARE GROWTH

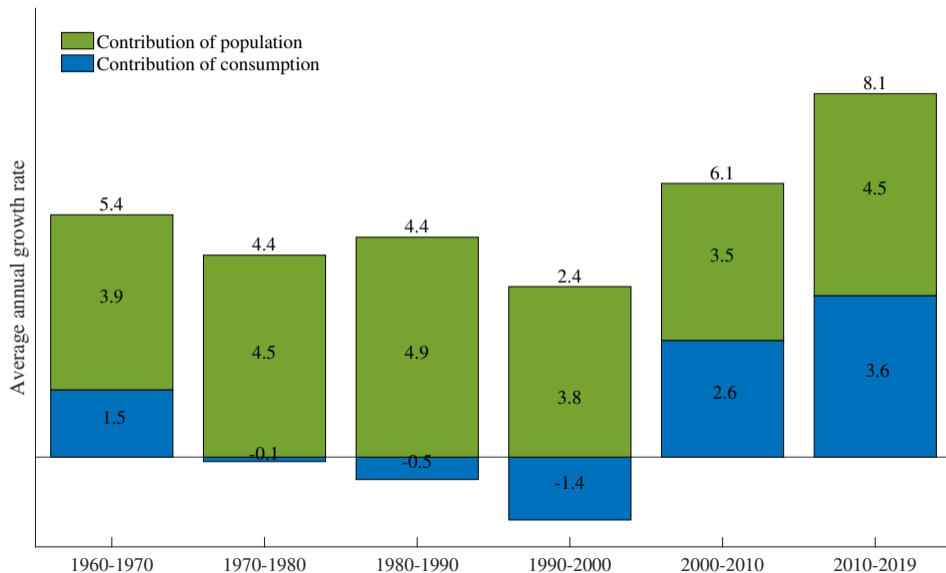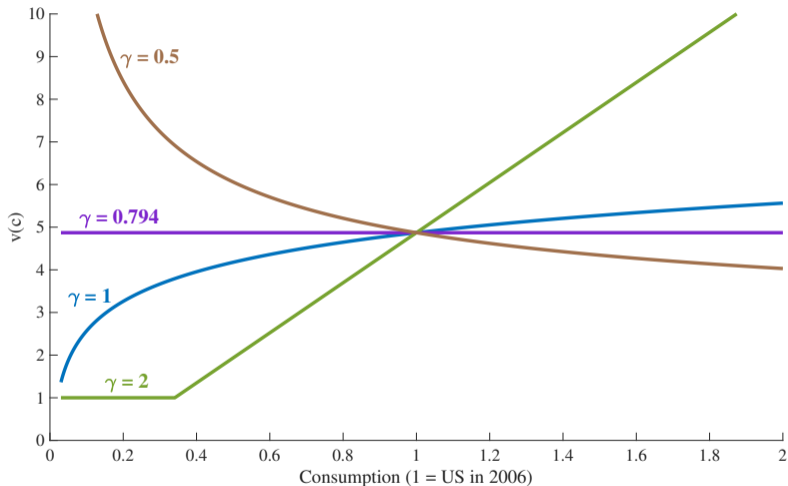**CONSUMPTION GROWTH**

Average annual growth in Japan
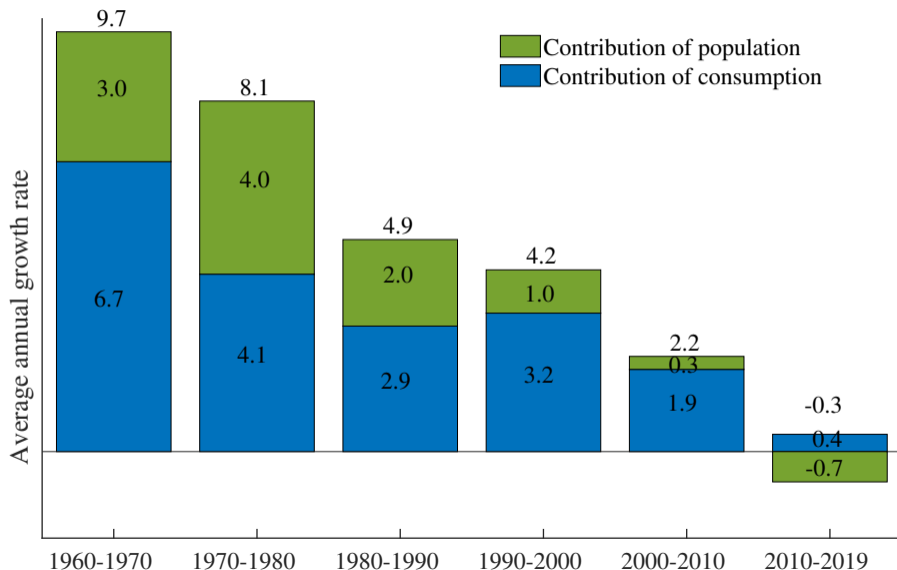
Average annual growth in China

Average annual growth in Sub-Saharan Africa

$v(c)$ for different values of γ

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

Robustness to alternative values of γ

	$\gamma = 1$	$\gamma = 2$	$\gamma = 0.794$
CE-Welfare Growth	6.2%	4.2%	10.9%
Contribution of population	4.1%	2.1%	8.8%
Average value of life $v(c)$	2.7	1.3	4.9
Pop Share of CE-Welfare Growth	66%	53%	76%
Pop Share (if weight by population)	51%	40%	70%
# of countries with pop share $\geq 50\%$	78	47	90

Notes: In our calibration, when $\gamma = 0.794$, $v = 4.87$ for all country-years.
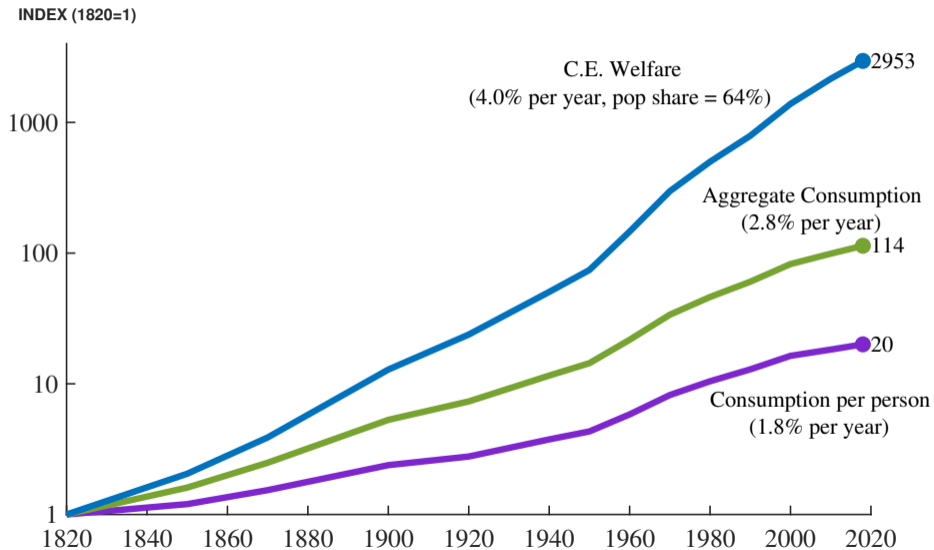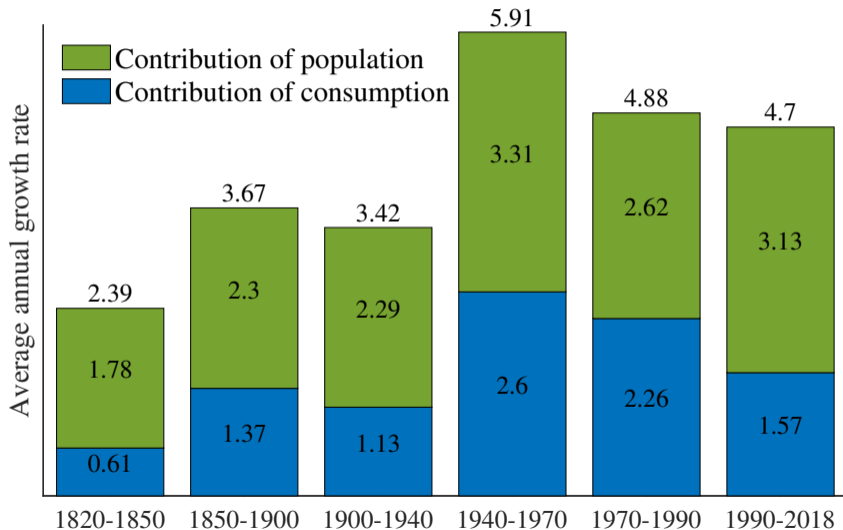
Part II. Adjusting for migration

Aggregation to deal with immigration

- Should countries receive "credit" for population growth from immigration?

- Affects the Western Hemisphere vs. Europe in past century-plus

- Looking at "The West" as a whole should mitigate this problem
  - Includes Western Europe, U.S., Canada, Australia, New Zealand

- We do so back to 1820 to encompass the Age of Mass Migration

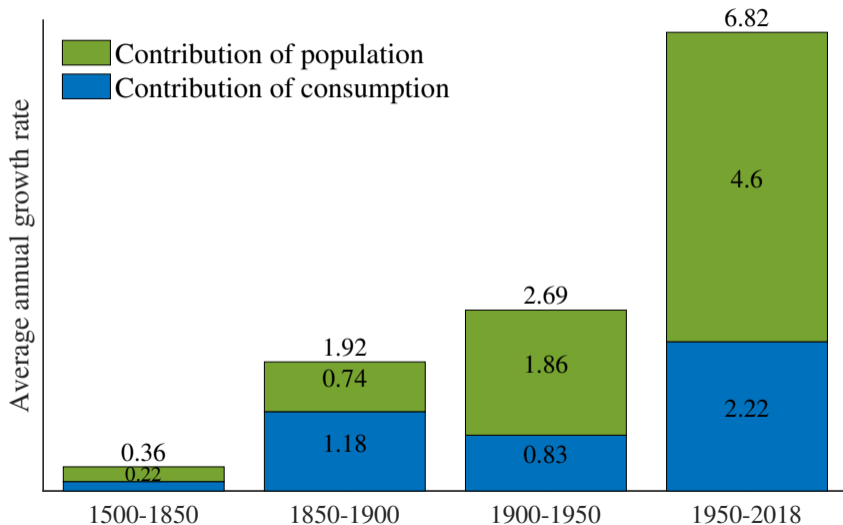## Cumulative growth in "The West", 1820–2018

INDEX (1820=1)

C.E. Welfare
(4.0% per year, pop share = 64%)

Aggregate Consumption
(2.8% per year)

Consumption per person
(1.8% per year)

2953

114

20

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

World cumulative growth, 1500-2018

INDEX (1500=1)

C.E. Welfare
(1.6% / year
pop share = 61%)   3714

Aggregate
Consumption
(1.1% / year)   316

Consumption
per person
(0.6% / year)   20

1000

100

10

1

1500 1550 1600 1650 1700 1750 1800 1850 1900 1950 2000
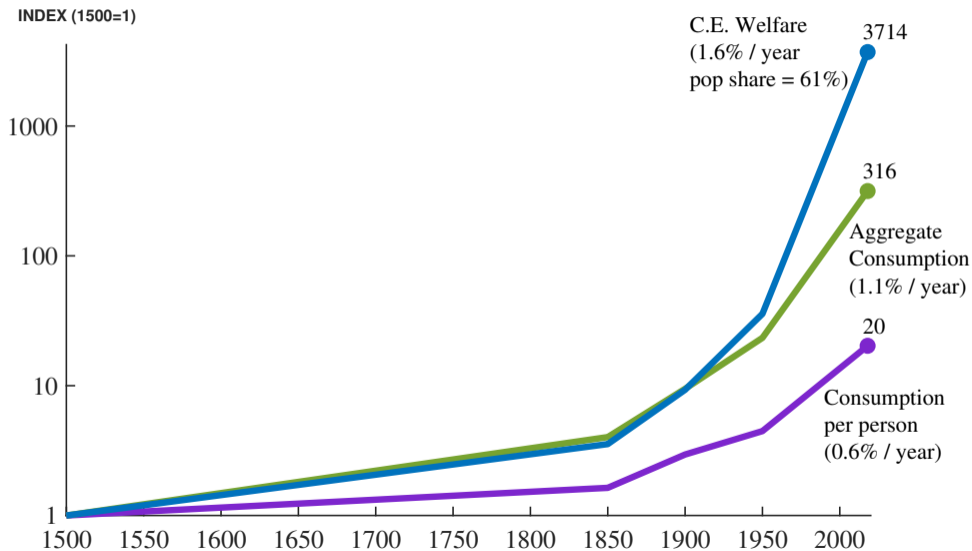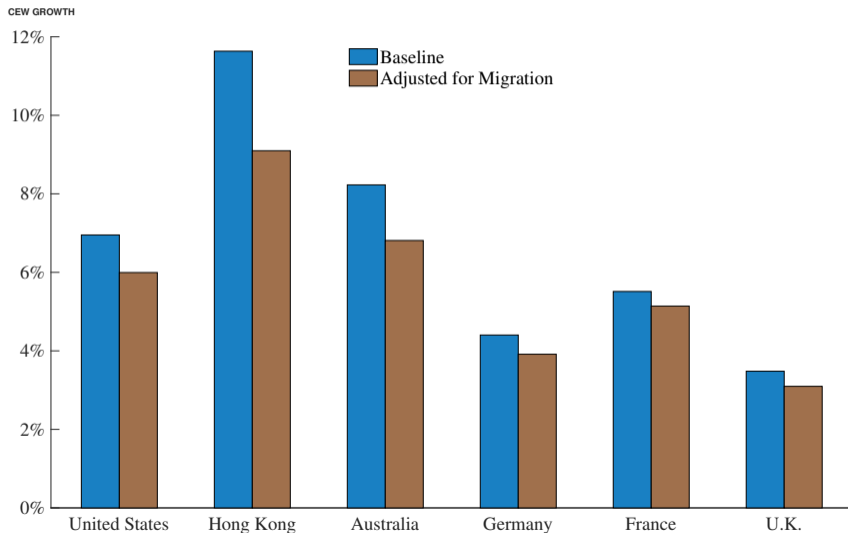
Growth in country welfare adjusted for migration

- 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 for which in-migration biases our baseline upward

CEW GROWTH

Legend: Baseline, Adjusted for Migration

Categories: United States, Hong Kong, Australia, Germany, France, U.K.

Countries for which out-migration biases our baseline downward
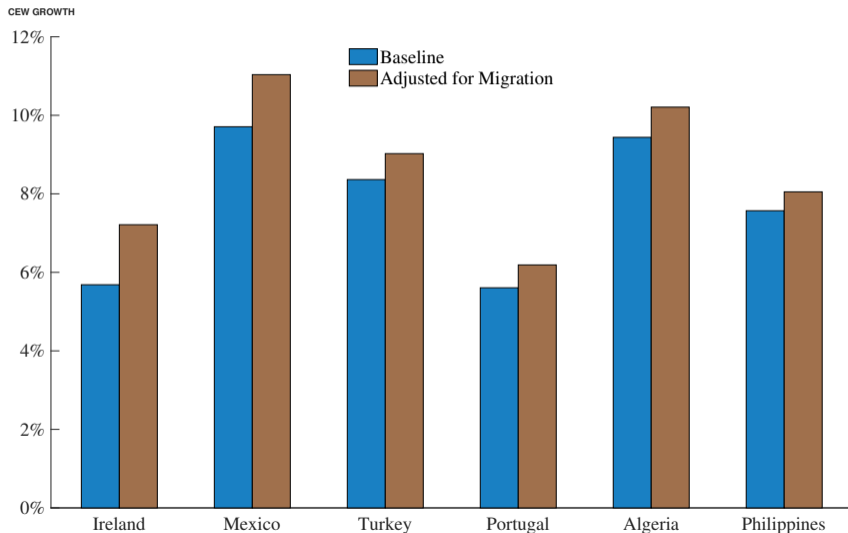
Part III. Parental altruism and endogenous fertility

a la Barro-Becker (1989)

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 $\implies$ 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

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

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

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

- 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

- To implement calculation need series for:

  - # 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 $- l_{ct} - b_t \cdot e_t$

- 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

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	5.0	3.2	1.5	0.1	0.5	−0.3
NLD	4.5	2.5	2.1	4.3	2.0	2.1	0	0.7	−0.4
JPN	2.3	0.4	1.9	2.2	0.3	1.9	0	0.3	−0.4
KOR	4.4	1.7	2.6	4.7	1.5	2.6	0.6	0.7	−0.8
MEX	6.5	4.9	1.6	4.4	3.8	1.6	−0.3	0.2	−0.8
ZAF	6.8	4.3	2.6	6.4	3.3	2.6	1	0.6	−1

Share of population in CEW growth: Macro vs Micro

	MACRO	Baseline	Larger θ	Smaller θ	Larger v_k	Smaller v_k
USA	72%	65%	66%	63%	65%	64%
NLD	54%	46%	47%	44%	44%	47%
JPN	16%	13%	15%	11%	2%	22%
KOR	40%	32%	34%	30%	26%	37%
MEX	76%	87%	89%	84%	86%	87%
ZAF	63%	52%	54%	51%	51%	54%

The header spans: MACRO ——— MICRO ———, with sub-header Baseline ——— Robustness ———

<u>Tentative Conclusions</u>

- Population growth contributes 1/2 to 2/3 of growth in country welfare

  ○ Complementary perspective to per capita consumption growth

- Because consumption runs into diminishing returns, 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

- Results are robust to adjusting for migration and incorporating parent utility from children and privately optimal fertility choices