The Wealth of Working Nations

Jesús Fernández-Villaverde[1] Gustavo Ventura [2] Wen Yao[3]

January 30, 2024

[1]University of Pennsylvania

[2]Arizona State University

[3]Tsinghua University

Motivation

- As the populations of advanced economies age, output growth per capita is becoming an increasingly misleading indicator for growth theory.
- Changes in the working-age population have become so large that output growth per capita can hide important movements in output per working-age adult (adults between 15 and 64 years old).
- Output per working-age adult: measure of how much we produce given available L and prevailing social norms.
- Caveats:
  1. YES, we are aware that some adults over 64 continue working.
  2. YES, we are aware that you can also measure GDP per worker/hour worked.
- We will return to these caveats later.

This matters...a lot!

- Japan: the poster child of bad economic performance.
- Between 1990 and 2019, GDP in Japan grew at an annual rate of 0.93%, much lower than the 2.49% of the U.S.

Pesek (2014) and Japanization

...few lessons are more timely or critical than those offered by Japan, a once-vibrant model for developing economies that joined the world's richest nations, lost its way and has been struggling to relocate it ever since.

In this book I explore what the world can learn from a Japanese economic funk that began more than 20 years ago and has never really ended. That means exploring where Japan went wrong, how it sank under the weight of hubris and political atrophy, and missed opportunity after opportunity to scrap an insular model based on overinvestment, export-led growth, and excessive debt.

The blame game

- Fear of Japanization leads to vehement policy recommendations:
    1. More aggressive fiscal/monetary policy.
    2. More structural reforms.
- From another side, if one looks at output per working-age adult, Japan has grown at an annual rate of 1.44%, while the U.S. has grown at a very similar 1.56%.
- A bit of reverse engineering: from 1998 to 2019, Japan has grown *slightly faster* than the U.S. in terms of per working-age adult: an accumulated 31.9% vs. 29.5%.
- Difference: since 1990, working-age adults in Japan have fallen 14%; in the U.S., they have increased by 30%.

But, but, what about older people working?

- Participation rate of adults in Japan 65 and over: 24.3% in 1990 and 25.3% in 2019.
- Participation rate of adults in the U.S. 65 and over: 11.8% in 1990 and 20.2% in 2019.
- We lack more detailed info on what older workers do (e.g., hours, occupation, etc.) and their contribution to GDP, so any conclusion is conjectural.
- Based on the change in participation rates, it is likely that any re-definition of the working-age population will probably make our case *stronger*.

Why not GDP per worker/hour worked?

- An alternative: report GDP per worker/hour worked.
- For example, it is often argued that Western Europe's performance in terms of output per worker is much better than its performance in terms of output per capita.
- Minor point: data on hours is pretty bad.
- Bigger point: number of workers and hours worked are *endogenous* to labor market policies, taxes, etc.
- But if restrictive labor regulations or high taxes expel from the labor force the less productive workers (as one would expect), average labor productivity would increase through a composition effect.
- Thus, high growth (or level) of GDP per worker/hour worked can be highly misleading.

Policy implications: Migration and fertility

- We do not have much to say about migration *per se*. As far as it changes population, it is captured in our different measures.
- Interestingly: low correlation between immigration and output growth per working adult.
- Fertility? Really long lags (we will return to this later).

On the continuing usefulness of GDP and GDP per capita

- GDP and GDP per capita are still useful for many purposes.
- GDP: sustainability of public debt.
- GDP per capita: welfare.
- Klenow et al. (2023) argue for the importance of considering the total population to evaluate social welfare growth.

Rest of the presentation

- Document the main argument for a larger sample of countries.
- Think about the data through the lenses of the neoclassical growth model.
- Discuss several extensions.
- Talk about China and India.
- Some final thoughts on the demographic future of humanity.
- (Maybe after we finish): Some fun examples about forecasting demographics.

Data

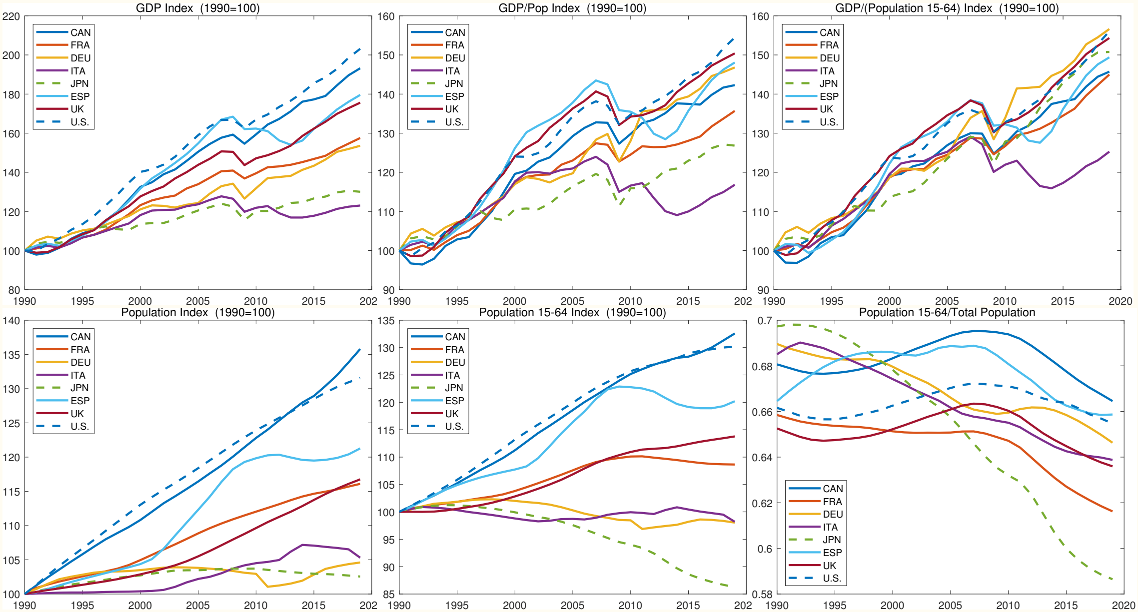
Data and definitions

- We use the World Bank's World Development Indicators (WDI) database.
- We did not have a good experience with the Penn World Tables (PWT). See Pinkovskiy and Sala-i-Martin (2016).
- G7 countries plus Spain.
- Real GDP is the GDP in national constant prices.
- The working-age population is the population between 15 and 64 years old.

Some facts, I

Table 1: G7 plus Spain: Basic Growth and Population Facts, 1990-2019

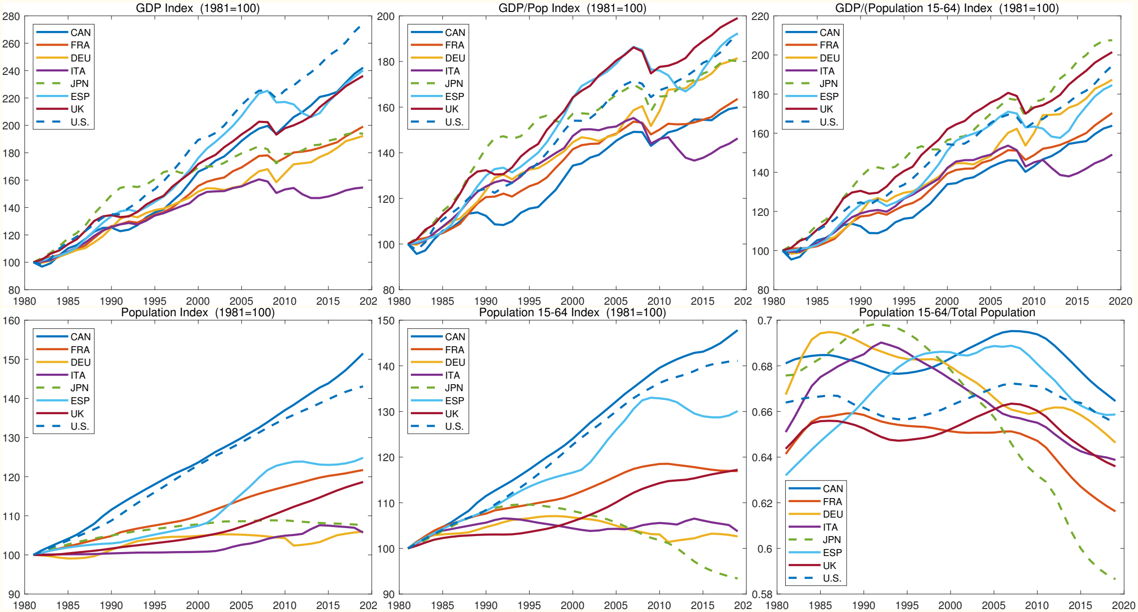
Statistics	Canada	France	Germany	Italy	Japan	Spain	UK	U.S.
GDP	2.31	1.59	1.51	0.73	0.93	2.06	1.97	2.49
GDP per Capita	1.24	1.07	1.35	0.56	0.84	1.39	1.43	1.52
Population	1.06	0.52	0.16	0.18	0.09	0.67	0.54	0.95
GDP per Working-age adult	1.32	1.30	1.58	0.80	1.44	1.41	1.52	1.56
Working-age Population	0.98	0.29	-0.07	-0.06	-0.51	0.64	0.45	0.91
Working-age Pop. Ratio	0.68	0.65	0.67	0.66	0.65	0.68	0.65	0.66


GDP Index (1990=100)
GDP/Pop Index (1990=100)
GDP/(Population 15-64) Index (1990=100)
Population Index (1990=100)
Population 15-64 Index (1990=100)
Population 15-64/Total Population
CAN
FRA
DEU
ITA
JPN
ESP
UK
U.S.

Some facts, II

Table 2: G7 plus Spain: Basic Growth and Population Facts, 1981-2019

Statistic	Canada	France	Germany	Italy	Japan	Spain	UK	U.S.
GDP	2.37	1.84	1.75	1.17	1.78	2.35	2.30	2.71
GDP per Capita	1.26	1.31	1.60	1.03	1.58	1.76	1.84	1.74
Population	1.10	0.52	0.15	0.15	0.19	0.59	0.45	0.95
GDP per Working-age Adult	1.33	1.42	1.69	1.07	1.96	1.65	1.88	1.78
Working-age Population	1.03	0.41	0.07	0.10	-0.18	0.70	0.42	0.91
Working-age Pop. Ratio	0.68	0.65	0.67	0.67	0.66	0.67	0.65	0.66


GDP Index (1981=100)
GDP/Pop Index (1981=100)
GDP/(Population 15-64) Index (1981=100)
Population Index (1981=100)
Population 15-64 Index (1981=100)
Population 15-64/Total Population
CAN
FRA
DEU
ITA
JPN
ESP
UK
U.S.

Model

Why a model?

- We want a model to organize our thinking about the effects of changes in the working-age population.
- We could go as complex as desired (OLG structure, endogenous growth, endogenous fertility, migration, ...).
- I have done all of those in previous papers.
- The goal today is simpler: get the right intuition and orders of magnitude.
- Thus, a minimalistic model is better.

The Neoclassical growth model

- The economy populated by an infinitely lived representative household of varying size N_t.
- Preferences:

$$\max_{C_t/N_t} \sum_{t=0}^{\infty} \beta^t N_t \log\left(\frac{C_t}{N_t}\right)$$

- Output: $Y_t = K_t^{\theta}(A_t L_t)^{1-\theta}$.
- $A_t = A_0(1+g)^t$: labor-augmenting technology. Thus, TFP equals $A_t^{1-\theta}$.
- $K_{t+1} = I_t + (1-\delta)K_t$.
- $C_t + I_t = Y_t$.
- $N_t = \prod_{i=1}^{t}(1+n_i)$, given $N_0 = 1$.

Normalization

- Given the growth of technology g and population n, we must normalize the variables:

$$c_t = \frac{C_t}{A_t N_t},$$
$$k_t = \frac{K_t}{A_t N_t},$$
$$i_t = \frac{I_t}{A_t N_t},$$
$$y_t = \frac{Y_t}{A_t N_t} = \left(\frac{K_t}{A_t N_t}\right)^{\theta} \left(\frac{A_t L_t}{A_t N_t}\right)^{1-\theta} = k_t^{\theta} l_t^{1-\theta},$$

where $l_t = L_t / N_t$.

Intuition of the model

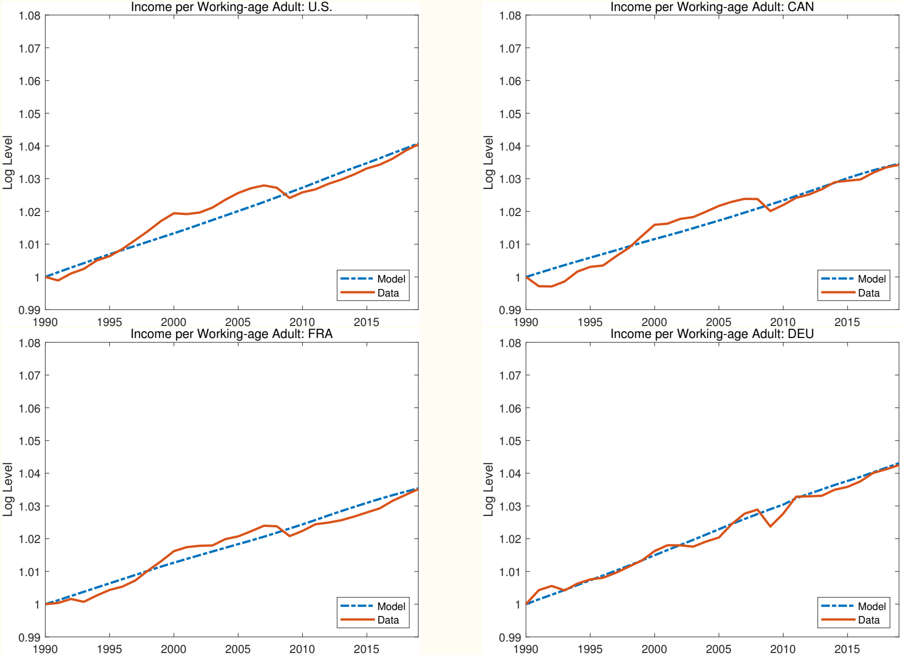
- A standard Euler equation:

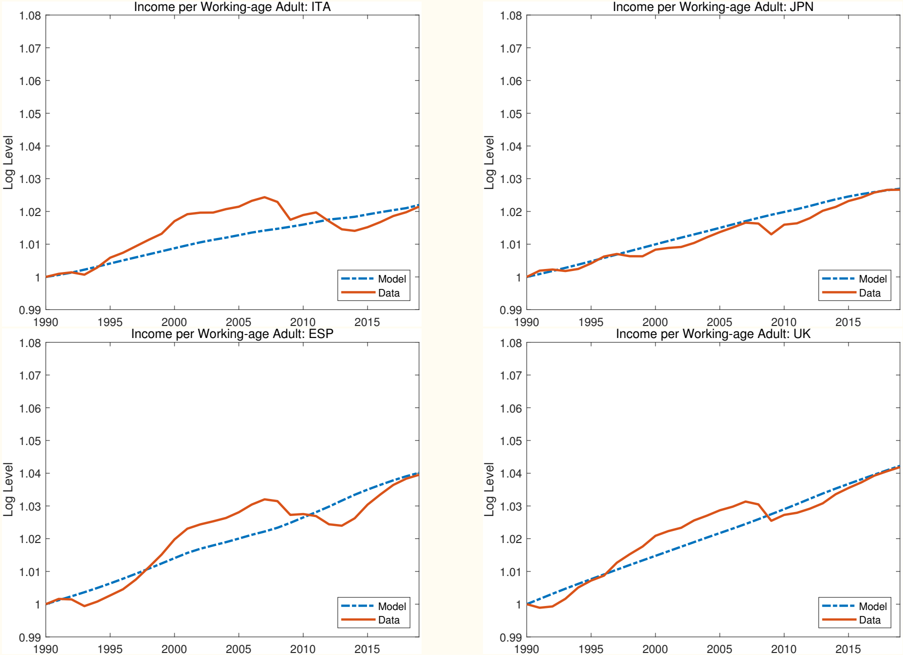
$$c_t^{-1}(1+g) = \beta c_{t+1}^{-1}\left(\theta (k_{t+1})^{\theta-1}(l_{t+1})^{1-\theta} + 1 - \delta\right).$$

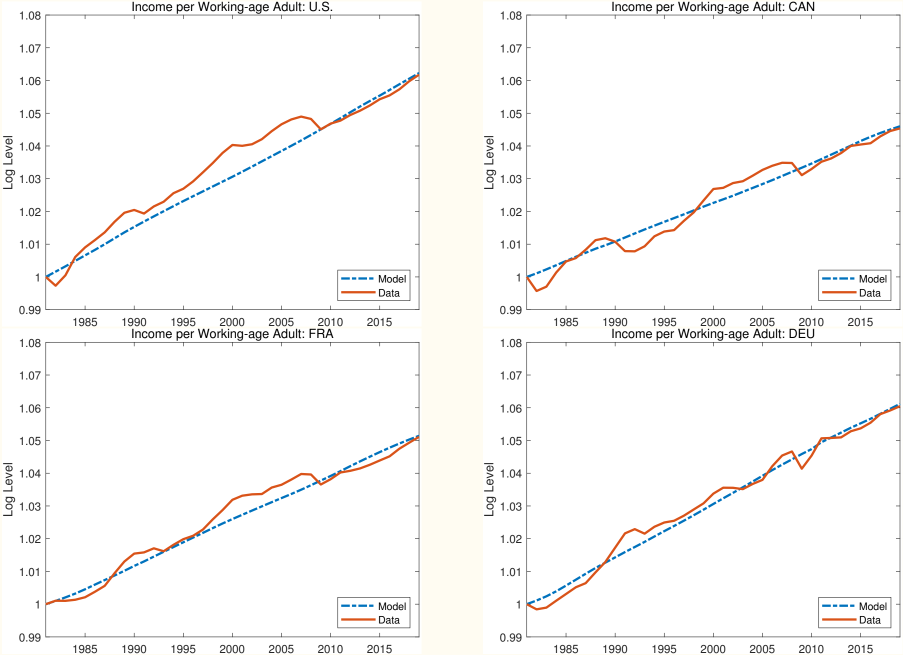
- This Euler equation looks like the optimality condition of the textbook neoclassical growth model with population and trend technological growth except for l_{t+1}.
- Case 1: $l_{t+1} = \widehat{l}$ is constant. This is equivalent to a constant in front of the (normalized) production function and, hence, irrelevant to the dynamics of the model. Shocks to A_t have the usual effects on output and investment.
- Case 2: l_{t+1} changes. This is equivalent to a technological shock: a drop in l_{t+1} lowers total production, investment, and output.
- In other words, changes in l_{t+1} have the same effect as technological shocks in a real business cycle model without labor choice (and with the same persistence and propagation).

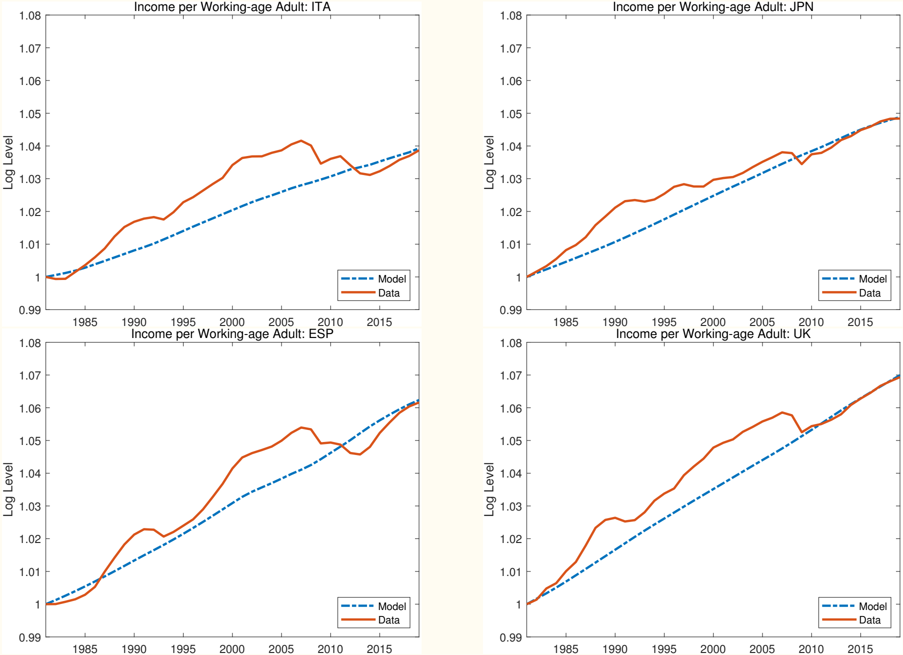
Calibration

Parameter		Value
Discount factor	β	0.946
Capital share	θ	0.39
Depreciation rate	δ	0.04
Labor augmenting technology growth rate, Canada	g	0.0133
Labor augmenting technology growth rate, France	g	0.0103
Labor augmenting technology growth rate, Germany	g	0.0169
Labor augmenting technology growth rate, Italy	g	0.0107
Labor augmenting technology growth rate, Japan	g	0.0196
Labor augmenting technology growth rate, Spain	g	0.0165
Labor augmenting technology growth rate, U.K.	g	0.0188
Labor augmenting technology growth rate, U.S.	g	0.0178


Income per Working-age Adult: U.S.
Income per Working-age Adult: CAN
Income per Working-age Adult: FRA
Income per Working-age Adult: DEU
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1990
1995
2000
2005
2010
2015
Model
Data


Income per Working-age Adult: ITA
Income per Working-age Adult: JPN
Income per Working-age Adult: ESP
Income per Working-age Adult: UK
Log Level
Model
Data
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1990
1995
2000
2005
2010
2015

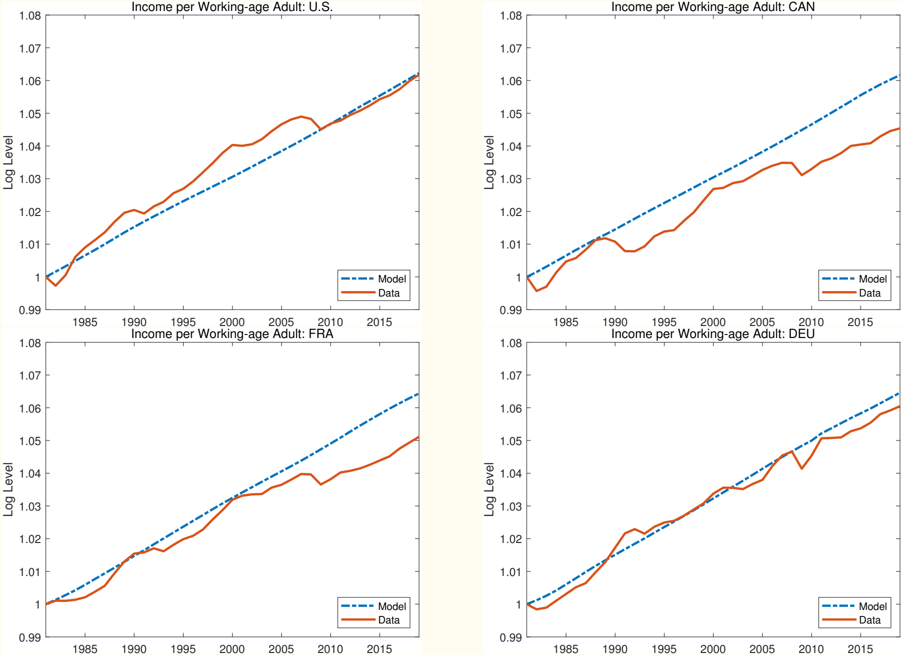

Income per Working-age Adult: U.S.
Income per Working-age Adult: CAN
Income per Working-age Adult: FRA
Income per Working-age Adult: DEU
Log Level
Model
Data
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015


Income per Working-age Adult: ITA
Income per Working-age Adult: JPN
Income per Working-age Adult: ESP
Income per Working-age Adult: UK
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015
Model
Data

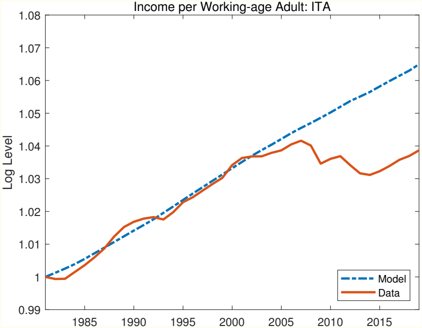
Extensions

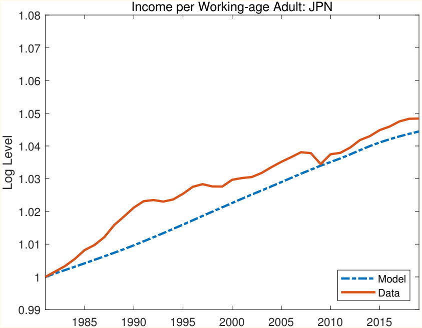
An alternative calibration

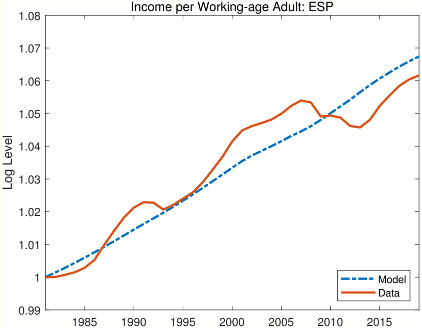
- What if we use g from the U.S. instead of each country's?
- As a first-order approximation, one can consider the U.S.' g as a measure of the growth of the world's technological frontier.
- This exercise controls for the possibility that different aging speeds in each country might lead to different g's.
- This exercise helps visualize the economies that have had mediocre (e.g., Canada) or disastrous performance (e.g., Italy).

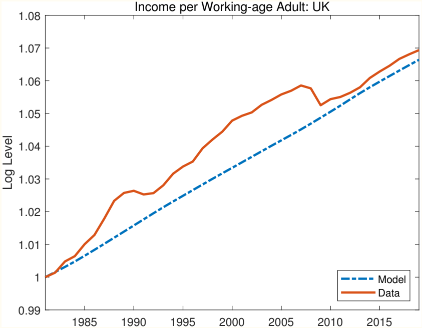


Income per Working-age Adult: U.S.
Income per Working-age Adult: CAN
Income per Working-age Adult: FRA
Income per Working-age Adult: DEU
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015
Model
Data


Income per Working-age Adult: ITA
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015
Model
Data


Income per Working-age Adult: JPN
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015
Model
Data


Income per Working-age Adult: ESP
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015
Model
Data

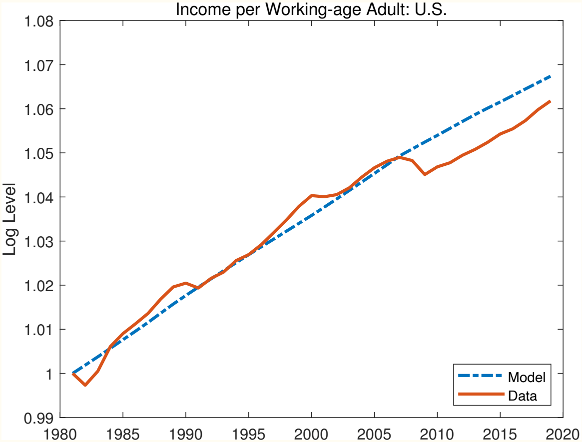

Income per Working-age Adult: UK
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1985
1990
1995
2000
2005
2010
2015
Model
Data

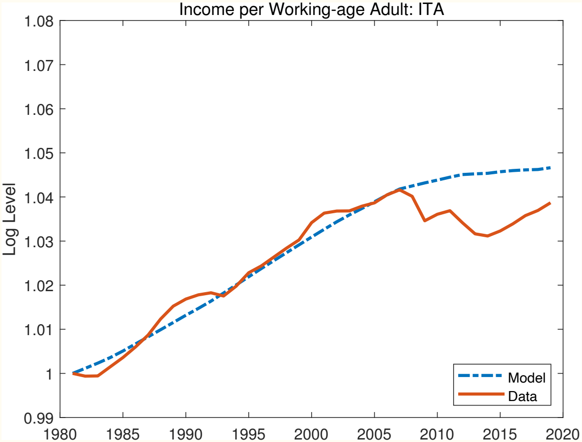
Changing trends

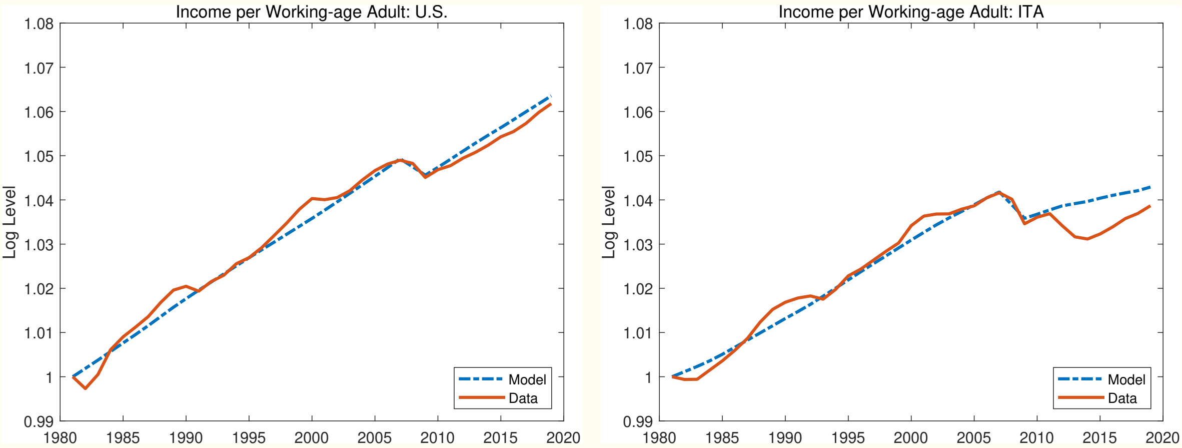
- We split our sample between the periods 1981-2007 and 2008-2019, or before and after the financial crisis.
- How can we incorporate this idea into the model?
    1. Different trend.
    2. Permanent drop.

1981-2007	Canada	France	Germany	Italy	Japan	Spain	UK	USA
GDP	2.68	2.24	1.99	1.84	2.41	3.15	2.76	3.19
GDP per Capita	1.57	1.67	1.80	1.71	2.08	2.44	2.43	2.11
Population	1.09	0.56	0.19	0.13	0.32	0.70	0.33	1.05
GDP per Working-age Adult	1.49	1.61	1.84	1.67	2.25	2.10	2.31	2.06
Working-age Population	1.17	0.62	0.15	0.17	0.15	1.03	0.44	1.10
Working-age Pop. Ratio	0.68	0.65	0.68	0.67	0.68	0.67	0.65	0.66

2008-2019	Canada	France	Germany	Italy	Japan	Spain	UK	USA
GDP	1.79	1.03	1.27	-0.23	0.58	0.61	1.43	1.81
GDP per Capita	0.65	0.61	1.16	-0.36	0.68	0.38	0.71	1.11
Population	1.13	0.42	0.11	0.14	-0.10	0.23	0.71	0.70
GDP per Working-age Adult	1.07	1.11	1.35	-0.11	1.49	0.78	1.10	1.34
Working-age Population	0.71	-0.07	-0.08	-0.12	-0.90	-0.16	0.33	0.46
Working-age Pop. Ratio	0.68	0.63	0.66	0.65	0.61	0.67	0.65	0.66


Income per Working-age Adult: U.S.
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1980
1985
1990
1995
2000
2005
2010
2015
2020
Model
Data

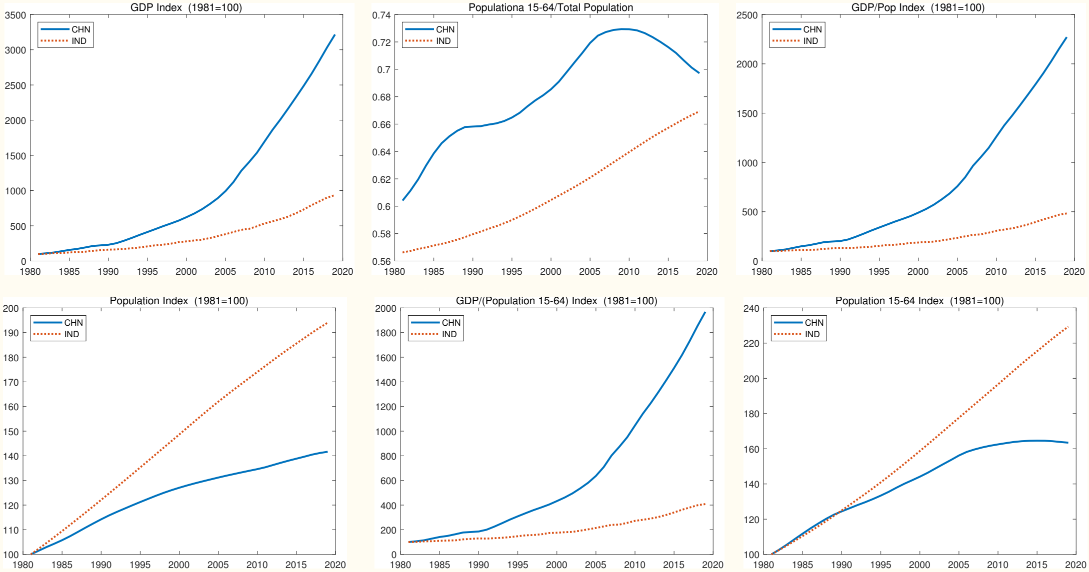

Income per Working-age Adult: ITA
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1980
1985
1990
1995
2000
2005
2010
2015
2020
Model
Data



Income per Working-age Adult: U.S.
Log Level
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
1980
1985
1990
1995
2000
2005
2010
2015
2020
Model
Data
Income per Working-age Adult: ITA

China and India

1981-2019	China	India
GDP	9.60	6.08
GDP per Capita	8.60	4.25
Population	0.92	1.76
GDP per Working-age Adult	8.18	3.79
Working-age Population	1.31	2.21
Working-age Pop. Ratio	0.68	0.61


GDP Index (1981=100)
CHN
IND
Populationa 15-64/Total Population
CHN
IND
GDP/Pop Index (1981=100)
CHN
IND
Population Index (1981=100)
CHN
IND
GDP/(Population 15-64) Index (1981=100)
CHN
IND
Population 15-64 Index (1981=100)
CHN
IND

Some final thoughts on the demographic future of humanity

Quid rides? Mutato nomine de te fabula narratur

- The present of Japan is the future of the globe.

The total fertility rate (TFR) of a population

The average number of children that would be born to a woman over her lifetime if:

1. She were to experience the current age-specific fertility rates throughout her lifetime.
2. She were to live through ages 15-44.

- Japan's TFR fell below 2.1 (explanation of the importance of 2.1 in next slide) in 1974. Right now is around 1.25.

- A few other examples:

    1. Iran: 1.69.
    2. U.S.: 1.62.
    3. Brazil: 1.45.
    4. China: 1.0
    5. South Korea: 0.7.

The replacement rate

- The TFR governs whether a population reaches the *replacement rate*: whether enough children are born to sustain population levels (forgetting net immigration).
- A simple formula:

$$\text{Replacement rate} \approx \frac{1 + \text{sex ratio at birth}}{\text{Probability of a woman to survive to 30}}$$

- Replacement rate for rich countries: ≈ 2.1. Why?
  - Without outside intervention ≈ 1.05 boys are born for every girl.
  - Probability of a woman surviving to 30 is about 0.98.
- Thus:

$$\text{Replacement rate rich country} \approx \frac{1 + 1.05}{0.98} \approx 2.1$$

The replacement rate in developing economies

- Think, however, about developing countries with different parameters:

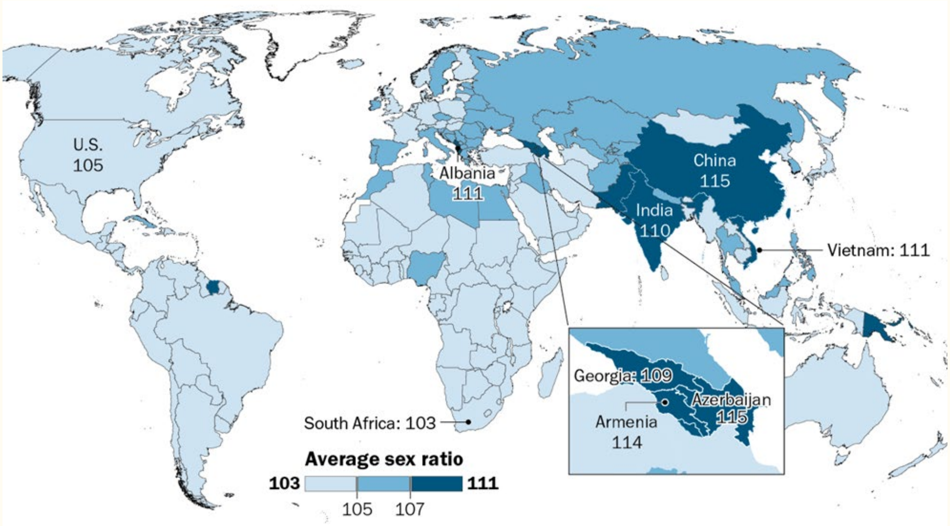
  1. Many populations practice selective abortions.
  2. Female mortality rates are quite higher.

- Thus:

$$\text{Replacement rate developing country} \approx \frac{1+1.1}{0.8} \approx 2.6$$

- Replacement rate for some African countries can be as high as 3.

Average sex ratio at birth, or the number of male births per 100 female births, from 2000-20



Note: Globally, the natural sex ratio at birth ranges from 103 to 107 boys per 100 girls.
Source: United Nations World Population Division, 2019.
"India's Sex Ratio at Birth Begins To Normalize"

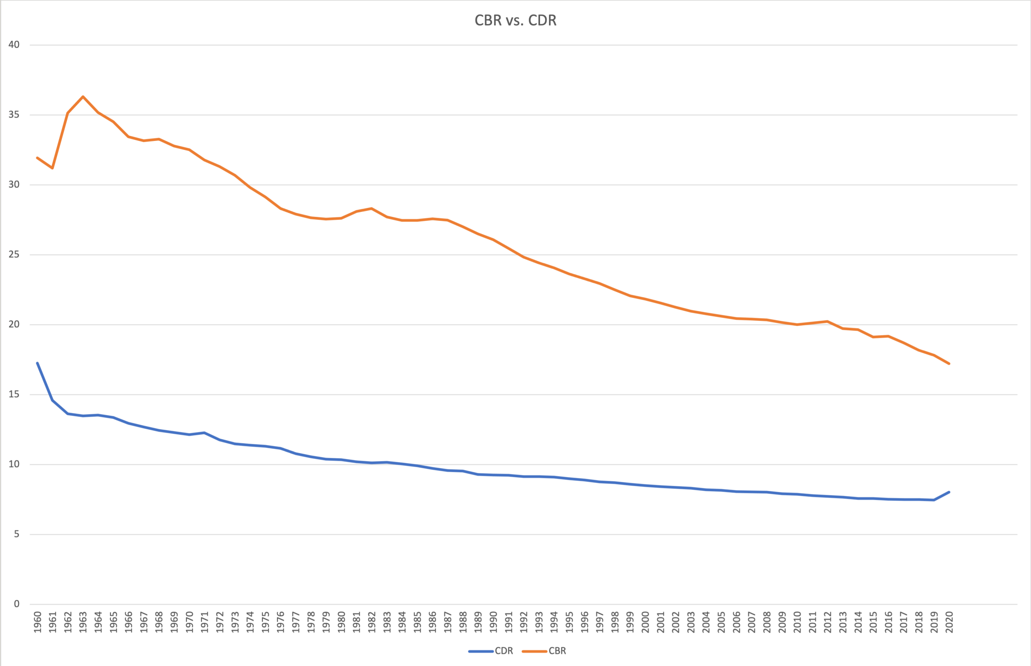
PEW RESEARCH CENTER

The world replacement rate

- The world replacement rate in 2023:

$$\text{Replacement rate world} \approx \frac{1 + 1.07}{0.91} \approx 2.25$$

- According to the United Nations World Population Prospects 2022, the world TFR is 2.3.
- However, the United Nations World Population Prospects *overestimate* the world TFR. For example, in 2023, there were 9 million births in China vs. 10.6 million in the UN forecast.
- I calculate that we are around 2.1-2.2.
- Thus, most likely, the world is *already below* the replacement rate.
- The world population is still growing: momentum effect of past large cohorts and increases in life expectancy.


CBR vs. CDR
40
35
30
25
20
15
10
5
0
1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
CDR
CBR

When will momentum end?

- More uncertainty here: it depends on the future evolution of fertility and mortality.
- According to the United Nations World Population Prospects 2022, medium variant, the world population will peak in 2086 at 10.43 billion (vs. 8 billion right now).
- I disagree. I see the peak of population size at around 9.7 billion c. 2055.
- Why?
  1. United Nations World Population Prospects are conservative in their assumptions about the fall of fertility:
     - For example, China had in 2023 the births the United Nations World Population Prospects forecasted for 2050.
     - The United Nations World Population Prospects assumes partial recoveries of fertility in low-fertility countries. We have yet to see many examples of this happening.
  2. My research shows that fertility falls are becoming faster.

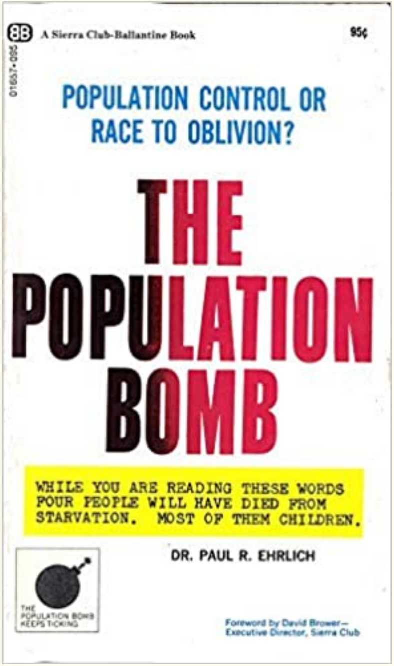
An easy way to check: "the rule of 85"

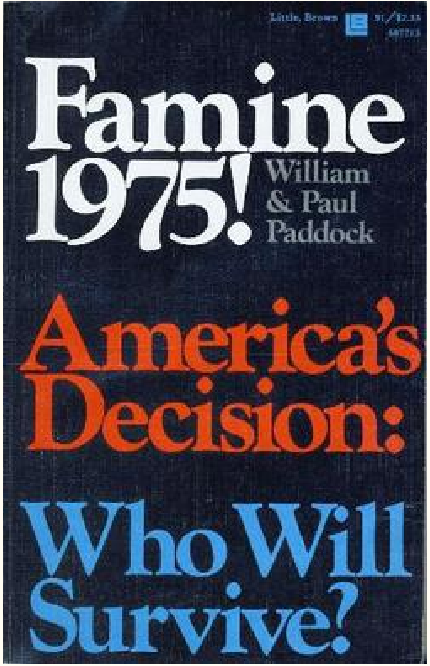
- Imagine you have a country where life expectancy is 85 years: the highest life expectancy in the world right now (Japan, Spain, etc.).
- Imagine that, from now on, you have 1,000 births per year, every year.
- What would be your population in about 100 years? $85{,}000 = 85 * 1{,}000$.
- Thus, you can look at the current births of any given country, multiply by 85, and get *a sense* of the long-run population (without migrations).
- For example, South Korea had 230k births in 2023. Long-run population: 19.5 million (85*230k). Current population: 51.6 million.
- An equivalent way to look at it: $1000/85 = 11.76$. When a country's CBR falls below 11.76 per 1000, births are already insufficient to keep the population constant (this usually happens *around 30 years after* TFR falls below replacement).

Let me stop here

- First time that humanity is below replacement rate in the last 100,000 years.
- Yes, the world population often dropped. Still, it was caused by famines and diseases, not by low births (wars never were so crucial demographically speaking at the global level because they tend to be localized).
- Furthermore, the world TFR is falling very fast all across the globe (including Africa!).
- In fact, faster than most forecasts, even ten years ago.

Fun examples


A Sierra Club-Ballantine Book
95¢
POPULATION CONTROL OR RACE TO OBLIVION?
THE POPULATION BOMB
WHILE YOU ARE READING THESE WORDS FOUR PEOPLE WILL HAVE DIED FROM STARVATION. MOST OF THEM CHILDREN.
DR. PAUL R. EHRLICH
THE POPULATION BOMB KEEPS TICKING
Foreword by David Brower— Executive Director, Sierra Club


Little, Brown
Famine 1975!
William & Paul Paddock
America's Decision:
Who Will Survive?

Having some Monday morning quarterback fun, I

Ehrlich, The Population Bomb (revised edition, 1971), page 8

Doubling times for the populations of the ODCs tend to be in the 50-to-200-year range. Examples of 1970 doubling times are ... Japan, 63. These are industrialized countries that have undergone the so-called demographic transition–a transition from high to low growth rates....
It is important to emphasize, however, that the demographic transition does not result in zero population growth, but in a growth rate which in many of the most important ODCs results in populations doubling every seventy years or so.

- In 1970, Japan's TFR was 2.135. The book mentions "fertility rate" once! (And in another context).
- By 1970, it was clear that most rich countries were getting closer to or below the replacement rate.
- Nearly all population growth (net of migration) was due to momentum.

Having some Monday morning quarterback fun, II

Ehrlich, The Population Bomb (revised edition, 1971), page 8

This means, for instance, that even if most UDCs were to undergo a demographic transition (of which there is no sign) the world would still be faced by catastrophic population growth.

- Brazil started its demographic transition in 1957, South Korea in 1958, Malaysia in 1958, Costa Rica in 1958, Indonesia in 1959...
- In my own work, I document that *all* countries in the world have started the demographic transition by the early 2020s.
- In fact, transitions are getting faster than ever!

Having some Monday morning quarterback fun, III

Ehrlich, The Population Bomb (revised edition, 1971), page 11

Costa Rica's birth rate was 41 per thousand. Good for Costa Rica? Unfortunately, not very. Costa Rica's death rate was less than nine per thousand, while the other countries all had death rates above 20 per thousand. The population of Costa Rica in 1966 was doubling every 17 years...

- TFR in Costa Rica in 2023: 1.2 (below Japan's). CBR: 9.7 per thousand.
- Costa Rica's population has roughly tripled since 1966 (including substantial net migration). Net of migration, Costa Rica will lose population by 2028 or so.