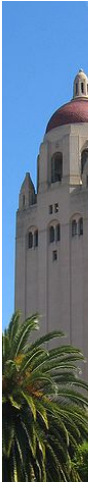

# Population and Welfare:

# The Greatest Good for the Greatest Number

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May 2023

## 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

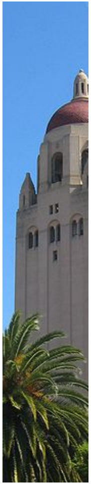
- The Black Death, HIV/AIDS, or Covid-19
- China's one-child policy
- What fraction of GDP should we spend to mitigate climate change in 2100?
  - How many people today versus in the year 2100?
- How much to spend to avoid existential risks (asteroids, nuclear war)?
  - Many billions of people-years 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

# Outline

- **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

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

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

- $v(c)$ = 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 $\sim$5 pp consumption growth

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

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

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

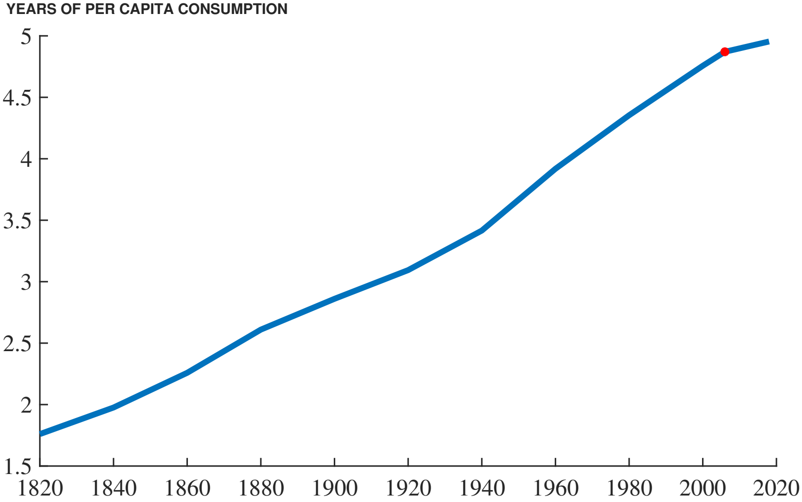
  Higher consumption raises the value of a year of life

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

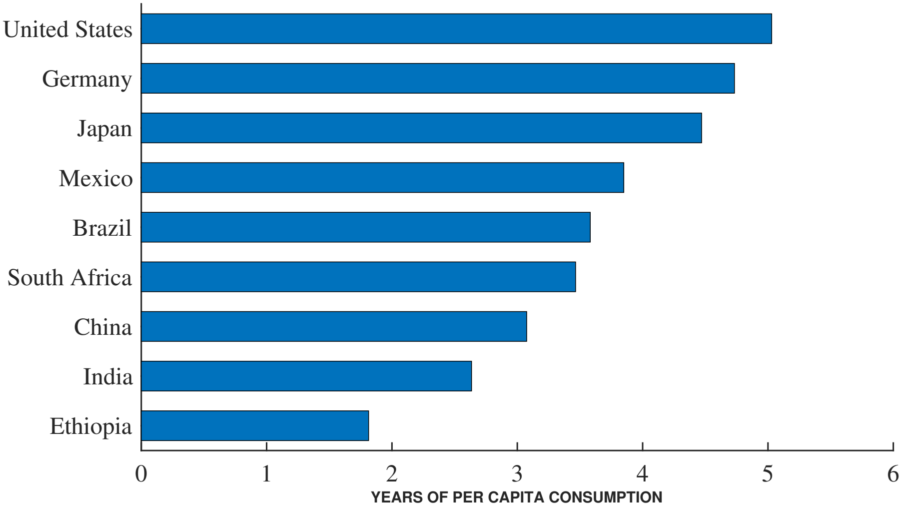
## Alternative calibrations of $\bar{u}$

- Baseline assumes $v(c_{2006,US}) = 4.87 \to \bar{u} = 4.87$ when normalize $c_{2006,US} = 1$
- Consider values from meta studies by Viscusi (1993), Viscusi and Aldy (2003)
  - Based on U.S. labor-market risks and expressed in $USD for 2000
- Median across all studies they discuss is $5 million
  - Assume 40 years of life expectancy, year 2000 consumption of $29,000
  - Yields $v(c_{2000,US}) = 4.30 \to \bar{u} = 4.44$ when $c_{2006,US} = 1$
- Median across their set of *preferred* studies is $7 million
  - Yields $v(c_{2000,US}) = 6.02 \to \bar{u} = 6.16$ when $c_{2006,US} = 1$

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



# $v(c)$ across countries in 2019



# Recap

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

$\lambda$ 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

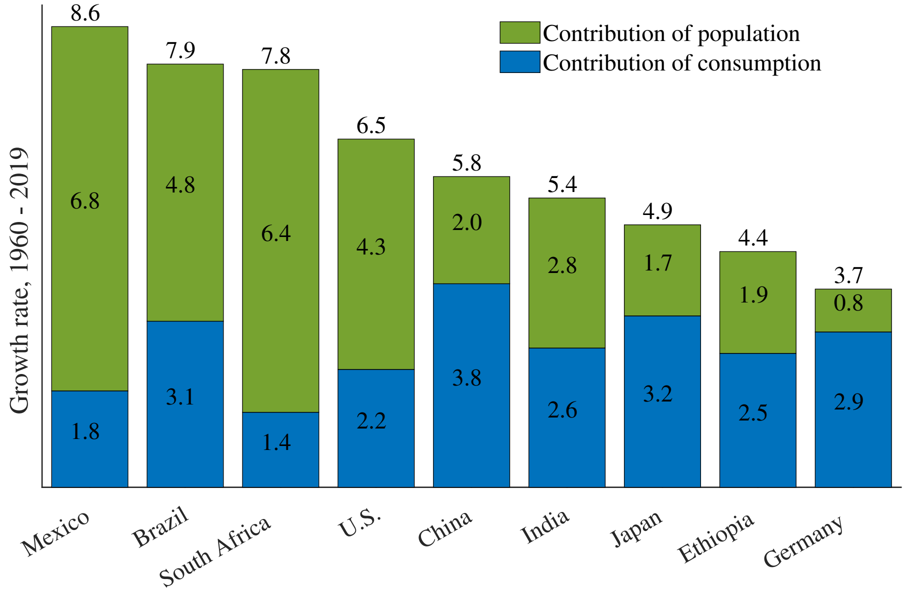
*Average* $g_c = 2.1\%$ *and average* $g_N = 1.8\%$ *across the 101 countries*

| | 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 |

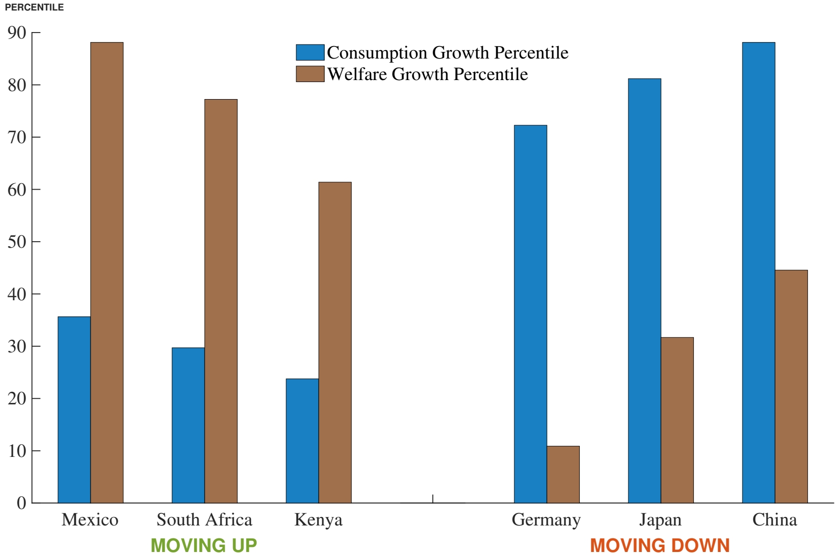
## Decomposing welfare growth in select countries, 1960–2019

| | $g_\lambda$ | $g_c$ | $g_N$ | $v(c)$ | $v(c) \cdot g_N$ | 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% |

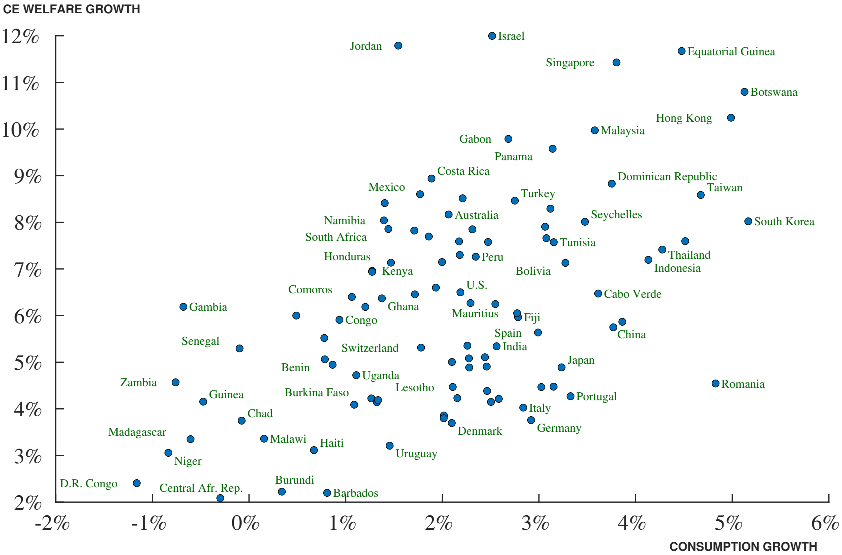
## Average CE welfare growth for select countries, 1960–2019



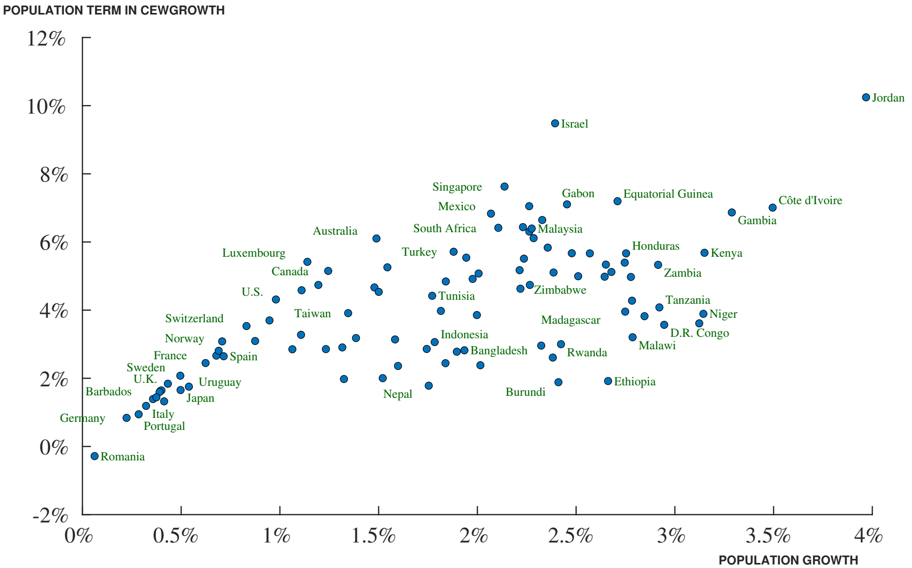
# Some big differences in percentiles, 1960–2019 growth



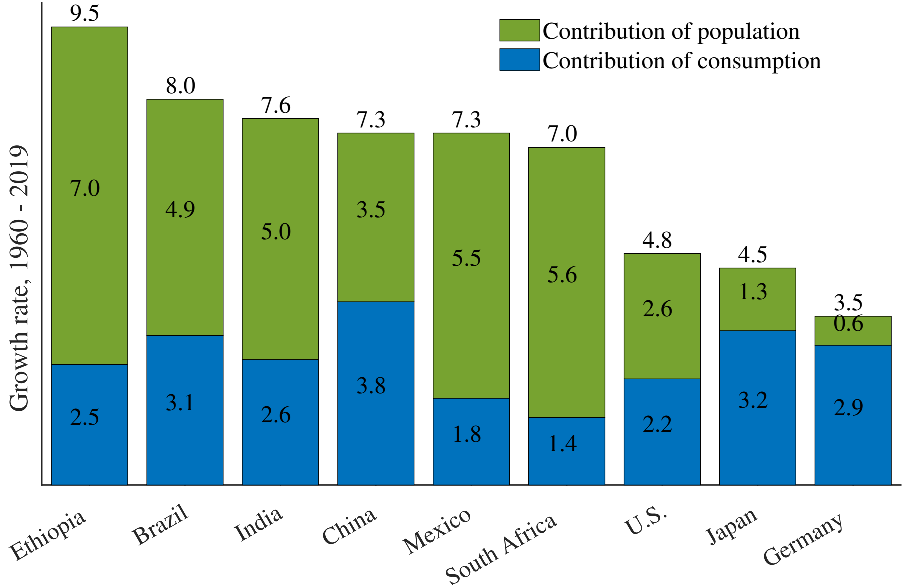
# Plot of CE-Welfare growth against consumption growth, 1960-2019



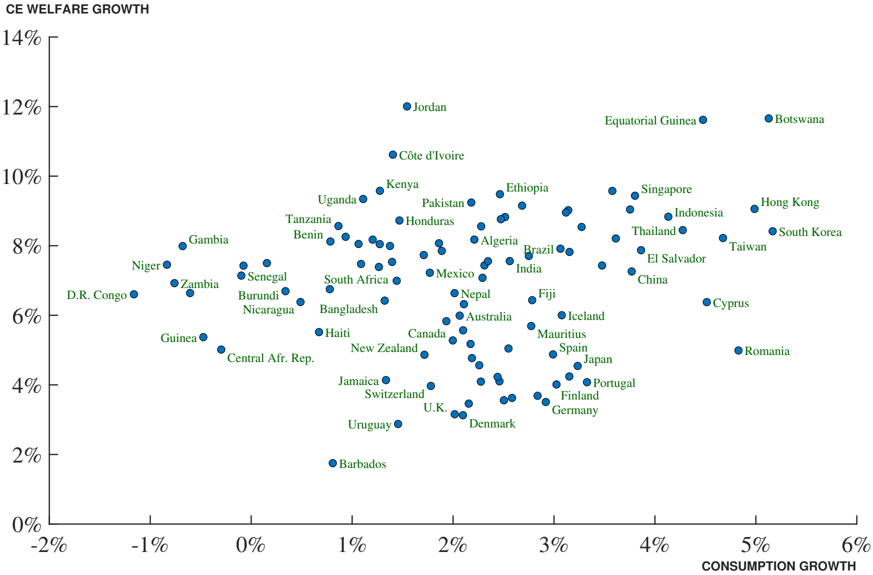
# Contribution of Population Growth



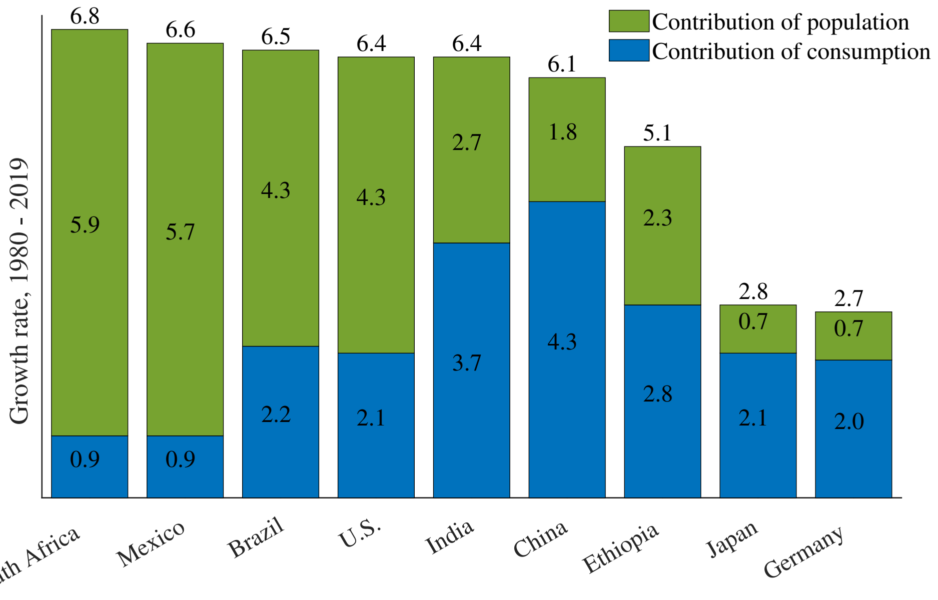
## Robustness to constant $v(c) = 2.7$, 1960–2019



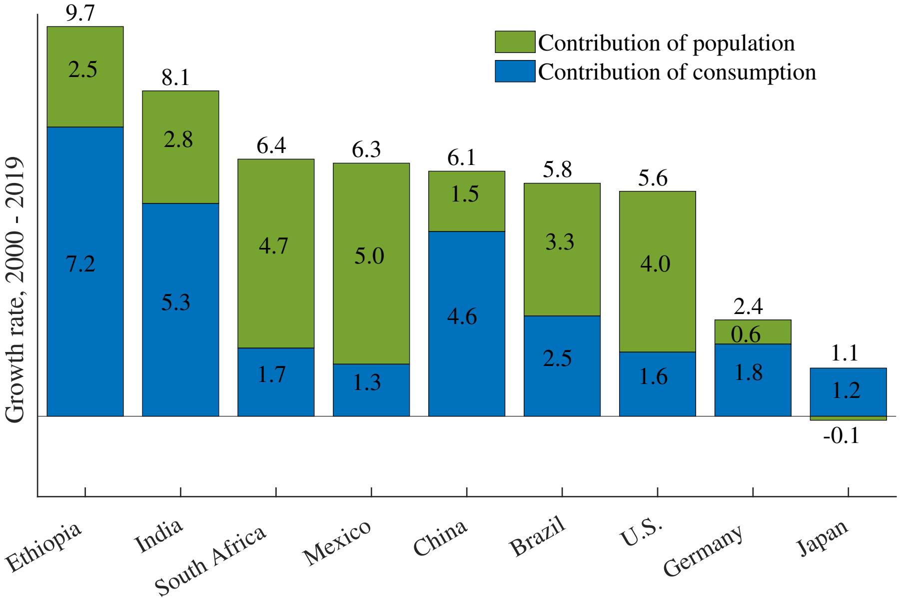
## Scatterplot with constant $v(c) = 2.7$, 1960-2019



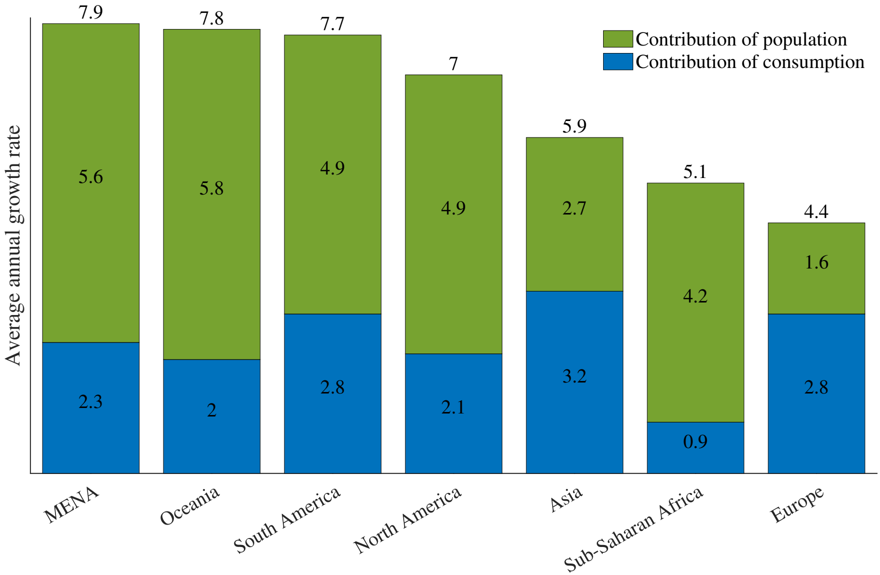
# Average CE welfare growth for select countries, only for 1980–2019



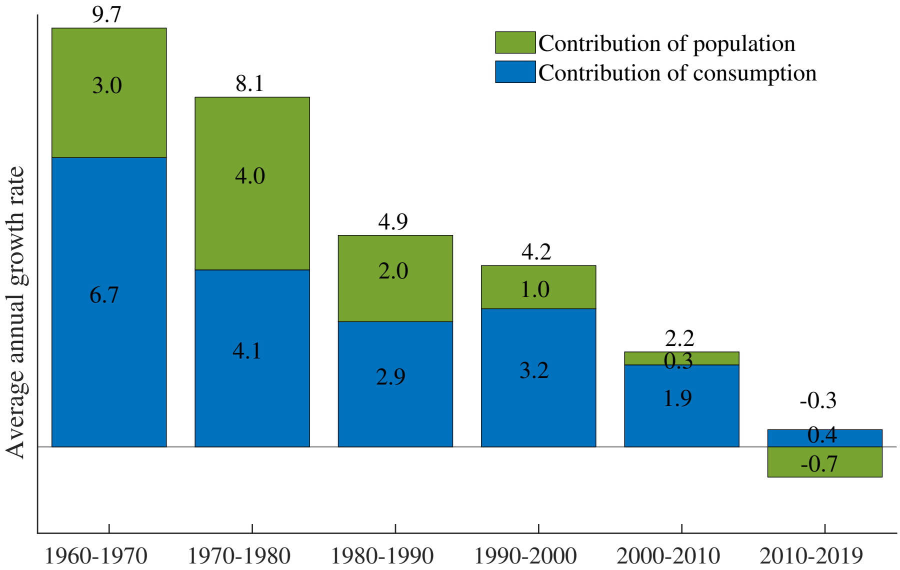
## Average CE welfare growth for select countries, only for 2000–2019



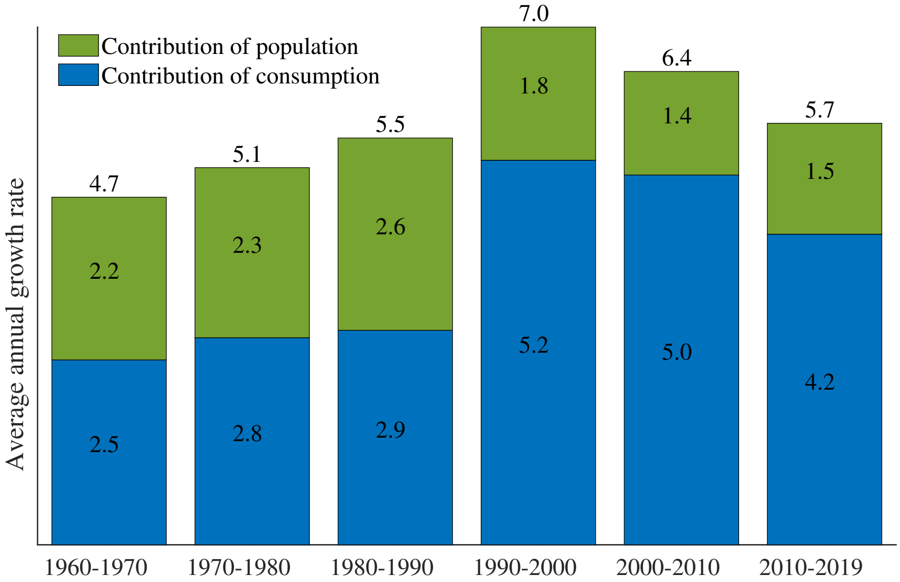
# Average CE welfare growth by region, 1960–2019



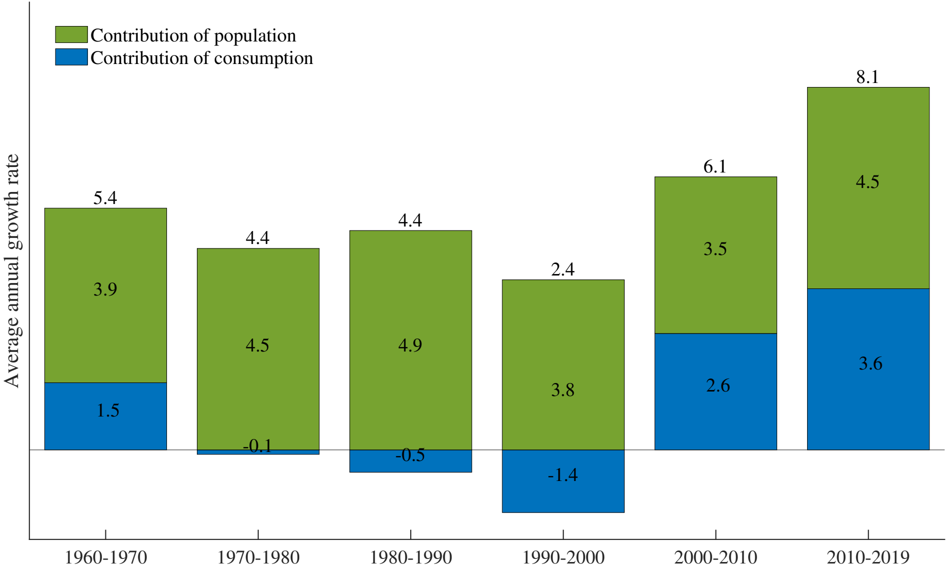
# Average annual growth in Japan



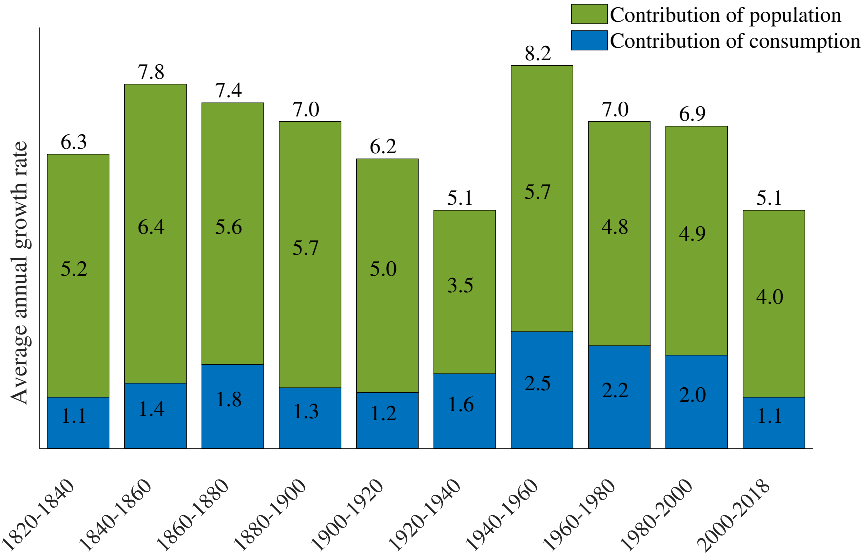
# Average annual growth in China



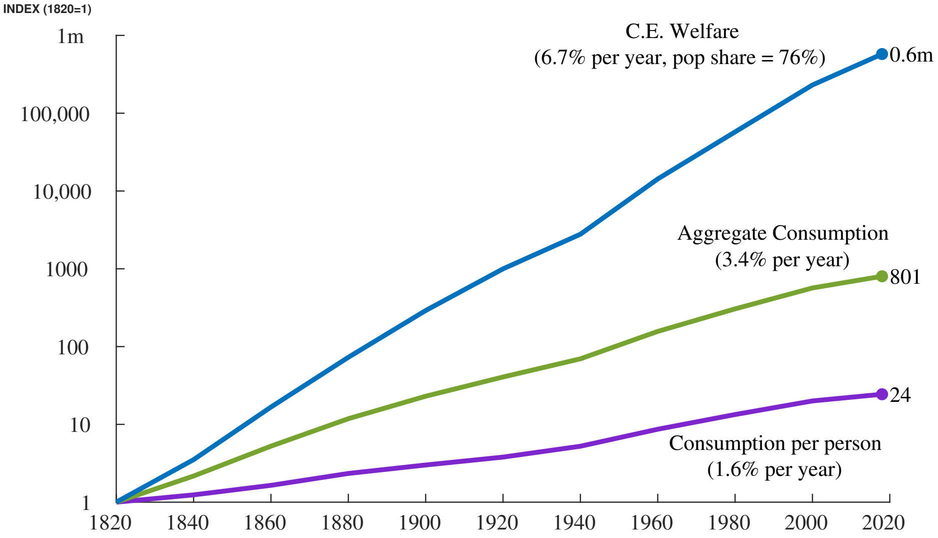
# Average annual growth in Sub-Saharan Africa

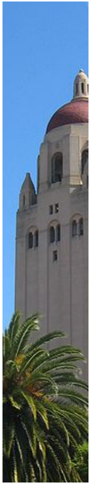


# Trends over the long run for the U.S. (1820–2018)



# U.S. cumulative growth, 1820–2018



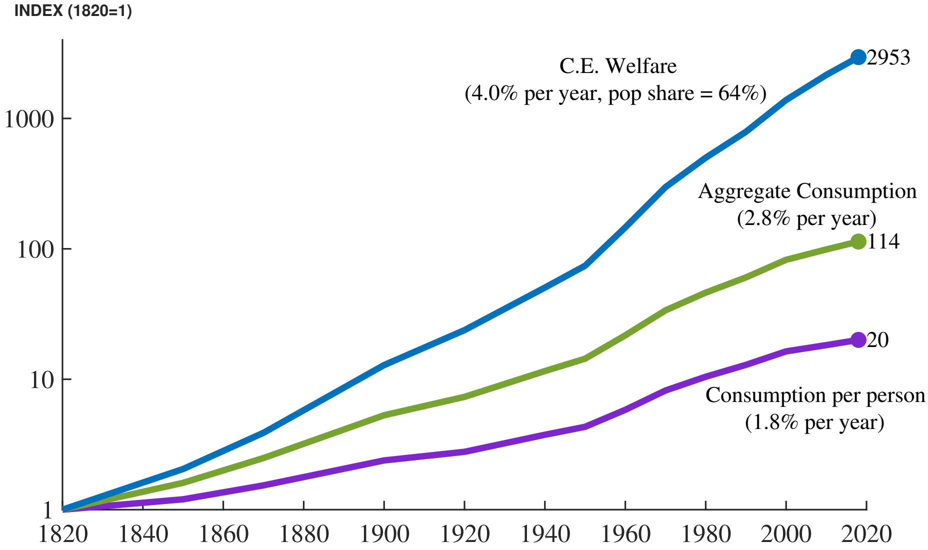


**Part II.** Adjusting for migration

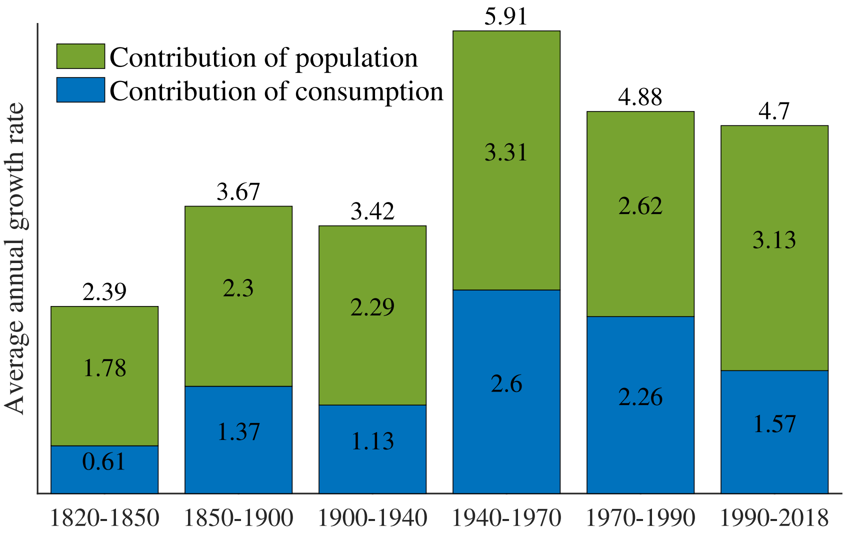
## Aggregation to deal with immigration

- 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 Europe and the Americas
- We do so back to 1850 to encompass the Age of Mass Migration

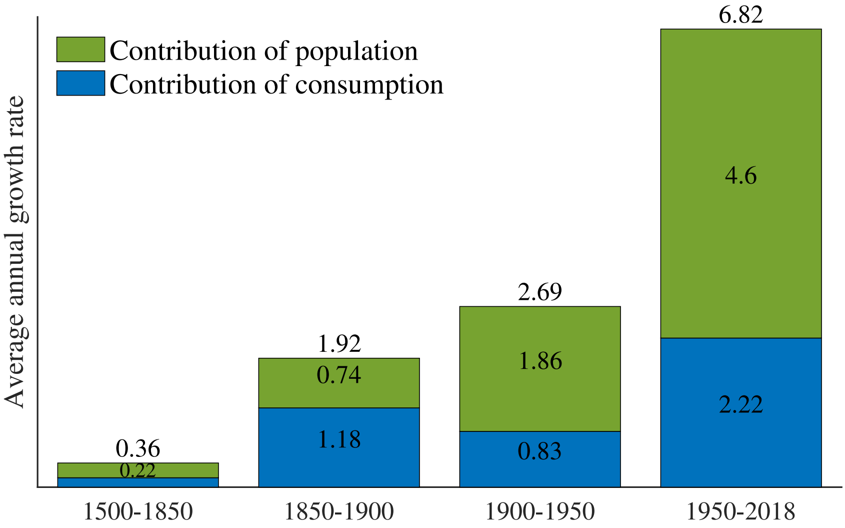
# Cumulative growth in “The West”, 1820–2018



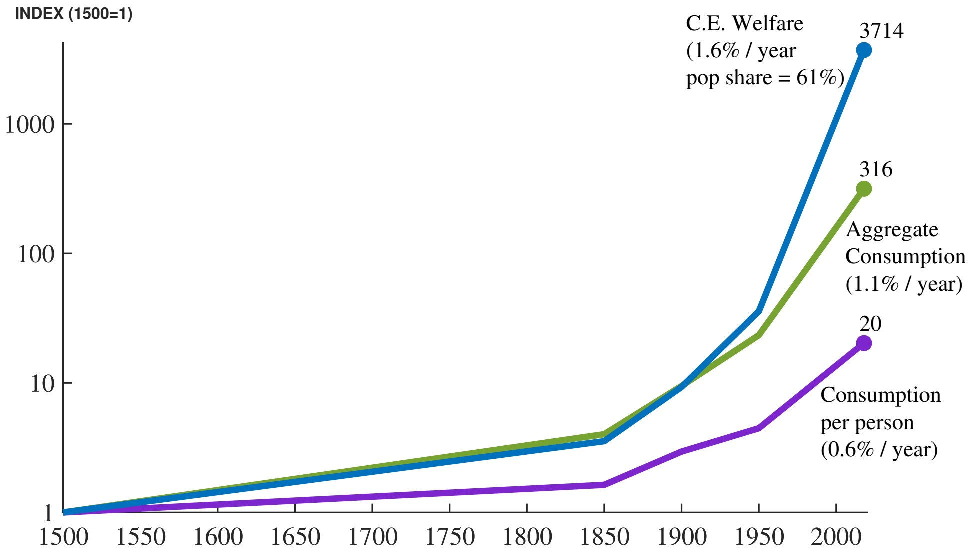
# West CE-Welfare growth over the long run, 1820-2018



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



# World cumulative growth, 1500-2018



## Adjusting *country* welfare for migration

$$W_{it} = N_{it} \cdot u(c_{it}) + \sum_{j \neq i} N_{i \to j,t} \cdot u(c_{jt}) - \sum_{j \neq i} N_{j \to i,t} \cdot u(c_{it})$$

- $N_{i \to j,t}$ = population born in country $i$, living in country $j$ in year $t$
- $N_{j \to i,t}$ = population born in country $j$, living in country $i$ in year $t$
- Could also explore intermediate cases

# Growth in country welfare adjusted for migration

$$g_{\lambda_{it}} = v(c_{it}) \cdot g_{N_{it}} \quad + \quad g_{c_{it}}$$

$$+ \quad \sum_{j \neq i} \frac{N_{i \to j,t}}{N_{it}} \cdot \frac{u(c_{jt})}{u(c_{it})} \left( v(c_{it}) \cdot g_{N_{i \to j,t}} + \frac{v(c_{it})}{v(c_{jt})} \cdot g_{c_{jt}} \right)$$

$$- \quad \sum_{j \neq i} \frac{N_{j \to i,t}}{N_{it}} \left( v(c_{it}) \cdot g_{N_{j \to i,t}} + g_{c_{it}} \right)$$

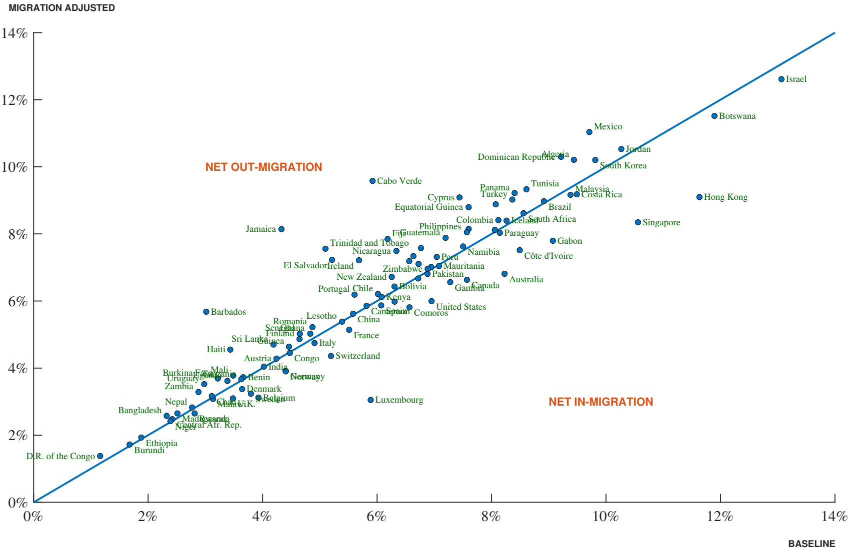
- Our baseline credits all immigrants to **destination** country
- Migration adjustment credits them to **source** country instead

## Summary of migration results

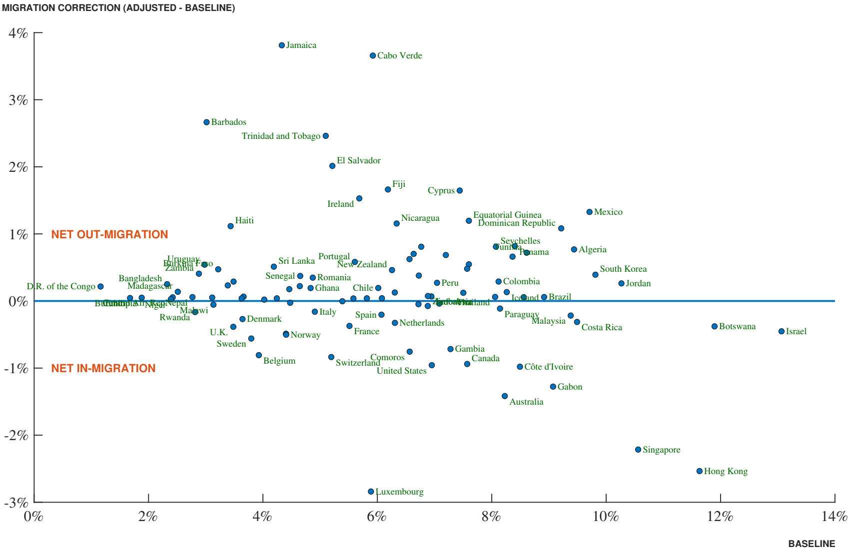
- Have the necessary data for 81 countries from 1960 to 2000
- Results with and without the migration adjustment highly correlated at 0.92
- But the adjustments for individual countries can be large $\sim$ 2pp
- Average absolute adjustment is 0.6pp

Source: The World Bank's Global Bilateral Migration Database

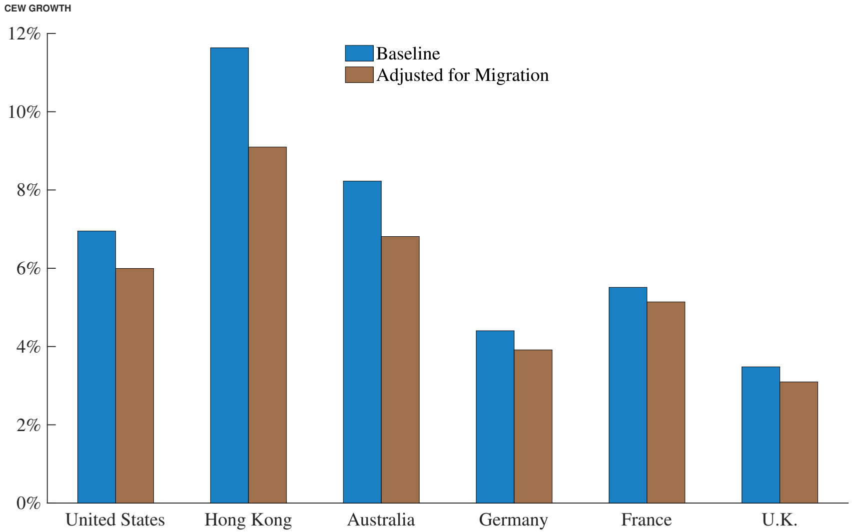
# Baseline vs. Migration-Adjusted CEW growth



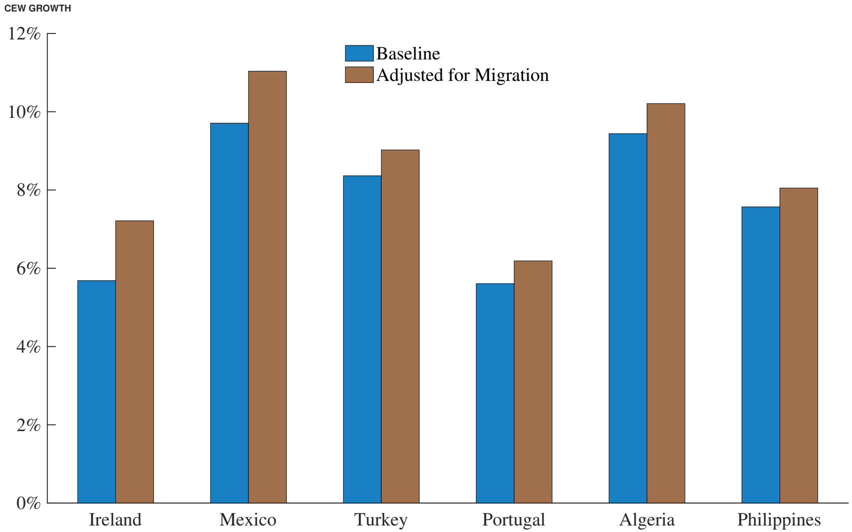
# Migration correction vs Baseline CEW growth

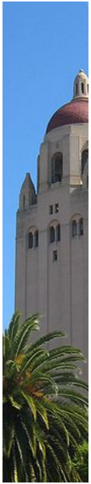


# Countries for which in-migration biases our baseline upward



# 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 $\Longrightarrow$ 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

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

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

Consumption equivalent welfare:

$$W(N_t^p,\, N_t^k,\, \lambda_t \cdot c_t,\, l_t,\, \lambda_t \cdot c_t^k,\, h_t^k,\, b_t) = W(N_{t+dt}^p\,,\, N_{t+dt}^k\,,\, c_{t+dt}\,,\, l_{t+dt}\,,\, c_{t+dt}^k\,,\, h_{t+dt}^k\,,\, b_{t+dt})$$

## 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

# Parents' vs. Kids' Consumption

- Make two assumptions on preferences:
  - *Assumption 1:* $u(c_t^p, c_t^k, \vec{x}_t) = \log(c_t^p) + \alpha b_t^\theta \log(c_t^k) + g(l_t, b_t, h_t^k)$
  - *Assumption 2:* $\widetilde{u}(c^k) = \bar{u}_k + log(c_t^k)$
- With these assumptions: $\frac{c_t^k}{c_t^p} = \alpha b_t^{\theta - 1}$
  - For $\theta < 1$, $\frac{c_t^k}{c_t^p}$ falls with $b_t$
  - Conditional on calibrating $\alpha$ and $\theta$, do not need data on trends in $\frac{c_t^k}{c_t^p}$

# Consumption-equivalent welfare growth

$$g_{\lambda_t} = \text{pop\_term}_t$$
$$+ \pi_t^p \cdot \left( \frac{dc_t^p}{c_t^p} + u_{l_t} l_t \cdot \frac{dl_t}{l_t} + u_{h_t^k} h_t^k \cdot \frac{dh_t^k}{h_t^k} + u_{b_t} b_t \cdot \frac{db_t}{b_t} \right) + (1 - \pi_t^p) \cdot \frac{dc_t^k}{c_t^k},$$

where $\pi_t^p = \frac{N_t^p}{(1 + \alpha b_t^\theta) N_t^p + N_t^k}$

$$\text{pop\_term}_t = \frac{1 + b_t}{1 + \alpha b_t^\theta + b_t} \left[ \frac{N_t^P}{N_t^K + N_t^P} \cdot \frac{dN_t^P}{N_t^P} \cdot v(c_t^p, ...) + \frac{N_t^K}{N_t^K + N_t^P} \cdot \frac{dN_t^K}{N_t^K} \cdot \tilde{v}(c_t^k) \right]$$

Two differences in the population term relative to baseline calculation:

1. Not imposing $\tilde{v}(c_t^k) = v(c_t, \dots)$
2. Altruism term $\alpha b_t^\theta \implies$ special case on next slide for intuition

## Special case – just for intuition

- Let $\theta = 1 \Rightarrow \frac{dc^k}{c^k} = \frac{dc^p}{c^p}$ and evaluate at $\tilde{v}(c_t^k) = v(c_t^p, ...) = v(c_t)$

$$
\begin{aligned}
\Longrightarrow g_{\lambda_t} = & \frac{dc_t}{c_t} + \frac{N_t^p + N_t^k}{N_t^p + 2N_t^k} \cdot v(c_t) \cdot \frac{dN_t}{N_t} && \textit{Base terms} \\
& + \frac{N_t^p}{N_t^p + 2N_t^k} \cdot \frac{u_{lt} l_t}{u_{ct} c_t} \cdot \frac{dl_t}{l_t} && \textit{Leisure} \\
& + \frac{N_t^p}{N_t^p + 2N_t^k} \cdot \frac{u_{bt} b_t}{u_{ct} c_t} \cdot \frac{db_t}{b_t} && \textit{Quantity of kids} \\
& + \frac{N_t^p}{N_t^p + 2N_t^k} \cdot \frac{u_{h^k t} h_t^k}{u_{ct} c_t} \cdot \frac{dh_t^k}{h_t^k} && \textit{Quality of kids}
\end{aligned}
$$

*Double counting kids' consumption downweights all non-consumption terms*

## Implementing the generalized growth accounting

- Parents' FOCs maps *relative* weights in growth accounting to observables
  - $l_t$: $\frac{u_{lt} l_t}{u_{ct} c_t} = \frac{w_t h_t l_t}{c_t}$
  - $b_t$: $\frac{u_{bt} b_t}{u_{ct} c_t} = \frac{N_t^k}{N_t^p} \frac{(c_t^k + w_t h_t e_t)}{c_t}$
  - $h_t^k$: $\frac{u_{h^k t} h_t^k}{u_{ct} c_t} = \frac{N_t^k}{N_t^p} \frac{1}{\eta_t} \frac{w_t h_t e_t}{c_t}$, where: $\eta_t = \frac{f'(h_t e_t) h_t e_t}{f(h_t e_t)}$
- Calibrating $\eta$
  - Set $\eta = 0.24$
    - Sum of Mincer coefficients for parents' schooling, relative to own, for kids' wage ($= .0142/.0591$, Lee, Roys, Seshadri, 2014)
  - Choose $e_t$ generously (all childcare) and $\frac{dh_t^k}{h_t^k}$ generously (all wage growth from $H$) $\implies$ generous quality growth

## Kids' vs. Parents' Consumption and the Value of Life

- Calibrating $\alpha$ and $\theta$ for $\frac{c_t^k}{c_t} = \alpha b^{\theta}$
  - USDA (2012) study: spending on kids vs. parents, 2-parent households
  - Spending with 2 kids ($b = 1$) gives $\alpha = 2/3$
  - Across 1, 2, or 3 kids suggests $\theta \approx 0.8$ (also consider $\theta = .6$ and $\theta = 1$)
- Calibrate value of year of life as same for child and adult in U.S. in 2006
  - Given preferences, implies equal utility flows at that time in U.S.
  - Consider robustness to $\frac{\tilde{v}(c_t^k)}{v(c_t,...)} = 0.8$ or $1.2$
  - Allow $v(c_t, ...)$ and $\tilde{v}(c_t^k)$ to evolve over time

## 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 4 countries:
  - US (2003–2019)
  - Netherlands (1975–2005)
  - Japan (1991–2016)
  - South Korea (1999–2019)
- 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 | 5.1 | 3.2 | 1.5 | 0.1 | 0.6 | −0.3 |
| NLD | 4.5 | 2.5 | 2.0 | 4.9 | 2.6 | 2.0 | 0.1 | 0.7 | −0.4 |
| JPN | 2.3 | 0.4 | 1.9 | 2.2 | 0.5 | 1.9 | 0.0 | 0.2 | −0.4 |
| KOR | 4.4 | 1.7 | 2.6 | 5.0 | 1.9 | 2.6 | 0.6 | 0.7 | −0.8 |

# Share of population in CEW growth: Macro vs Micro

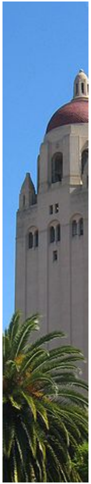
| | MACRO | MICRO | | | | |
|---|---|---|---|---|---|---|
| | | Baseline | Robustness | | | |
| | | | Larger $\theta$ | Smaller $\theta$ | Larger $v_k$ | Smaller $v_k$ |
| USA | 72% | 62% | 64% | 61% | 63% | 62% |
| NLD | 55% | 53% | 54% | 51% | 52% | 54% |
| JPN | 16% | 21% | 23% | 20% | 11% | 29% |
| KOR | 40% | 38% | 40% | 36% | 32% | 42% |

## Tentative Conclusions

- 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

# Things to add

- Decompose population growth into fertility versus falling mortality
  - The former in poor countries, the latter in rich countries
- Incorporate Time Use data for more countries
  - Mexico, South Africa, Tanzania
- Add positive knowledge externalities and negative pollution externalities
  - Calculate *socially* optimal fertility



# BACKUP SLIDES

# Details of micro calculations for US

| Country | Case | | Baseline (Macro) | | | | | Extension (Micro) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Theta | vk / vp (US, 2006) | CEW growth | v(c) | pop term | cons term | Pop share of growth (in %) | CEW growth | v_p | v_k | pop term | cp term | ck term | leisure term | quality of kids term | quantity of kids term | Pop share of growth (in %) | c_p | c_k |
| US | 0.8 | 1 | 5.4 | 4.9 | 3.9 | 1.5 | 72 | 5.1 | 5.0 | 4.9 | 3.2 | 0.9 | 0.6 | 0.1 | 0.6 | -0.3 | 62 | 1.08 | 0.88 |
| | 0.6 | 1 | | | | | | 5.0 | 5.0 | 4.9 | 3.1 | 0.8 | 0.7 | 0.1 | 0.6 | -0.3 | 61 | 1.03 | 1.02 |
| | 1 | 1 | | | | | | 5.1 | 5.0 | 4.9 | 3.3 | 0.9 | 0.5 | 0.1 | 0.5 | -0.2 | 64 | 1.13 | 0.75 |
| | 0.8 | 0.8 | | | | | | 5.0 | 5.0 | 3.9 | 3.1 | 0.9 | 0.6 | 0.1 | 0.6 | -0.3 | 62 | 1.08 | 0.88 |
| | 0.6 | 0.8 | | | | | | 5.0 | 5.0 | 4.0 | 3.0 | 0.8 | 0.7 | 0.1 | 0.6 | -0.3 | 61 | 1.03 | 1.02 |
| | 1 | 0.8 | | | | | | 5.1 | 5.0 | 3.9 | 3.2 | 0.9 | 0.5 | 0.1 | 0.5 | -0.2 | 64 | 1.13 | 0.75 |
| | 0.8 | 1.2 | | | | | | 5.1 | 5.0 | 5.9 | 3.2 | 0.9 | 0.6 | 0.1 | 0.6 | -0.3 | 63 | 1.08 | 0.88 |
| | 0.6 | 1.2 | | | | | | 5.0 | 5.0 | 5.9 | 3.1 | 0.8 | 0.7 | 0.1 | 0.6 | -0.3 | 61 | 1.03 | 1.02 |
| | 1 | 1.2 | | | | | | 5.2 | 5.0 | 5.9 | 3.3 | 0.9 | 0.5 | 0.1 | 0.5 | -0.2 | 64 | 1.13 | 0.75 |

# Details of micro calculations for Netherlands

| Country | Case | | Baseline (Macro) | | | | | Extension (Micro) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Theta | vk / vp (US, 2006) | CEW growth | v(c) | pop term | cons term | Pop share of growth (in %) | CEW growth | v_p | v_k | pop term | cp term | ck term | leisure term | quality of kids term | quantity of kids term | Pop share of growth (in %) | c_p | c_k |
| | 0.8 | 1 | | | | | | 4.9 | 4.9 | 4.2 | 2.6 | 1.2 | 0.9 | 0.1 | 0.7 | -0.4 | 53 | 0.52 | 0.42 |
| | 0.6 | 1 | | | | | | 4.9 | 5.0 | 4.2 | 2.5 | 1.1 | 1.0 | 0.1 | 0.7 | -0.5 | 51 | 0.49 | 0.5 |
| | 1 | 1 | | | | | | 4.9 | 4.9 | 4.2 | 2.7 | 1.2 | 0.7 | 0.1 | 0.7 | -0.4 | 54 | 0.54 | 0.36 |
| | 0.8 | 0.8 | | | | | | 5.0 | 4.9 | 3.2 | 2.7 | 1.2 | 0.9 | 0.1 | 0.7 | -0.4 | 54 | 0.52 | 0.42 |
| NLD | 0.6 | 0.8 | 4.5 | 4.2 | 2.5 | 2.0 | 55 | 5.0 | 5.0 | 3.2 | 2.6 | 1.1 | 1.0 | 0.1 | 0.7 | -0.5 | 53 | 0.49 | 0.5 |
| | 1 | 0.8 | | | | | | 5.0 | 4.9 | 3.3 | 2.8 | 1.2 | 0.7 | 0.1 | 0.7 | -0.4 | 55 | 0.54 | 0.36 |
| | 0.8 | 1.2 | | | | | | 4.8 | 4.9 | 5.1 | 2.5 | 1.2 | 0.9 | 0.1 | 0.7 | -0.4 | 52 | 0.52 | 0.42 |
| | 0.6 | 1.2 | | | | | | 4.8 | 5.0 | 5.2 | 2.4 | 1.1 | 1.0 | 0.1 | 0.7 | -0.5 | 50 | 0.49 | 0.5 |
| | 1 | 1.2 | | | | | | 4.8 | 4.9 | 5.1 | 2.5 | 1.2 | 0.7 | 0.1 | 0.7 | -0.4 | 53 | 0.54 | 0.36 |

# Details of micro calculations for Japan

| Country | Case | | Baseline (Macro) | | | | | Extension (Micro) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Theta | vk / vp (US, 2006) | CEW growth | v(c) | pop term | cons term | Pop share of growth (in %) | CEW growth | v_p | v_k | pop term | cp term | ck term | leisure term | quality of kids term | quantity of kids term | Pop share of growth (in %) | c_p | c_k |
| JPN | 0.8 | 1 | 2.3 | 4.3 | 0.4 | 1.9 | 16 | 2.2 | 4.5 | 4.4 | 0.5 | 1.2 | 0.7 | 0.0 | 0.2 | -0.4 | 21 | 0.58 | 0.51 |
| | 0.6 | 1 | | | | | | 2.3 | 4.5 | 4.5 | 0.4 | 1.1 | 0.9 | 0.0 | 0.2 | -0.5 | 20 | 0.55 | 0.65 |
| | 1 | 1 | | | | | | 2.2 | 4.5 | 4.3 | 0.5 | 1.2 | 0.6 | 0.0 | 0.2 | -0.3 | 23 | 0.61 | 0.41 |
| | 0.8 | 0.8 | | | | | | 2.5 | 4.5 | 3.4 | 0.7 | 1.2 | 0.7 | 0.0 | 0.2 | -0.4 | 29 | 0.58 | 0.51 |
| | 0.6 | 0.8 | | | | | | 2.5 | 4.5 | 3.5 | 0.7 | 1.1 | 0.9 | 0.0 | 0.2 | -0.5 | 27 | 0.55 | 0.65 |
| | 1 | 0.8 | | | | | | 2.4 | 4.5 | 3.3 | 0.8 | 1.2 | 0.6 | 0.0 | 0.2 | -0.3 | 31 | 0.61 | 0.41 |
| | 0.8 | 1.2 | | | | | | 2.0 | 4.5 | 5.3 | 0.2 | 1.2 | 0.7 | 0.0 | 0.2 | -0.4 | 11 | 0.58 | 0.51 |
| | 0.6 | 1.2 | | | | | | 2.0 | 4.5 | 5.4 | 0.2 | 1.1 | 0.9 | 0.0 | 0.2 | -0.5 | 10 | 0.55 | 0.65 |
| | 1 | 1.2 | | | | | | 1.9 | 4.5 | 5.3 | 0.3 | 1.2 | 0.6 | 0.0 | 0.2 | -0.3 | 13 | 0.61 | 0.41 |

# Details of micro calculations for Korea

| Country | Case | | Baseline (Macro) | | | | | Extension (Micro) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Theta | vk / vp (US, 2006) | CEW growth | v(c) | pop term | cons term | Pop share of growth (in %) | CEW growth | v_p | v_k | pop term | cp term | ck term | leisure term | quality of kids term | quantity of kids term | Pop share of growth (in %) | c_p | c_k |
| KOR | 0.8 | 1 | 4.4 | 4.1 | 1.7 | 2.6 | 40 | 5.0 | 4.2 | 4.1 | 1.9 | 1.5 | 1.1 | 0.6 | 0.7 | -0.8 | 38 | 0.47 | 0.4 |
| | 0.6 | 1 | | | | | | 5.1 | 4.2 | 4.2 | 1.8 | 1.4 | 1.5 | 0.6 | 0.7 | -0.9 | 36 | 0.45 | 0.48 |
| | 1 | 1 | | | | | | 5.0 | 4.2 | 4.1 | 2.0 | 1.5 | 0.9 | 0.6 | 0.7 | -0.7 | 40 | 0.49 | 0.33 |
| | 0.8 | 0.8 | | | | | | 5.4 | 4.2 | 3.2 | 2.3 | 1.5 | 1.1 | 0.6 | 0.7 | -0.8 | 42 | 0.47 | 0.4 |
| | 0.6 | 0.8 | | | | | | 5.4 | 4.2 | 3.2 | 2.2 | 1.4 | 1.5 | 0.6 | 0.7 | -0.9 | 40 | 0.45 | 0.48 |
| | 1 | 0.8 | | | | | | 5.4 | 4.2 | 3.1 | 2.4 | 1.5 | 0.9 | 0.6 | 0.7 | -0.7 | 44 | 0.49 | 0.33 |
| | 0.8 | 1.2 | | | | | | 4.6 | 4.2 | 5.1 | 1.5 | 1.5 | 1.1 | 0.6 | 0.7 | -0.8 | 32 | 0.47 | 0.4 |
| | 0.6 | 1.2 | | | | | | 4.7 | 4.2 | 5.1 | 1.4 | 1.4 | 1.5 | 0.6 | 0.7 | -0.9 | 31 | 0.45 | 0.48 |
| | 1 | 1.2 | | | | | | 4.6 | 4.2 | 5.1 | 1.6 | 1.5 | 0.9 | 0.6 | 0.7 | -0.7 | 34 | 0.49 | 0.33 |