The Future of Markets

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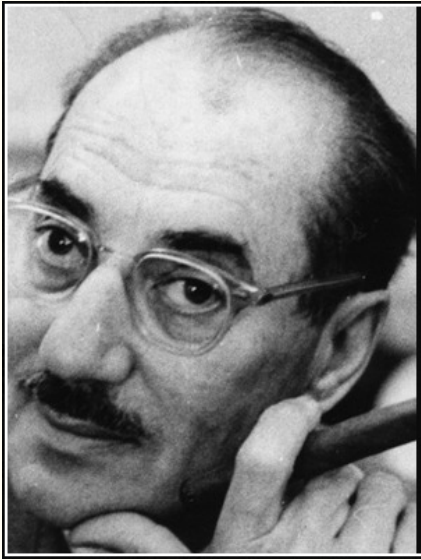


Why should I care about posterity?
What's posterity ever done for me?

— Groucho Marx —

AZ QUOTES

What is the future of markets?

Niels Bohr?

It is difficult to make predictions, especially about the future.

- But I see four key forces:
  1. Demographics.
  2. Climate change.
  3. Geopolitical fragmentation.
  4. Artificial intelligence.
- I will focus on the first two and briefly mention the last two.
- Also, I will skip a discussion of intellectual forces.

The demographic future of humanity

Table 1: G7 plus Spain: Basic Growth and Population Facts

1991-2019	Canada	France	Germany	Italy	Japan	Spain	UK	U.S.
GDP	2.47	1.61	1.38	0.70	0.83	2.05	2.08	2.58
GDP per capita	1.40	1.10	1.25	0.52	0.76	1.35	1.53	1.63
Population	1.05	0.50	0.14	0.18	0.08	0.68	0.54	0.94
GDP per working-age adult	1.48	1.33	1.47	0.79	1.39	1.41	1.62	1.65
Working-age population	0.98	0.27	-0.09	-0.08	-0.54	0.63	0.46	0.91

Table 2: Output Growth Decomposition

1991-2019	Canada	France	Germany	Italy	Japan	Spain	UK	U.S.
GDP	2.47	1.61	1.38	0.70	0.83	2.05	2.08	2.58
Population	1.05	0.50	0.14	0.18	0.08	0.68	0.54	0.94
Working-age per person	-0.08	-0.23	-0.22	-0.27	-0.62	-0.05	-0.08	-0.03
Emp. rate per working-age	0.42	0.35	0.57	0.34	0.74	0.90	0.36	0.17
Hours worked per worker	-0.17	-0.30	-0.40	-0.26	-0.61	-0.14	-0.11	-0.04
GDP per hour worked	1.23	1.28	1.31	0.71	1.26	0.67	1.37	1.53
GDP per worker	1.05	0.98	0.90	0.45	0.65	0.53	1.25	1.49
GDP per working-age adult	1.48	1.33	1.47	0.79	1.39	1.41	1.62	1.65
Total hours worked	1.23	0.33	0.08	0.00	-0.43	1.40	0.71	1.04
Working-age pop.	0.98	0.27	-0.09	-0.08	-0.54	0.63	0.46	0.91

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 1.2.
- A few other examples:

1. Iran: 1.66.
2. U.S.: 1.60.
3. Brazil: 1.44.
4. China: 1.07.
5. South Korea: 0.72.

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:

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

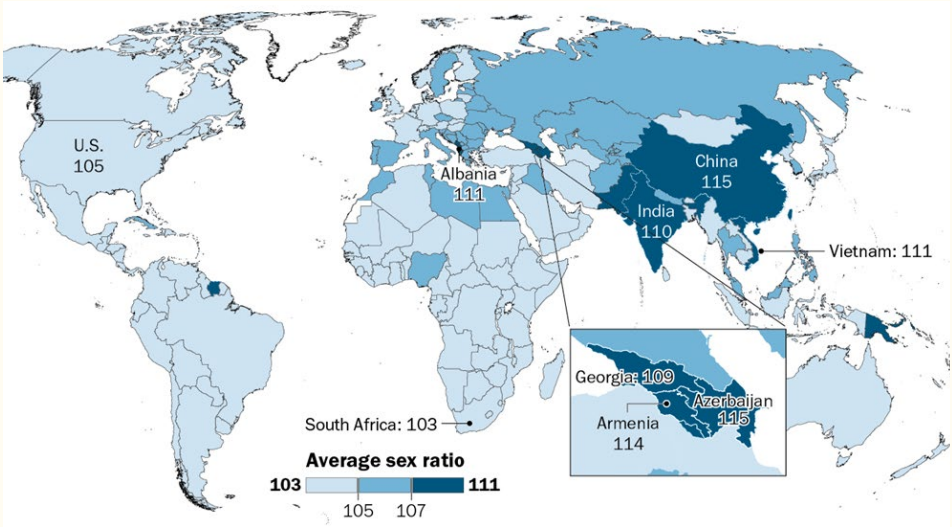
The replacement rate in developing economies

- 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



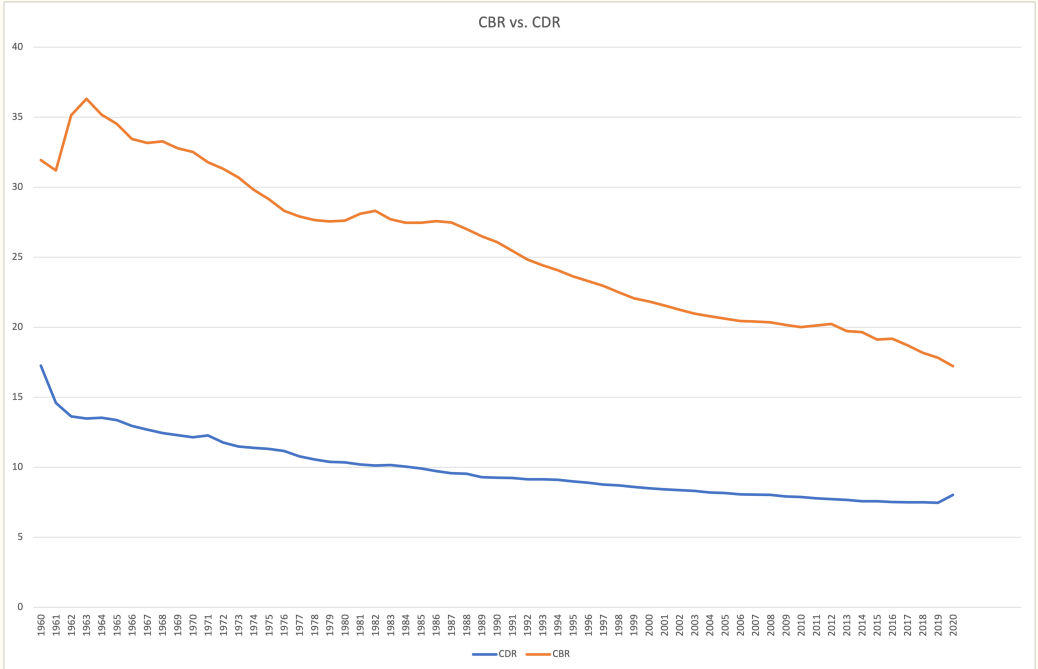
Note: Globally, the natural sex ratio at birth ranges from 103 to 107 boys per 100 girls.
Source: United Nations World Population Division, 2019.
"India's Sex Ratio at Birth Begins To Normalize"

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?

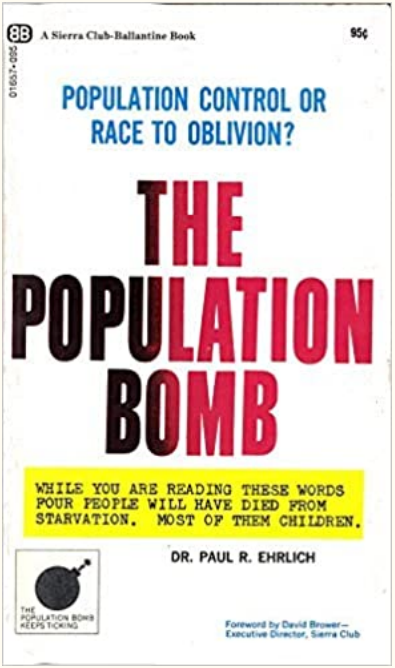
- More uncertainty here: it depends on the future evolution of fertility and mortality.
- According to the United Nations World Population Prospects 2022, medium variant, the world population will peak in 2086 at 10.43 billion (vs. 8 billion right now).
- I disagree. I see the peak of population size 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.

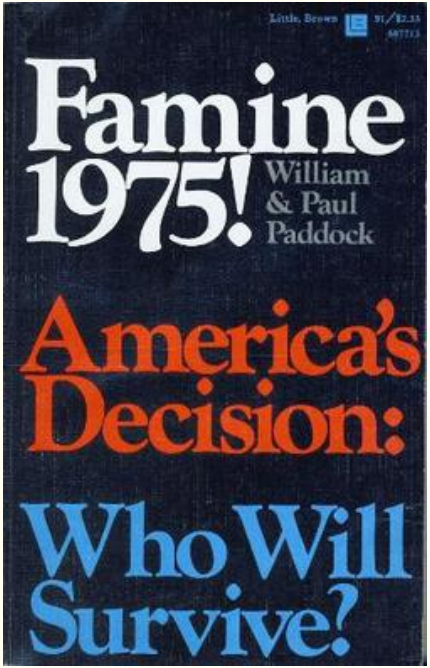
An easy way to check: "the rule of 85"

- 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).

Some economic consequences

- Like all changes, this momentous demographic shift will have good and bad consequences.
- Which ones will predominate will depend on the policy responses we offer.
- Also, please remember: we are venturing into *terra incognita*. Things can change.
- If you pick a social sciences textbook from the 1980s (or even 1990s), the main concern was the population explosion.
- When I was a kid, my parents bought a book that stated that population growth in Mauritius was so out of control that this island nation was doomed. Mauritius has had a negative population growth in 2022 and 2023.
- So, there is a non-trivial risk someone might make fun of me in 25 years.


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


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

First, the good news

- With a lower population growth rate or falling population, it is much easier to design policies that ensure the sustainability of natural resources.
- Fewer pressures on infrastructure, housing, emissions, etc.
- For example, we can re-design many of Latin America's cities.
- Also, before population aging really kicks in, many developing economies have extra fiscal space to take advantage of lower fertility and undertake essential reforms.

But there are also bad news

- The unpleasant arithmetic of demographics.
- Take any country you like: e.g., U.S., Germany, China,...
- A basic identity:

$$\underbrace{y}_{\text{output}} = \underbrace{\frac{y}{l}}_{\text{labor productivity}} * \underbrace{l}_{\text{labor}}$$

- Thus, output growth:

$$\underbrace{g_y}_{\text{output growth}} = \underbrace{g_{\frac{y}{l}}}_{\text{labor productivity growth}} + \underbrace{g_l}_{\text{labor growth}}$$

The way we were

- Your "average" advanced economy c. 1965 (in the middle of the so-called "thirty glorious years"):

$$\underbrace{3\%}_{\text{output growth}} = \underbrace{2\%}_{\text{labor productivity growth}} + \underbrace{1\%}_{\text{labor growth}}$$

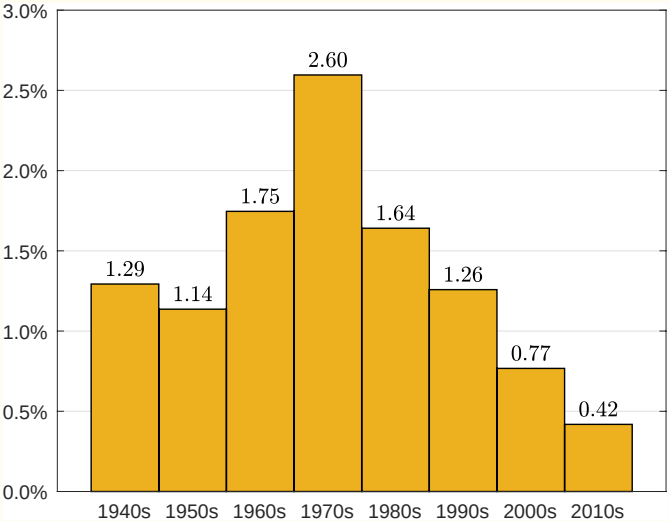
- 3% is the "normal" output growth that you expect:
  1. When the economy is booming (i.e., unemployment is falling and labor is growing faster than average), you see 4%.
  2. When the economy is depressed (i.e., unemployment is increasing and labor is growing slower than average), you see 2%.

The way we are

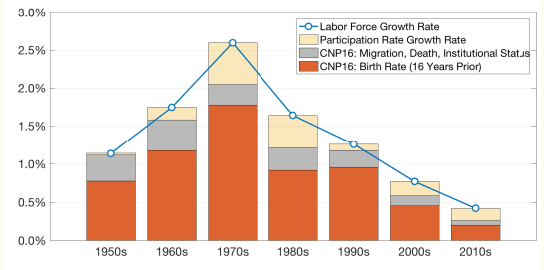
- Your "average" advanced economy c. 2025 (or Japan today):

$$\underbrace{1\%}_{\text{output growth}} = \underbrace{2\%}_{\text{labor productivity growth}} + \underbrace{-1\%}_{\text{labor growth}}$$

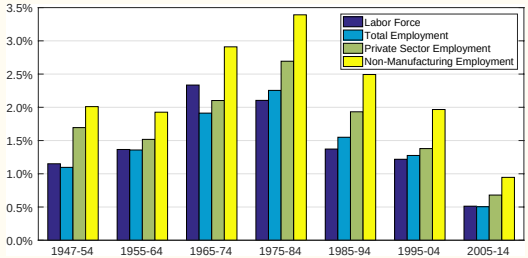
- 1% is the "normal" output growth that you expect:
  1. When the economy is booming (i.e., unemployment is falling and labor is growing faster than average), you see 2%.
  2. When the economy is depressed (i.e., unemployment is increasing and labor is growing slower than average), you see 0%.
- There is nothing the central bank can do with further monetary stimulus (or the fiscal authority with fiscal packages).
- As we saw above, Japan has been doing pretty well in terms of output per worker growth during the last 25 years.



Civilian Labor Force Growth Rate



(a) Sources

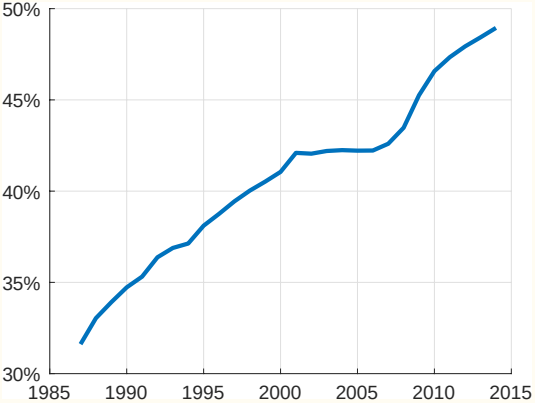


(b) Alternative Measures

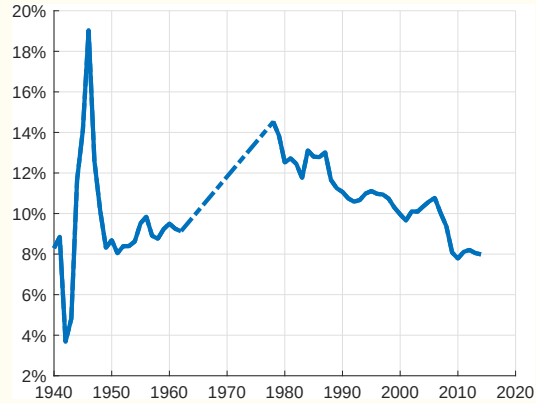
Labor Force Growth

What is the problem?

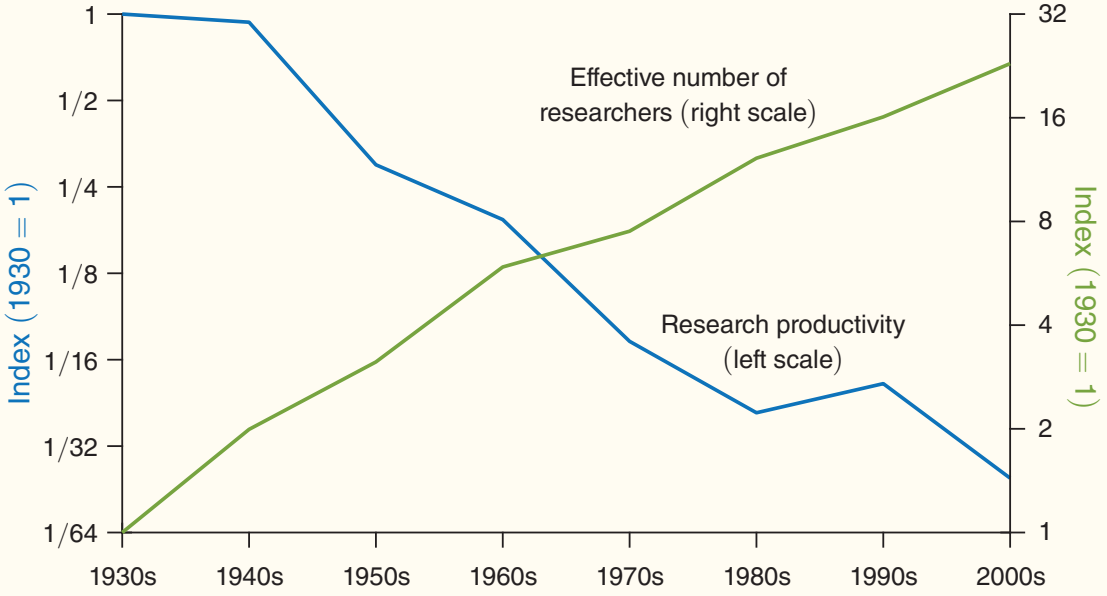
- Don't we care about output per capita?
- Yes and no.
- Yes, output per capita is the primary measure of individual welfare but...
- ...our ability to service debt and social security obligations depends on total output.
- Also, labor productivity is unlikely to grow at 2% any longer.
- Why?
  1. Firm dynamism.
  2. New technologies.



(a) Share of Firms Age 11+



(b) Entry Rate


1
1/2
1/4
1/8
1/16
1/32
1/64
Index (1930 = 1)
32
16
8
4
2
1
Index (1930 = 1)
Effective number of researchers (right scale)
Research productivity (left scale)
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s

Consequences

- Low output growth.
- Low (real) interest rates.
- Complex fiscal position of most governments.
- Depopulation of certain regions (mainly rural areas).
- Real estate prices.
- Education, health, and other public services.

Taking stock

- We are in a whole new world.
- I have skipped, in the interest of time, tons of other aspects.
- But, as a matter of fact, it is that, to a large extent, demography is destiny.
- Once you start thinking about it, it is hard to think about anything else.

Climate change

Five observations from Hassler et al. (2024)

1. A simple system of five difference equations describes the relation between emissions of CO_2 and global warming quite well, both qualitatively and quantitatively.

2. Global warming is approximately proportional to the cumulative emissions of CO_2, in both the short and long run.

3. The frequency and intensity of key weather extremes increase with the global mean temperature. The predicted increase is gradual and approximately linear, but the uncertainty is very large.

4. Global CO_2 emissions are not falling, but they are increasing at a lower rate than two decades ago. Both consumption- and production-based emissions have fallen in the EU and the U.S. over the last two decades, whereas the opposite is true for emissions in China and India.

5. The amount of fossil fuel left in the ground is very large compared to the carbon budgets for $1.5°C$ and $2°C$ global warming. The amount of oil and gas with low extraction costs is of the same order of magnitude as these carbon budgets.

Integrated assessment models

- Use of integrated assessment models (IAM): how the economy and climate interact *quantitatively*.
- Three blocks: economy, climate, and damages.
- Nonlinear and stochastic dynamics.
- Uses:
  1. Positive analysis $\Rightarrow$ future paths of variables of interest.
  2. Normative analysis $\Rightarrow$ design of optimal policies.
  3. Counterfactuals $\Rightarrow$ mitigation, changes in technology, ...
- Interestingly, IPCC does not have an IAM (and its economic analysis, in general, is pretty bad).

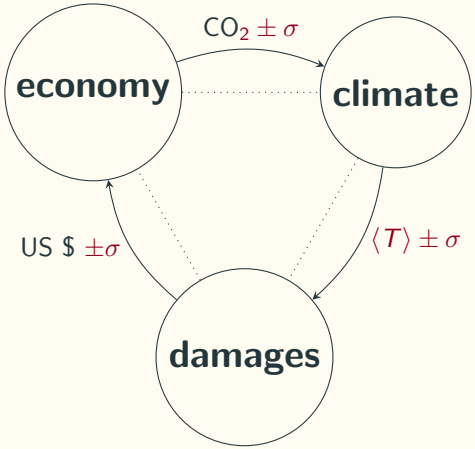
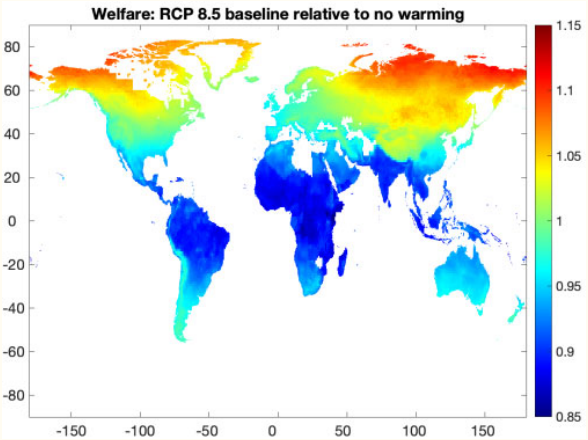
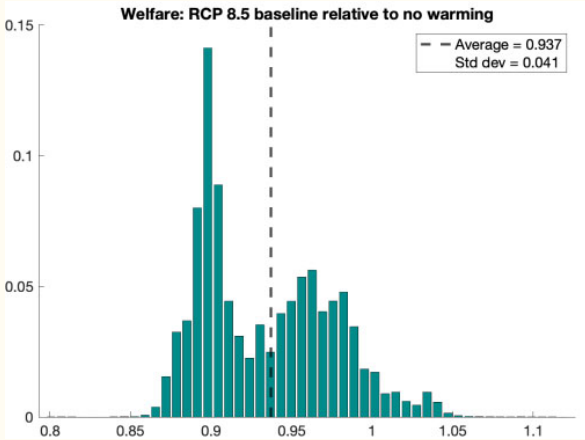


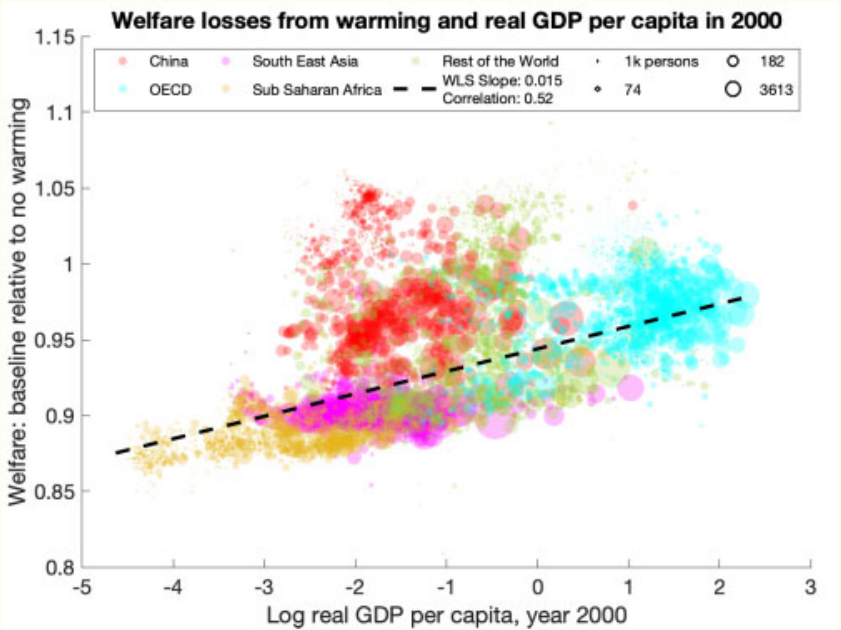
Figure 1: Stylized representation of an IAM.

A simple example

- Cruz and Rossi-Hansberg (2023).
- Average welfare losses of 6%.
- Large heterogeneity in climate damages across space: from welfare losses of 20% to gains of 11%.
- Large role of adaptation, particularly migration.
- Large disagreement across regions.

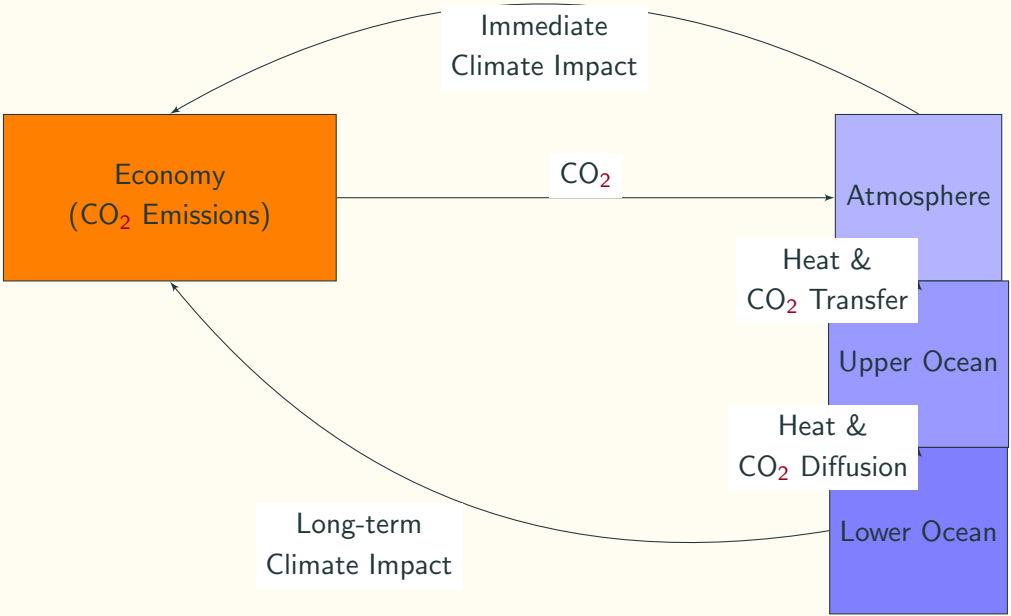

Welfare: RCP 8.5 baseline relative to no warming
80
60
40
20
0
-20
-40
-60
-80
-150
-100
-50
0
50
100
150
1.15
1.1
1.05
1
0.95
0.9
0.85


Welfare: RCP 8.5 baseline relative to no warming
Average = 0.937
Std dev = 0.041
0.15
0.1
0.05
0
0.8
0.85
0.9
0.95
1
1.05
1.1


Welfare losses from warming and real GDP per capita in 2000
China
South East Asia
Rest of the World
1k persons
182
OECD
Sub Saharan Africa
WLS Slope: 0.015
Correlation: 0.52
74
3613
Welfare: baseline relative to no warming
Log real GDP per capita, year 2000
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
-5
-4
-3
-2
-1
0
1
2
3

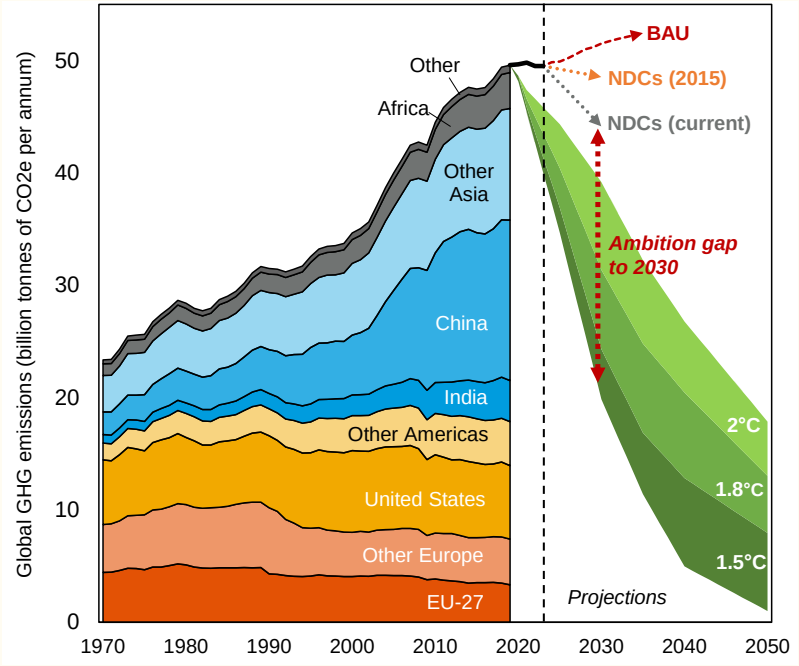
Task to complete

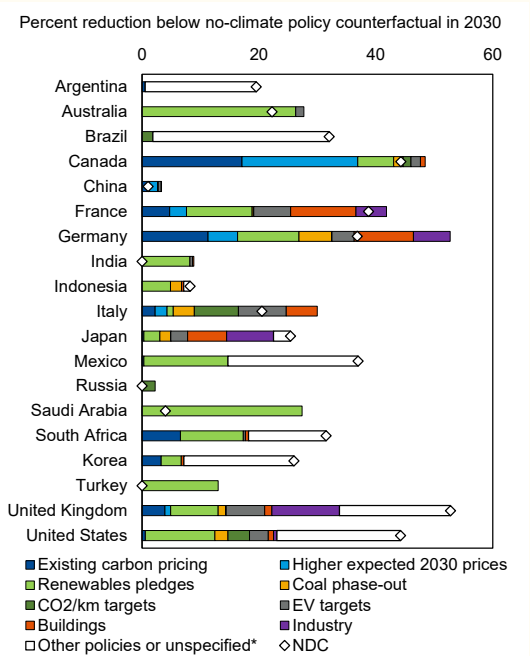
- Complex computation.
- Quality of climate emulators: Folini et al. (2024).
- Long-run impacts.
- Uncertainty:
  1. Precautionary behavior.
  2. Tail events.


Immediate
Climate Impact
Economy
(CO_2 Emissions)
CO_2
Atmosphere
Heat &
CO_2 Transfer
Upper Ocean
Heat &
CO_2 Diffusion
Lower Ocean
Long-term
Climate Impact

Some policy implications: The situation

- The 2015 Paris Agreement required limiting global warming to "well below 2°C."
- Current efforts are far from the goal.
- Particularly serious from China and India.


Global GHG emissions (billion tonnes of CO2e per annum)
0
10
20
30
40
50
1970
1980
1990
2000
2010
2020
2030
2040
2050
Other
Africa
Other Asia
China
India
Other Americas
United States
Other Europe
EU-27
BAU
NDCs (2015)
NDCs (current)
Ambition gap to 2030
2°C
1.8°C
1.5°C
Projections


Percent reduction below no-climate policy counterfactual in 2030
0
20
40
60
Argentina
Australia
Brazil
Canada
China
France
Germany
India
Indonesia
Italy
Japan
Mexico
Russia
Saudi Arabia
South Africa
Korea
Turkey
United Kingdom
United States
Existing carbon pricing
Higher expected 2030 prices
Renewables pledges
Coal phase-out
CO2/km targets
EV targets
Buildings
Industry
Other policies or unspecified*
NDC

The challenges, I

- Large transition costs.

"The worst economic argument ever"

The de-carbonization of the economy will create many "green" jobs, "green" investments,...

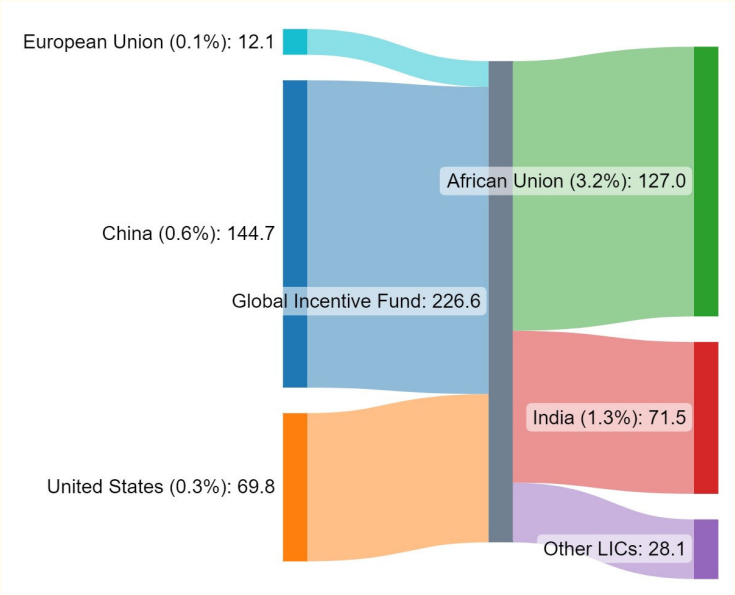
- Every job "created" (or investment required) is a cost for society, not a benefit.
- Which technology would you choose?
  1. A net-zero technology that would generate all the energy we need on earth, with an investment cost of \$1, and that only requires one worker to operate.
  2. A net-zero technology that would generate all the energy we need on earth, with an investment cost of \$1 trillion, and that requires ten million workers to operate?
- More in general, no, de-carbonization will *not* increase economic growth. Let's be honest with the public.

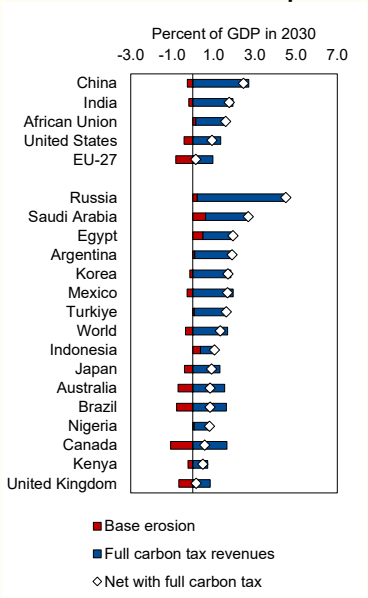

PEACE

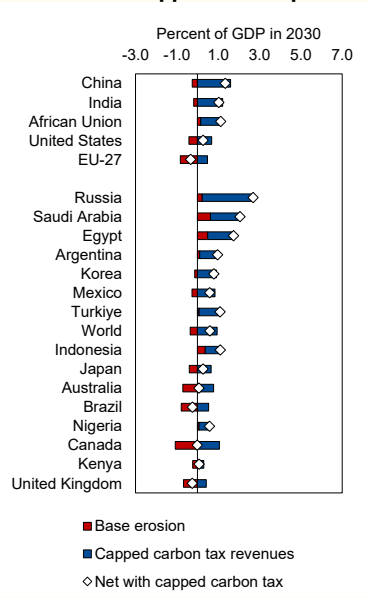
The challenges, II

- Large re-distributional effects: reallocation of production across space and sectors.
- Large free-riders problems.
- Border adjustments.
- Limited fiscal space.
- Geopolitical fragmentation.
- Higher interest rates?

Figure 8. Fiscal Transfers if Revenue of a $25 per ton Global Carbon Tax is Shared on a per-capita basis (2030)

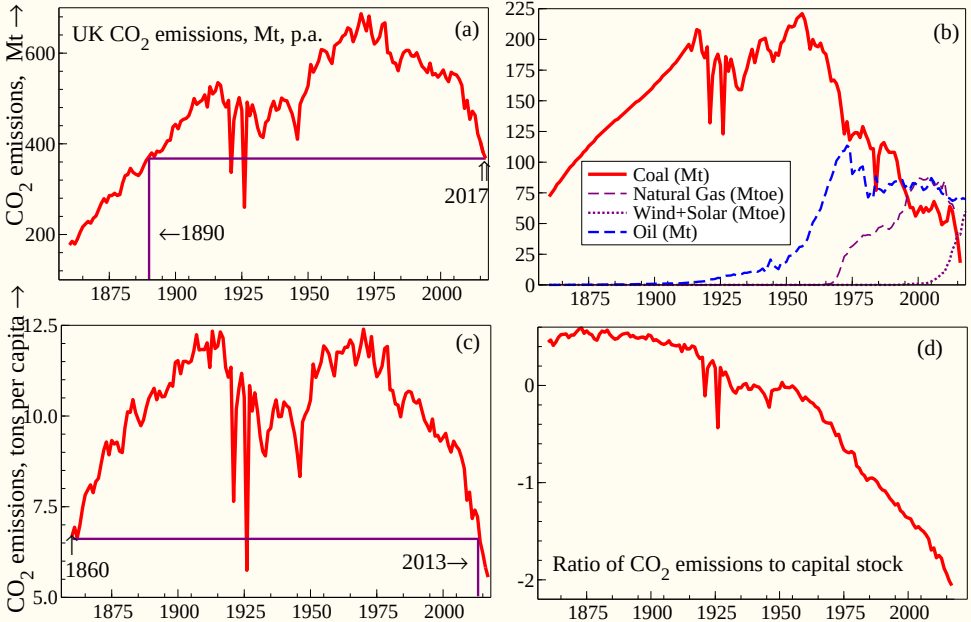


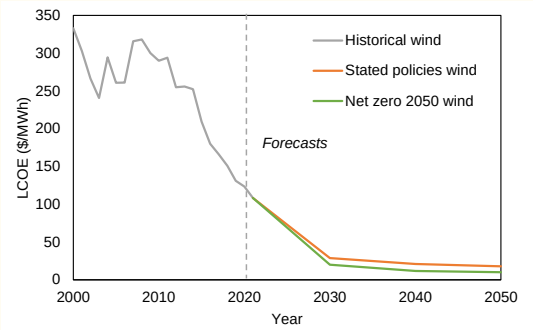

A.
Full carbon price
Percent of GDP in 2030
-3.0
-1.0
1.0
3.0
5.0
7.0
China
India
African Union
United States
EU-27
Russia
Saudi Arabia
Egypt
Argentina
Korea
Mexico
Turkiye
World
Indonesia
Japan
Australia
Brazil
Nigeria
Canada
Kenya
United Kingdom
Base erosion
Full carbon tax revenues
Net with full carbon tax

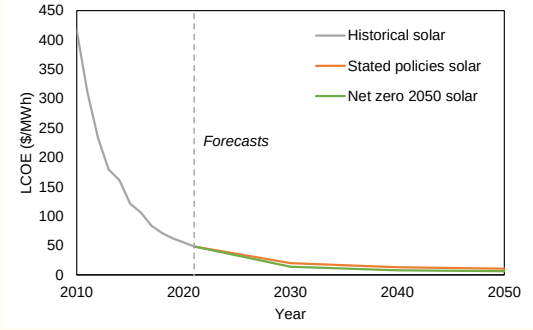

B.
Capped Carbon price
Percent of GDP in 2030
-3.0
-1.0
1.0
3.0
5.0
7.0
China
India
African Union
United States
EU-27
Russia
Saudi Arabia
Egypt
Argentina
Korea
Mexico
Turkiye
World
Indonesia
Japan
Australia
Brazil
Nigeria
Canada
Kenya
United Kingdom
Base erosion
Capped carbon tax revenues
Net with capped carbon tax

The opportunities

- Human ingenuity plus the power of incentives is extremely powerful.
- In fact, technology has progressed faster than expected.
  - Levelized Cost of Energy (LCOE) from state-of-the-art utility-range solar is probably now lower than any alternative ($\approx$ \$24 MWh).
  - Fast developments in syngas and carbon capture.
- Network externalities (van der Ploeg and Venables, 2022).
- Incredibly fast drop in global fertility.

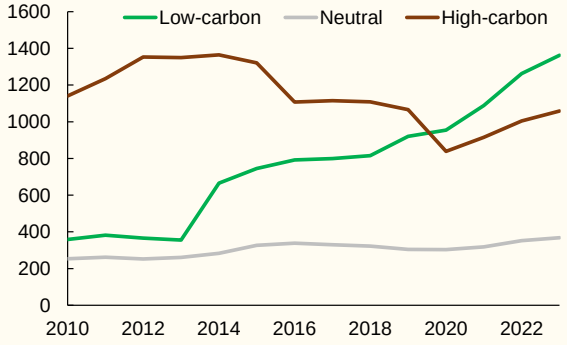

UK CO_2 emissions, Mt, p.a.
(a)
CO_2 emissions, Mt →
←1890
2017
(b)
Coal (Mt)
Natural Gas (Mtoe)
Wind+Solar (Mtoe)
Oil (Mt)
(c)
CO_2 emissions, tons per capita →
1860
2013→
(d)
Ratio of CO_2 emissions to capital stock


350
300
250
200
150
100
50
0
LCOE ($/MWh)
2000
2010
2020
2030
2040
2050
Year
Historical wind
Stated policies wind
Net zero 2050 wind
Forecasts


450
400
350
300
250
200
150
100
50
0
LCOE ($/MWh)
2010
2020
2030
2040
2050
Year
Historical solar
Stated policies solar
Net zero 2050 solar
Forecasts

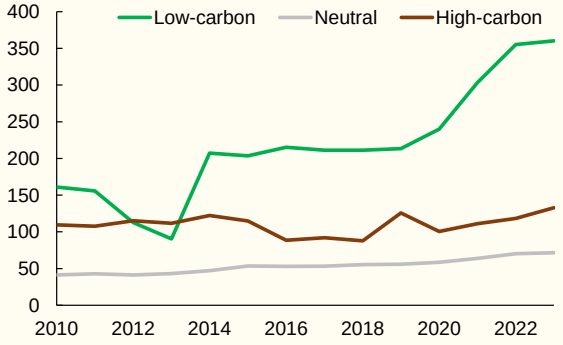
World

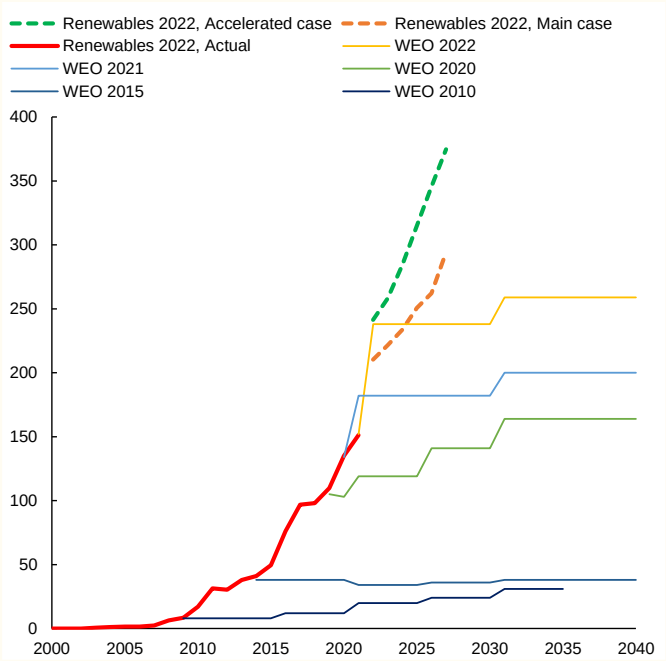
(2021 Billion USD)



Europe

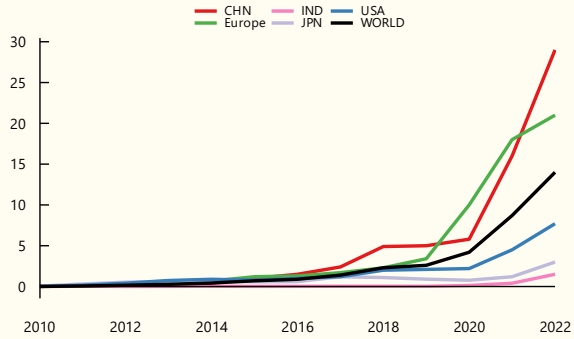
(2021 Billion USD)




Renewables 2022, Accelerated case
Renewables 2022, Main case
Renewables 2022, Actual
WEO 2022
WEO 2021
WEO 2020
WEO 2015
WEO 2010
400
350
300
250
200
150
100
50
0
2000
2005
2010
2015
2020
2025
2030
2035
2040

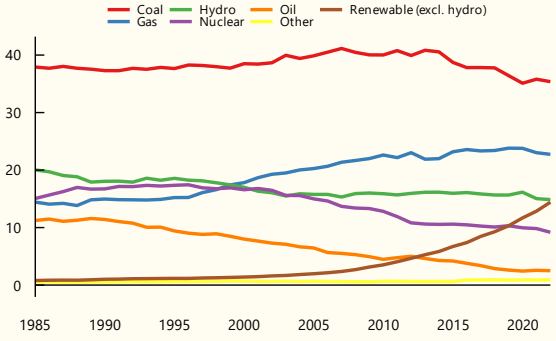
EV car sales

(percent of car sales volume)



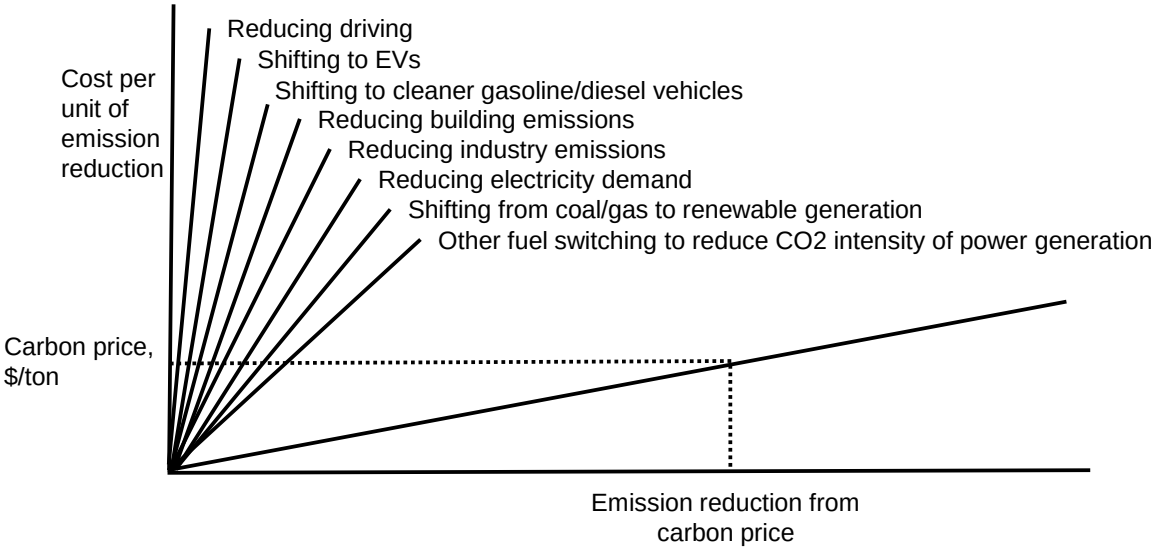
Share of global electricity generation by fuel

(percent)

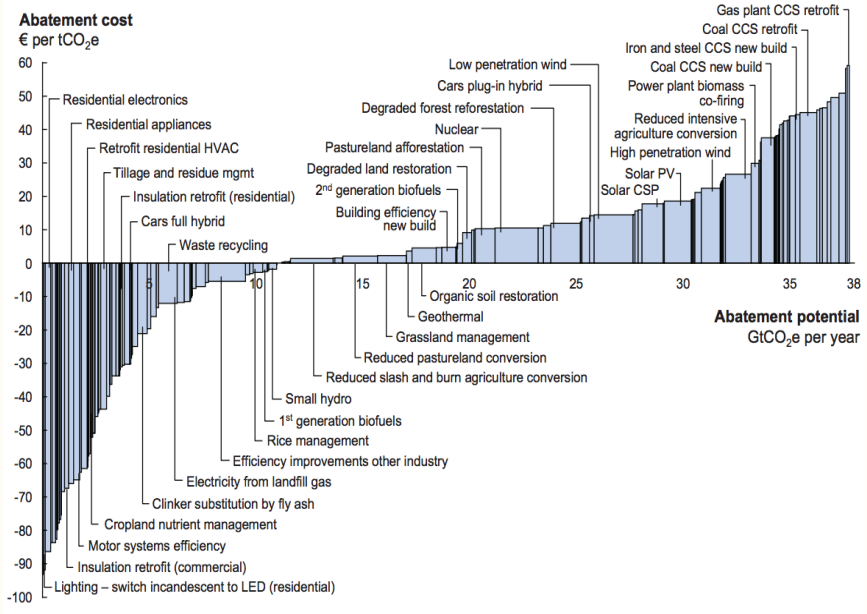


The policy balance, I

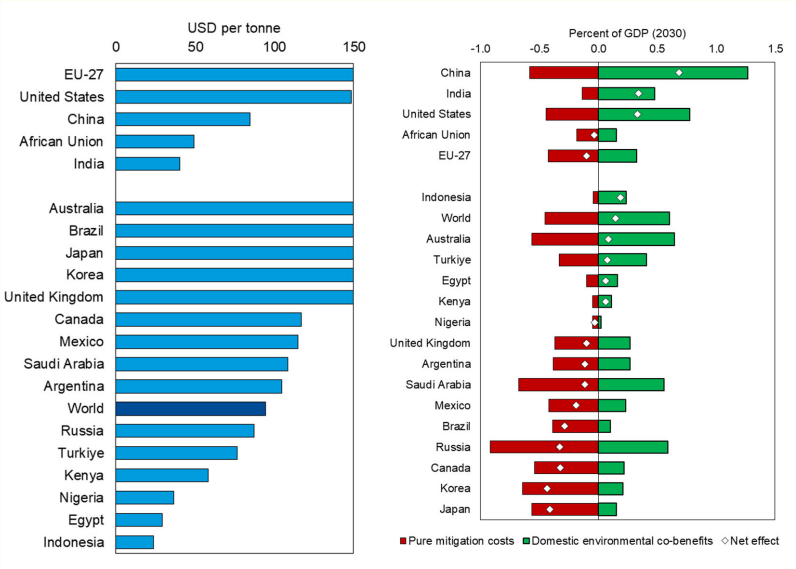
- How do we ensure that the opportunities dominate the challenges?
- Economists have traditionally defended carbon tax and technology-agnostic subsidies.
- Carbon tax: Golosov et al. (2014).
  1. Tax proportional to current GDP, damage parameter, and duration of carbon in the atmosphere.
  2. Independent of technology, future output, alternative energy, carbon capture, uncertainty, ...
  3. Also, rather robust to the mistake of being "pessimistic."
  4. A global carbon tax of around \$100/tc will probably get most of what we need.
  5. But even a carbon tax of around \$25/tc will make a considerable difference.
- See, also, Kotlikoff et al. (2023).


Reducing driving
Shifting to EVs
Shifting to cleaner gasoline/diesel vehicles
Reducing building emissions
Reducing industry emissions
Reducing electricity demand
Shifting from coal/gas to renewable generation
Other fuel switching to reduce CO2 intensity of power generation
Cost per unit of emission reduction
Carbon price, $/ton
Emission reduction from carbon price

Global GHG abatement cost curve beyond business-as-usual – 2030



- **A. Shadow CO_2 Prices (or Incremental Mitigation Costs)**
- **B. Mitigation Costs and Domestic Environmental Co-Benefits**



Source: Black, Parry, and Zhunussova (2023c).

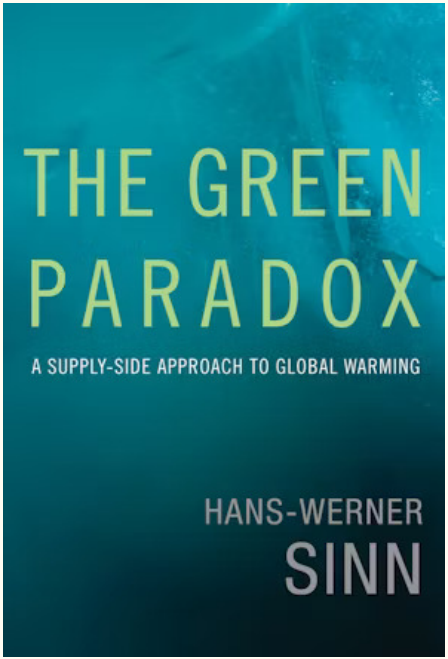
The policy balance, II

- Why technology-agnostic subsidies?
- Technological progress is directed.
- But also unknown.
- Not an idle worry:
  - If we had let nuclear energy develop in the 1970s, we would not be here.
  - Personally, I assess letting the nuclear technology train pass as one of the largest mistakes humanity has ever made.

The policy balance, III

- Political-economy considerations make optimal policies rather difficult to implement.
- Large range of alternative policies:
  1. Reduction emissions.
  2. Mitigation (and geoengineering?).
  3. R&D.
- Unfortunately, most policies selected by governments are too expensive for the results they yield or even counterproductive (e.g., IRA).
- What about Sinn's Green Paradox?


EXIT
MACRON
DEMISSION
POUR NOS
ENFANT


THE GREEN PARADOX
A SUPPLY-SIDE APPROACH TO GLOBAL WARMING
HANS-WERNER SINN

The policy balance, IV

- Most lifestyle changes (e.g., less flying and eating less meat) are at best useless, at worst counterproductive.
- Effect on total net global emissions is minuscule: not even a rounding error!
- Large negative welfare effects and alienate voters.
- Degrowth ideas are not even wrong.
- Nonetheless, better information (e.g., how to re-design houses to reduce electricity consumption with minimal effects on welfare) and solving network effects have proven to be useful.

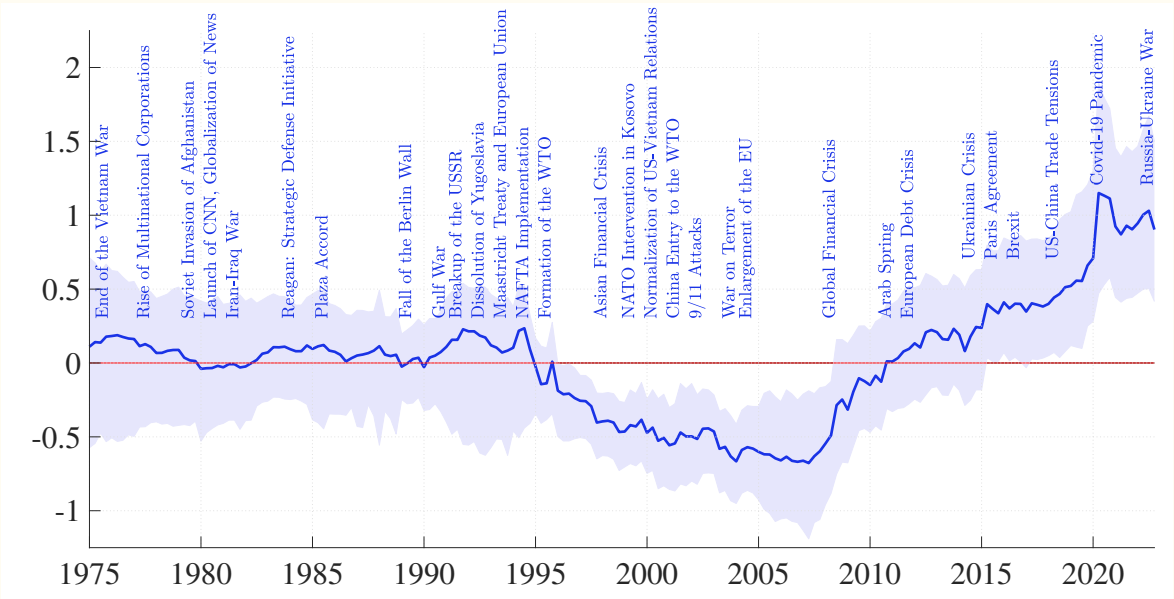
The policy balance, V

- Using monetary policy/central banks/financial regulation for climate change is truly an awful idea.
- Extremely costly: Abiry et al. (2022).
- It would be the end of the independence of central banks.
- There is plenty of capital out there without the need for "green bonds" or similar.
- The same goes for ESG. Most of it is greenwashing, and the rest is kidnapping shareholders for private political goals.
- There is, however, a genuine concern about stranded assets.

Taking stock

- From a purely technological perspective, the problem of climate change has been fixed.
- We have the technology (either already existing or in the short-run pipeline) to achieve net zero at a reasonable cost.
- And, no, we do not need to do crazy things (like all going vegan) or jeopardize monetary policy.
- Now the issue is merely of political economy: who will pay the bill?
- Of course, this is both optimistic and pessimistic.
- Think about Argentina: we perfectly know what has been wrong with it since 1945, and yet, no progress has been made.

Geopolitical fragmentation


End of the Vietnam War
Rise of Multinational Corporations
Soviet Invasion of Afghanistan
Launch of CNN, Globalization of News
Iran-Iraq War
Reagan: Strategic Defense Initiative
Plaza Accord
Fall of the Berlin Wall
Gulf War
Breakup of the USSR
Dissolution of Yugoslavia
Maastricht Treaty and European Union
NAFTA Implementation
Formation of the WTO
Asian Financial Crisis
NATO Intervention in Kosovo
Normalization of US-Vietnam Relations
China Entry to the WTO
9/11 Attacks
War on Terror
Enlargement of the EU
Global Financial Crisis
Arab Spring
European Debt Crisis
Ukrainian Crisis
Paris Agreement
Brexit
US-China Trade Tensions
Covid-19 Pandemic
Russia-Ukraine War
2
1.5
1
0.5
0
-0.5
-1
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

Artificial intelligence

Taking stock

- Effects on long-run growth?
- Effects on wage distribution.
- Effects on capital vs. labor.
- Effects on market power.
- Effects on regulation.
- Existential risk?