

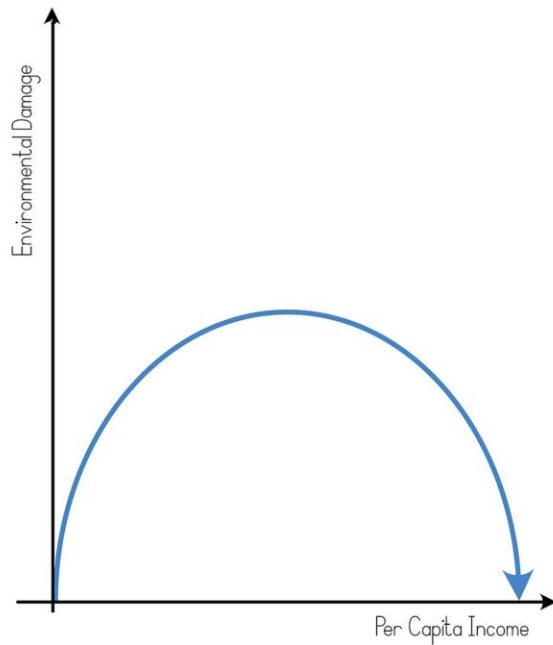
Can Economic Growth Really Solve Climate Change?

or

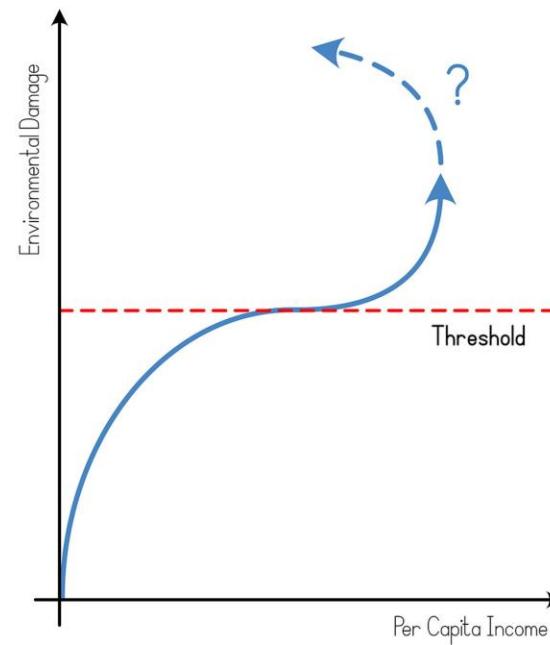
What if the Environmental Kuznets Curve can bend backwards?
And why would economists not have contemplated that possibility?

Duncan Austin
May 2023

Growth fixes problems...



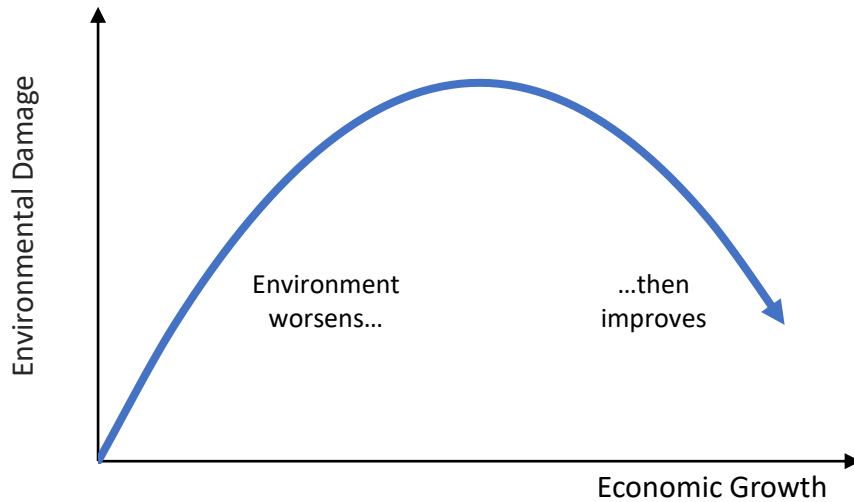
...or growth is the problem?



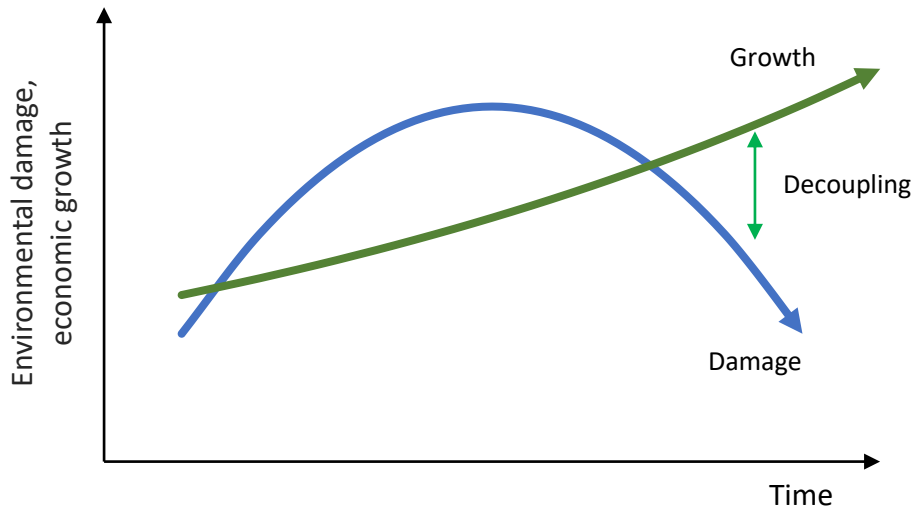
Summary in 6 slides

Summary (1 of 6): “Growth is the solution”?

The Environmental Kuznets Curve (EKC)...

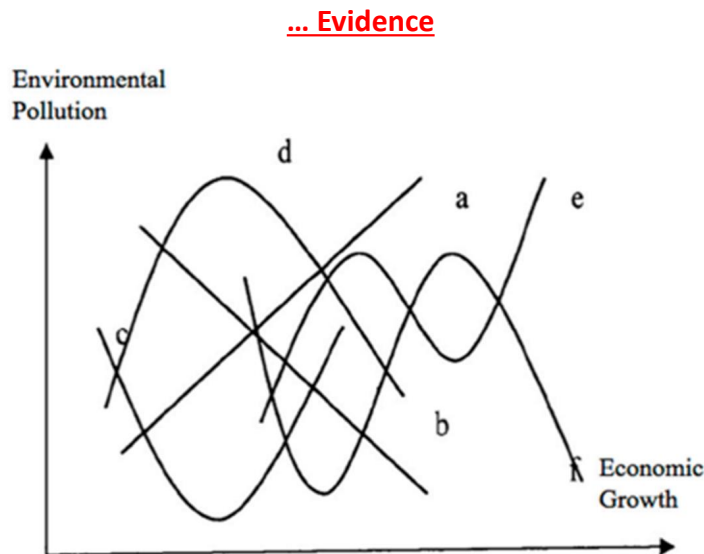
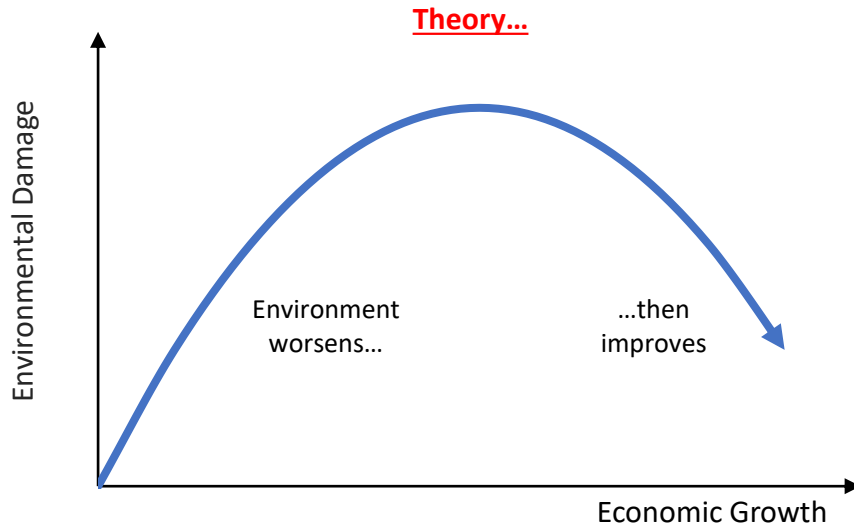


...and in 'decoupling' form



- **All sustainability reflections inevitably wend their way back to the issue of economic growth, yet public debate continues to shy away from this reality.**
- The central question: is economic growth good or bad for the environment? And, if the latter, what are the implications for how to address environmental and development challenges?
- For obvious reasons, the prevailing attitude is that ‘growth is the solution’, as demonstrated by enthusiasm for ‘green growth’ political goals and ‘win-win’ ESG strategies.
- As the science that has formalized and promoted ‘economic growth’, economics must have a theory that encourages this attitude.
- It does. It is called the Environmental Kuznets Curve hypothesis (EKC, top diagram), often presented in generalist media as the ‘decoupling’ hypothesis (bottom). The EKC posits that growth may initially increase environmental damage but will then reliably reduce it.
- **Alas, the EKC hypothesis is not reassuring at all.**
 - The empirical problem is that the evidence base for the EKC, – now comprising hundreds of studies – is very mixed.
 - The conceptual problem is that the EKC fails to recognize thresholds and ‘tipping points’ that ecologists are at pains to point out constitute the defining feature of global ecological challenges.

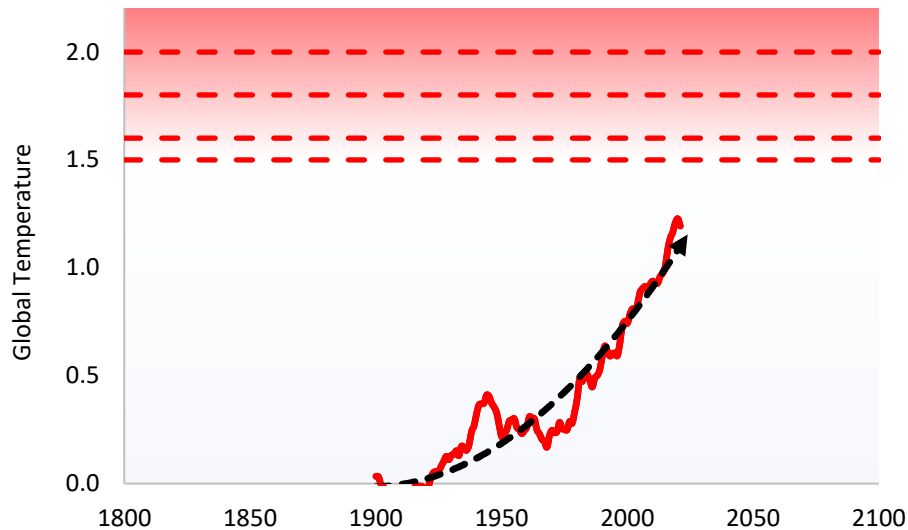
Summary (2 of 6): Empirical evidence for the EKC is weak



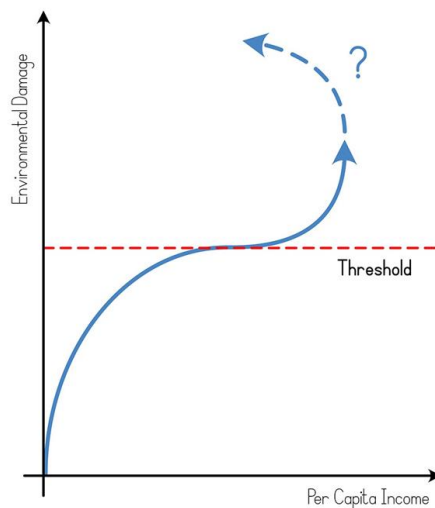
- The empirical problem is that meta-analyses of hundreds of EKC studies find very mixed evidence for whether the EKC holds or not.
- A typical conclusion: “...**absence of consensus** throughout the EKC literature on the existence and shape of the curve...”
- Roughly half of EKC research studies do not support the theory.
- Review articles routinely conclude that the EKC can take one of six basic forms (bottom diagram).
- Similar conclusions are found in reviews of ‘decoupling’ studies.
- An important sub-finding is that the EKC hypothesis seems to be weaker for global long-lagged problems (notably GHG emissions) than for more localized, shorter-lagged problems such as air and water quality, where it was first hypothesized.
- A major flaw in the invocation of the EKC, then, is in the casual extrapolation of success with some ‘short loop’ problems to ‘long loop’ – and still ongoing – global climate and biodiversity problems.

Summary (3 of 6): The EKC dismisses tipping points

Global Temperature with Tipping Points



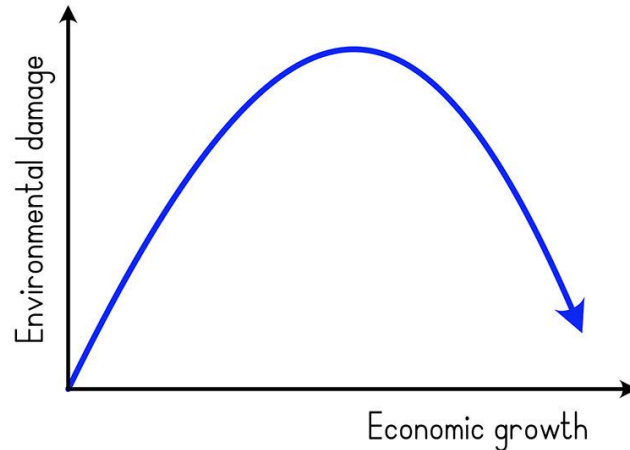
A Backward-Bending EKC?



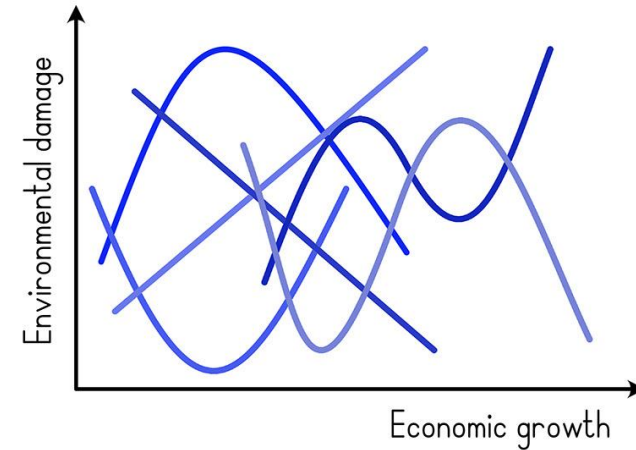
- The conceptual problem is that the EKC fails to recognize tipping points or thresholds that ecologists increasingly point out define global climate and biodiversity challenges.
- E.g., the core dynamic of climate change is that still-rising global temperatures will soon reach levels expected to trigger irreversible runaway changes in the climate system (top). Individual tipping points may interact to create a ‘tipping cascade’, in which heating dynamics reinforce each other.
- Adding thresholds to the space in which an EKC is plotted – i.e. *contextualizing the economy in biophysical reality!* – raises the possibility of the EKC bending backwards should it cross irreversible thresholds(bottom).
- Above such thresholds, causation reverses! The economy no longer drives environmental damage, but rather self-sustaining environmental dynamics start to delimit the economy.
- That this seems not to have occurred to economists betrays the ‘sort of thinking’ that economics has been – too abstract and decontextualized to do justice to global ecological dynamics characterized by non-linearities.
- There is, then, a major disconnect between scientists’ rising concerns about tipping points and economists persisting with early 1990s frameworks that dismiss tipping points by assumption. It is where the ball is being dropped between our understanding of ecological problems and the decision-making frameworks that guide practical response. Economists have not internalized what scientists are most worried about.

Summary (4 of 6): From 'inverted U' to 'backwards C'

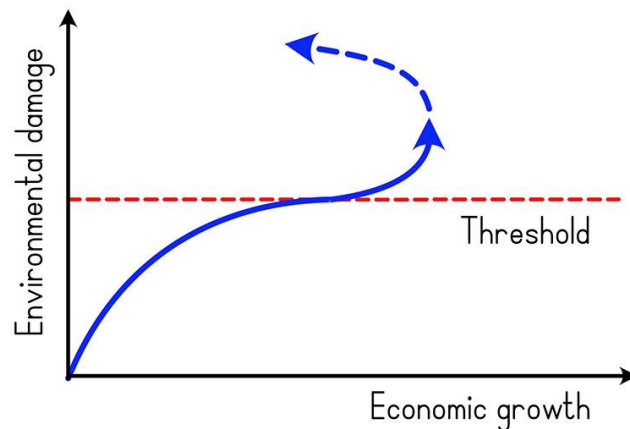
1 The EKC is economics' hypothesis that growth typically causes environmental damage to start before reliably reducing damage subsequently. Hence 'growth is the solution'! 'Decoupling' will save the day!



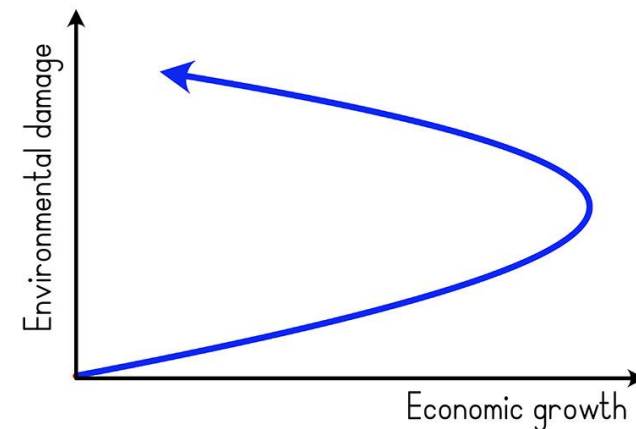
2 But the empirical support is very weak. The meta-conclusion from thousands of studies is that the EKC reliably takes one of these 6 forms...



3 Worse, EKC conventions deny the possibility of climate and ecological 'tipping points' that scientists are frantically pointing out define global challenges and which may induce a backward-bending curve.



4 Indeed, researchers who investigate the collapse of complex societies such as the Maya and Rapa Nui habitually plot not an inverted 'U' but a backwards 'C', as growth induces ecological overshoot and then decline.

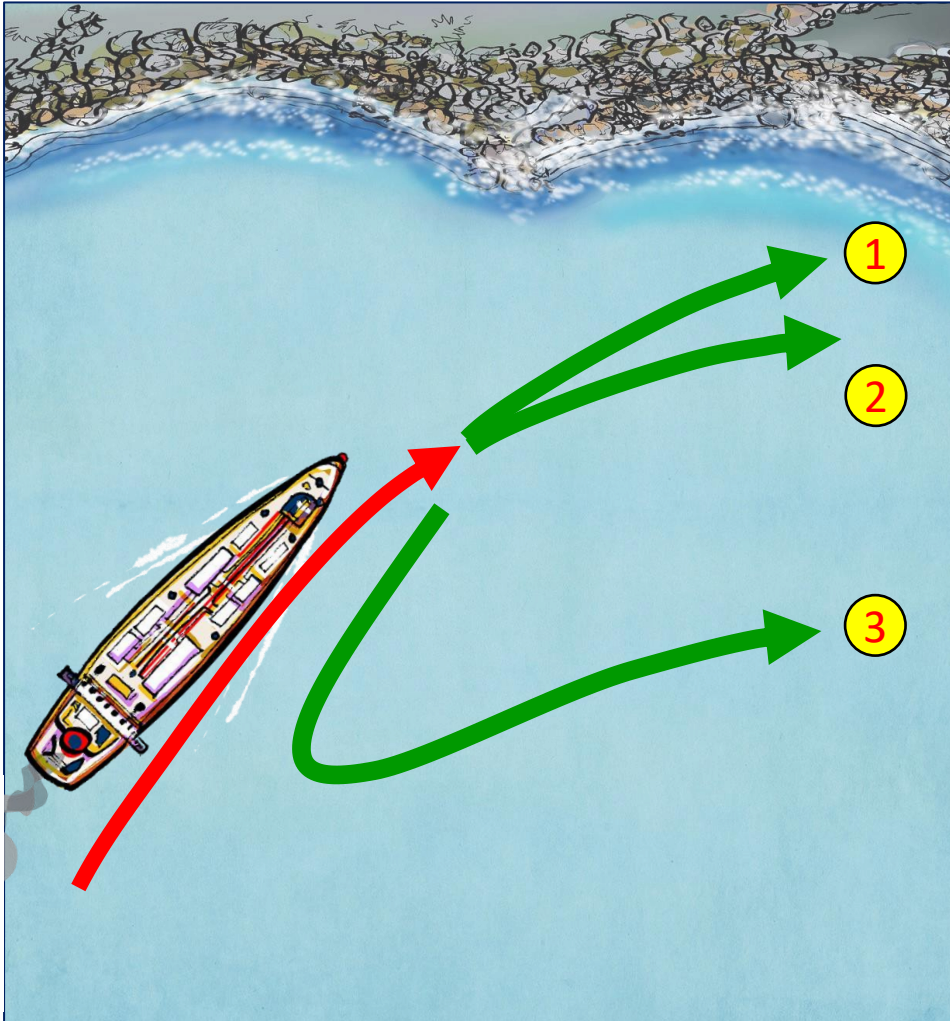


Summary (5 of 6): Why does this matter?



- The real-world consequence is that ‘win-win’ and ‘green growth’ proponents are relying on a *hypothesis* about the restorative power of economic growth at odds with both economics’ own evidence and scientific conceptions of the challenge.
- Notwithstanding empirical and conceptual problems, the comforting notions the EKC invites continue to be uncritically propagated by high-profile individuals and media, fostering unwarranted complacency about progress on sustainability and suppressing much-needed explicit debate about the overall effects of economic growth.
- Research into ‘degrowth’, ‘post-growth’, ‘wellbeing economies’, etc., continues to be marginalized in political debate and the boardroom.
- The presumption that ‘growth is the solution’ falsely insulates mainstream economics decision-making, i.e. monetary and fiscal policy, from its very real biophysical consequences.
- Certainly, challenging growth raises very difficult questions:
 - The modern world is now profoundly self-organized around the idea of uninterrupted economic growth.
 - Developing countries, in particular, though they justly point out that global ecological problems have been triggered by developed country growth, might reasonably worry that post-growth or degrowth ideas that took hold in developed countries might be unfairly and prematurely imposed on them.
- But the fact that challenging growth raises difficult questions cannot justify turning a blind eye to biophysical reality.

Summary (6 of 6): A 'turning' or 'bend the curve' problem



bothbrainsrequired.com

- The reality of tipping points means that climate change and other global ecological challenges have the basic form of 'turning' or 'bend the curve' problems, under constraints of time and ecological leeway.
- There are 3 meta-strategies available:
 - 1. Voluntary market-led growth ('win-win')**
 - Turning mechanism: voluntary technological substitution under existing prices and policies.
 - Challenge: is it working fast enough?
 - 2. Government-directed growth ('spend to win')**
 - Turning mechanism: market technological substitution accelerated by 'carrots' of subsidies, tax credits, direct investment etc.
 - Challenge: who pays for the additional cost?
 - 3. Government-directed degrowth ('buy time and space to win')**
 - Turning mechanism: technological substitution accelerated and complemented by behaviour change, through 'sticks' of higher carbon prices, environmental regulations, bans, etc.
 - Challenge: who bears costs of foregone growth (even if baseline expectations are becoming unrealistic) and how can they be compensated?
- Strategies 1 and 2 share a 'slippage' problem in that their endorsement of growth as a general strategy licences much economic activity that makes no contribution at all to a sustainable future and, indeed, is detrimental.

Contents

1. [The sustainability debate always comes back to growth...](#)
2. [Environmental Kuznets Curve \(EKC\) basics](#)
3. ['Decoupling': the EKC by another name \(and slightly different form\)](#)
4. [What is the evidence for the EKC?](#)
5. [Conceptual problems of the EKC model... or why the EKC may be able to bend backwards](#)
6. [OK, but is there any evidence for a backward-bending EKC?](#)
7. [High-profile misuse of the EKC feeds unwarranted complacency about our progress on sustainability](#)
8. [Can we learn and turn fast enough?](#)
9. [More realistic curves? The 'S' curves of restructurings](#)
10. [The concealed meta-strategies of ESG and carbon taxes](#)
11. [We have chained ourselves to growth in a way that only moral leadership can overcome.](#)

[Appendix 1: how the EKC exemplifies the deeper unsustainability of 'economic thinking', which has nonetheless profoundly shaped modern behaviour](#)

[Appendix 2: what are we 'growing' anyway when we 'grow' economically?](#)

[References](#)

Readers already familiar with the EKC and decoupling hypotheses may choose to start at Section 4.

Note on Format and Background

Why this format?

This format is the best solution for two challenges:

1. The EKC at the heart of the presentation – and systems concepts offered as an antidote to EKC thinking – both lend themselves to graphical exposition for which slides are a better format than an essay or journal article.
2. Leaning on diagrams and pictures has the further benefit of making the ideas as accessible as possible – needing no prior knowledge of e.g. ‘Environmental Kuznets Curve’ – which seems appropriate given the urgent nature of the issue.

References are noted on relevant slides with full details at end of document.

Personal Background

28-year career in the field of environmental economics and sustainable investing.

Academic

Philosophy, Politics, Economics (BA, 1994)

Environmental Economics (MSc, 1996)

Non-profit

Senior Economist at World Resources Institute (1996-2004)

For-profit


Partner at Generation Investment Management (2004-2018)

Independent

Independent researcher and writer since 2019.

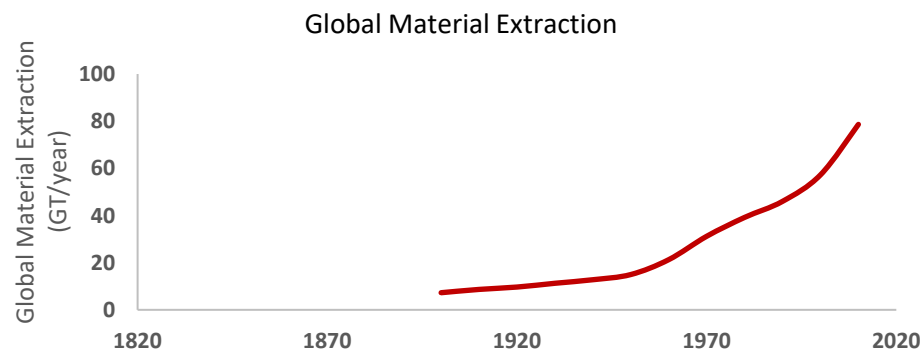
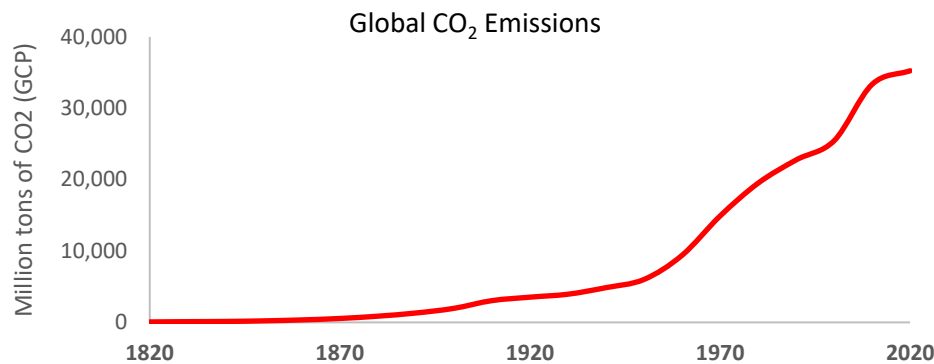
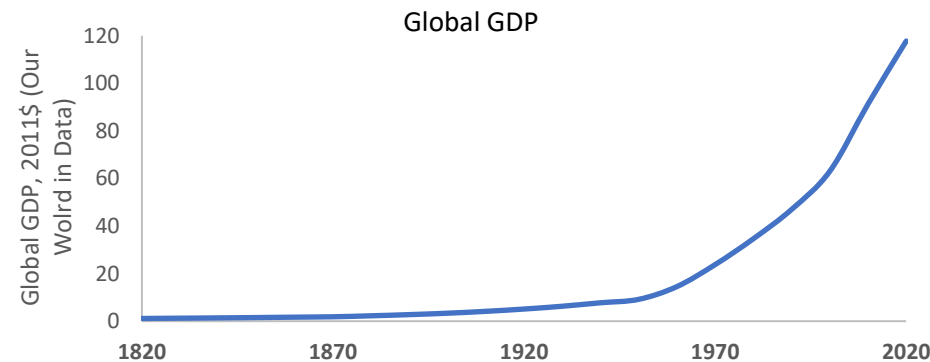
More details available here:

www.bothbrainsrequired.com



**1. The sustainability debate
always comes back to growth...**

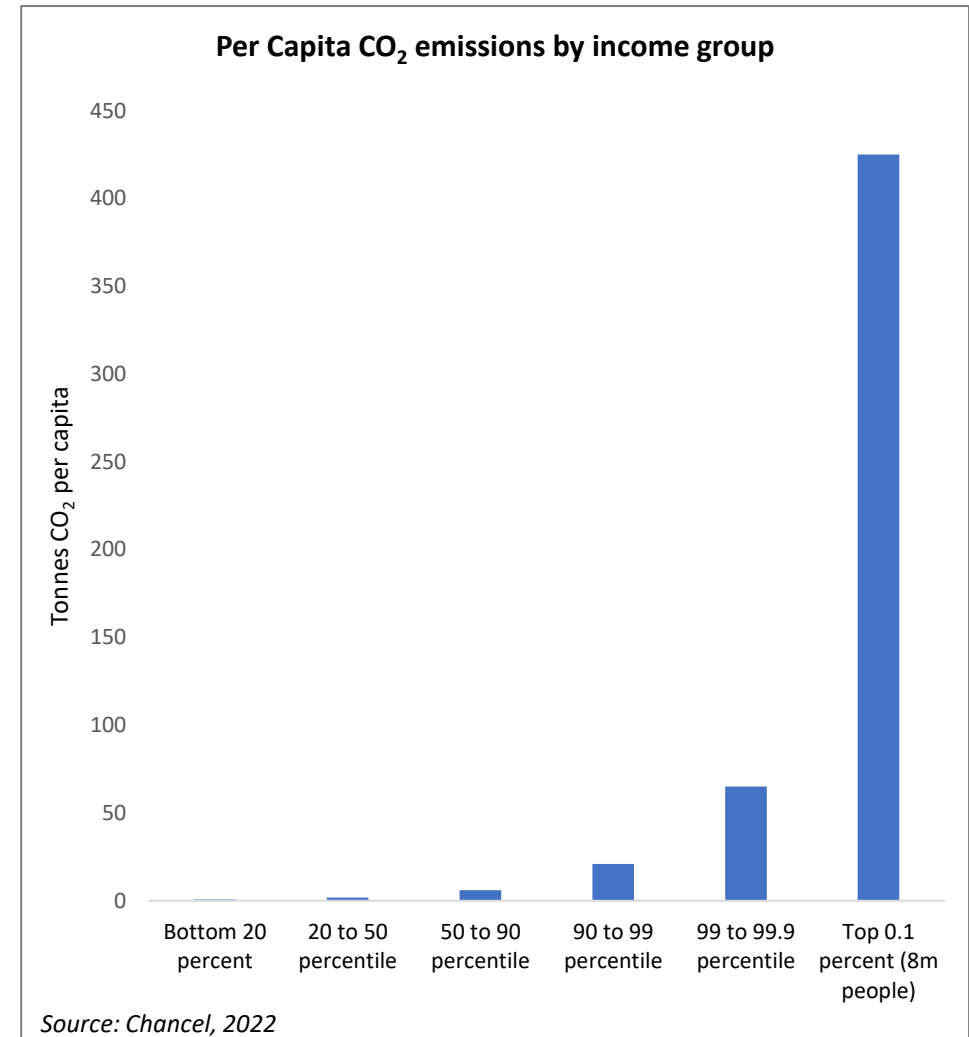
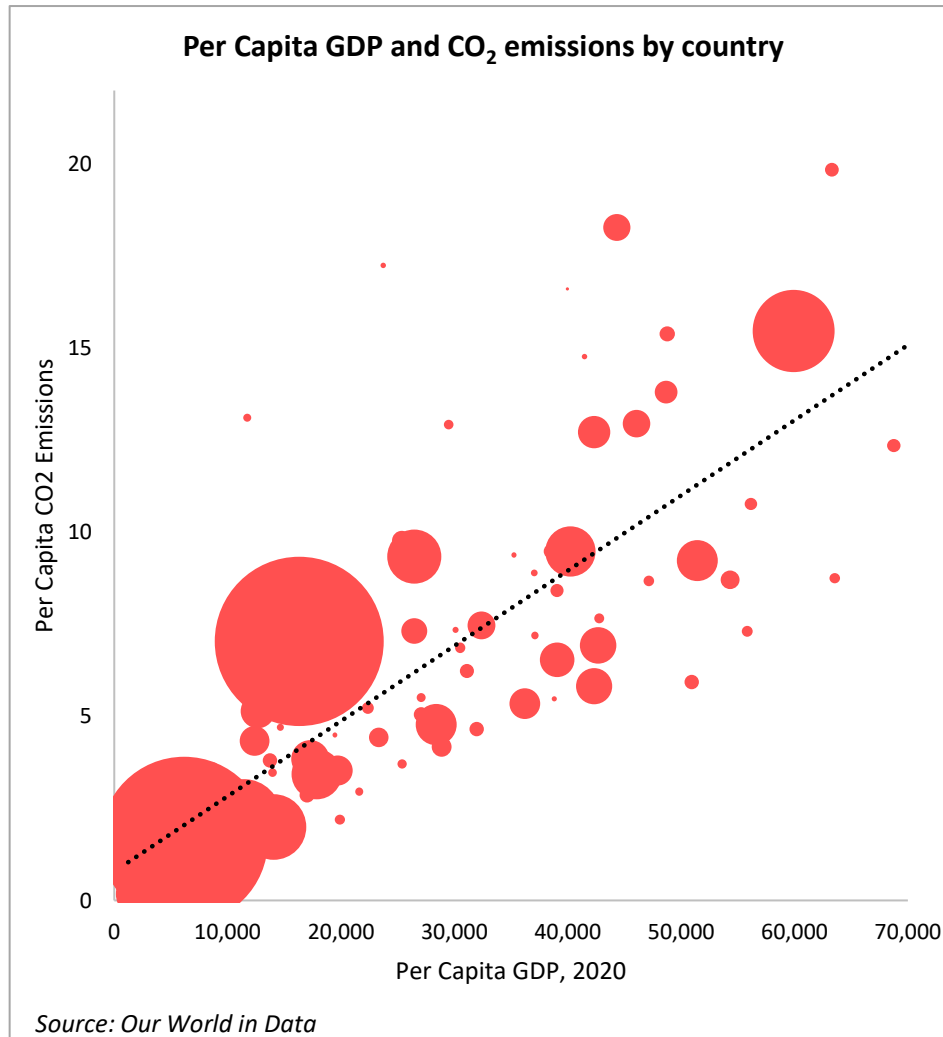
It always comes back to growth...



- All sustainability reflections invariably wend their way back to the clash at the heart of it all: the tension between economic growth and environmental protection.
- **Is economic growth good for the environment or bad?**
- The tension repeats in different forms at different scales:
- **Governments** are wary of pushing for environmental policies that might harm GDP growth.
- **Companies** want to be sustainable but not at the expense of profit maximization – on pain of activist takeover, breach of fiduciary duty, or foregone stock-based compensation.
- **Investors** want their 'ESG' funds to outperform financially to retain clients, assets under management (AUM) and to boost fees.
- **Savers** want their savings and pensions balance to increase, but also a broader sense of a safe future for them and their descendants.
- **Individuals** want to earn and spend to secure comfortable lives for themselves and family etc., even if we must increasingly suppress the thought that all that 'earning and spending' might add up to the problem...
- **The clash between economic growth and environmental protection remains the unavoidable crux of the matter.**

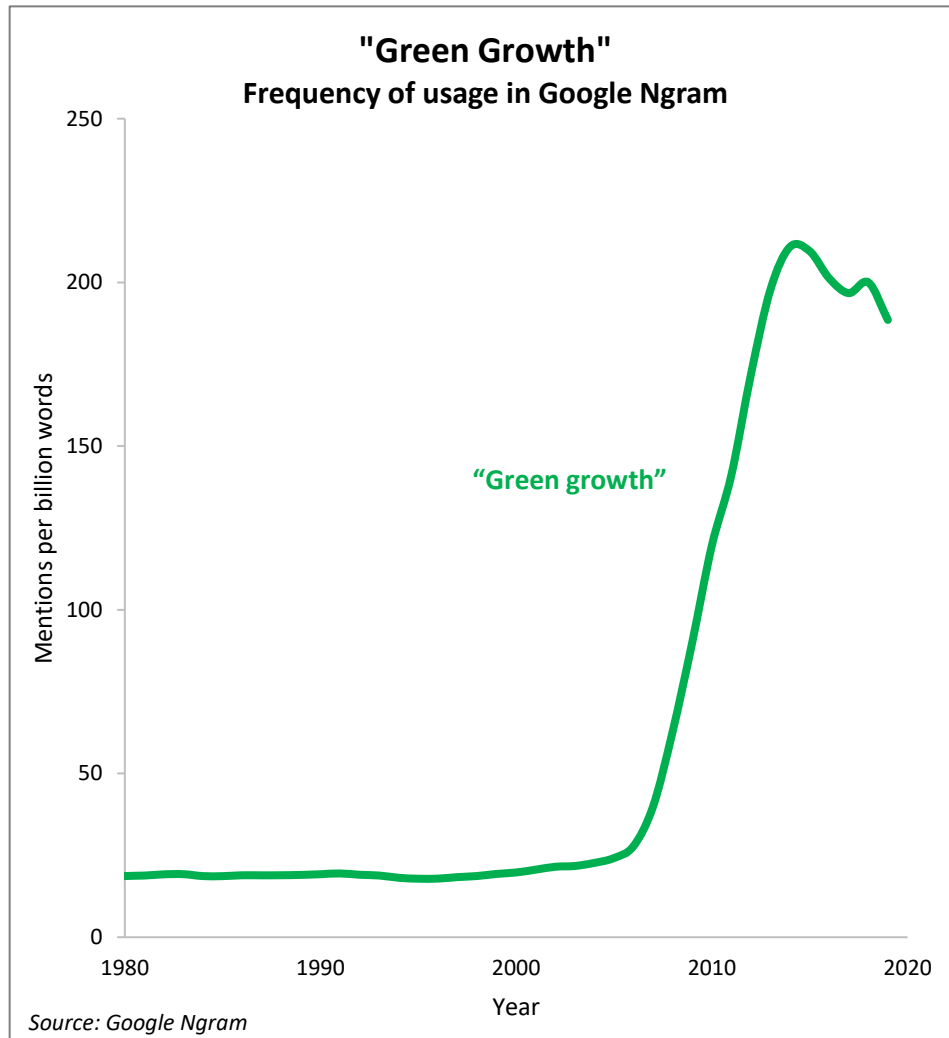
Strong correlations between economic wealth and environmental footprint

There are plainly strong correlations between economic growth and GHG emissions. Wealthier countries (left) and wealthier individuals (right) emit considerably more. 'Correlation does not imply causation' we are always cautioned, but of course in many cases it is the tell-tale signal.



Growth hailed as the answer

Notwithstanding correlations, growth is now widely seen as the solution to climate change. We just need 'green growth', as has been expressly articulated over the last 20 years and as reassuringly defended by high-profile economists and media.



Paul Krugman

OPINION

Wonking Out: Why Growth Can Be Green

Feb. 17, 2023



Illustration by Sam Whitney/The New York Times; photographs by Максим Шмаков and DoctorPic/Getty Images

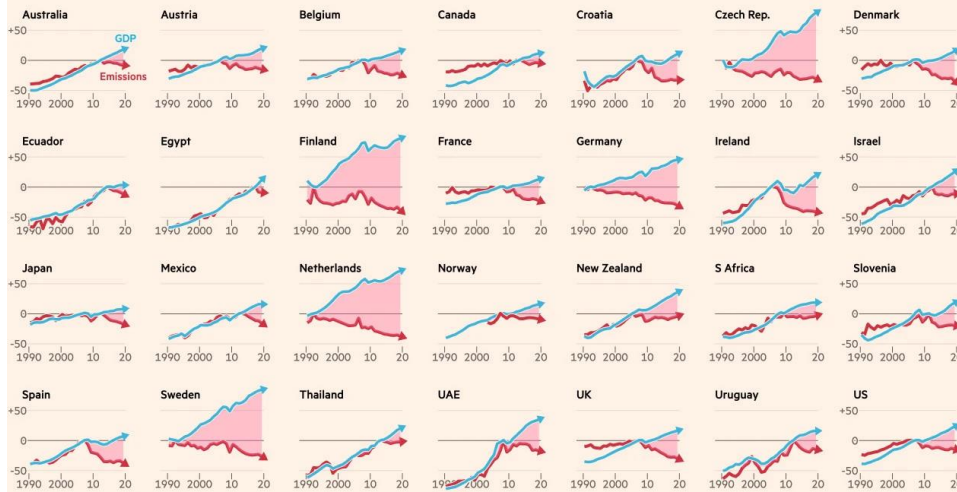
Source: New York Times, March 2023 - DRAFT

'Decoupling' narrative

A reassuring 'decoupling' narrative claims that economic growth need not cause environmental damage in the future.

Dozens of countries are now seeing a steady decline in CO2 emissions alongside economic growth

Recent trend in emissions and GDP, expressed as % change since divergence began



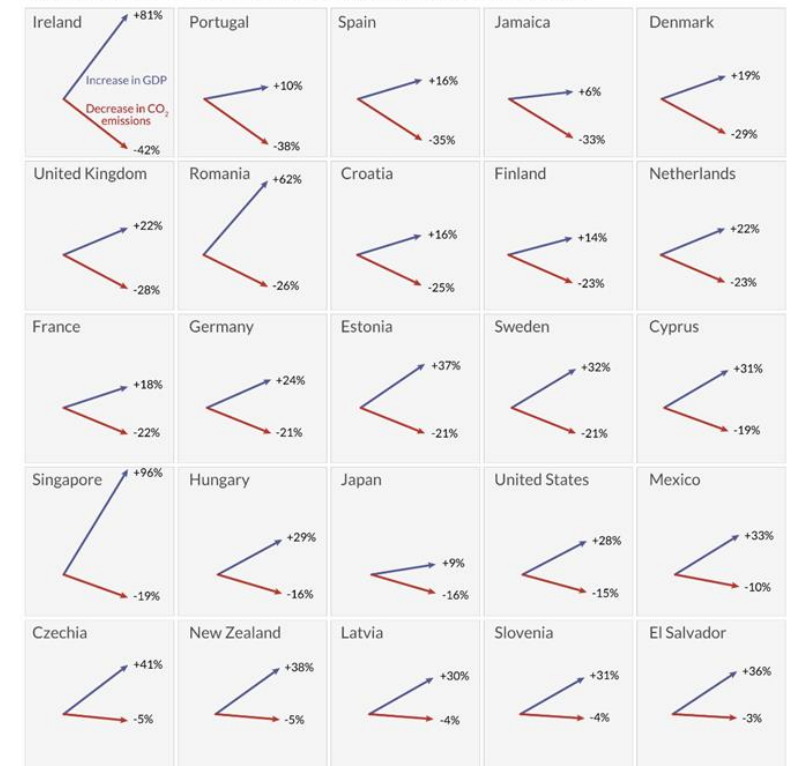
*All monetary values in constant 2017 PPPs. Emissions adjusted for offshoring of carbon-intensive products consumed domestically
 Source: FT analysis of data from Gapminder, Our World in Data, World Bank
 FT graphic: John Burn-Murdoch / @burnmurdoch
 © FT

Source: Financial Times;
 28 countries representing 29% of global CO₂ emissions and 16% of global population.

Decoupling: Countries that achieved economic growth while reducing CO₂ emissions, 2005-19



Emissions are adjusted for trade. This means that CO₂ emissions caused in the production of imported goods are added to its domestic emissions – and for goods that are exported the emissions are subtracted.

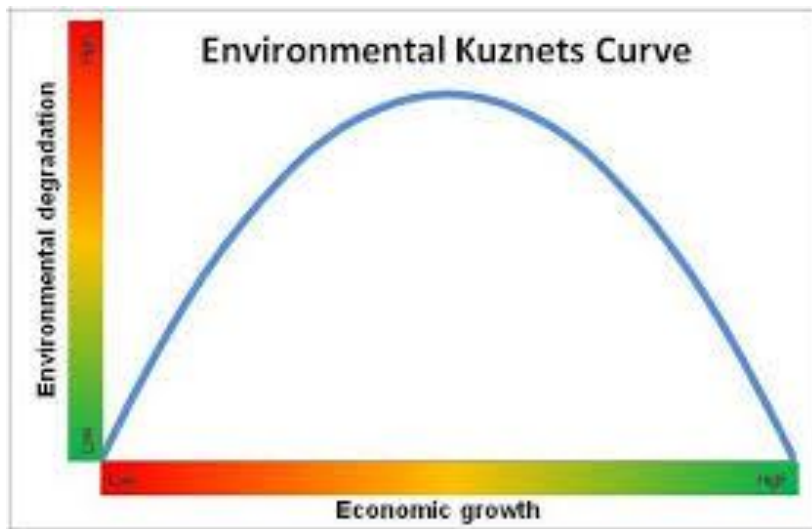


Data: Global Carbon Project & World Bank. There are more than these 25 countries that achieved the same. OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser

Source: Our World in Data;
 25 countries representing 24% of global CO₂ emissions and 12% of global population.

There must be a good theory, right?



It is obvious why people wish growth to be the solution, but for that wish to be well-founded, economics – as the discipline that has elevated and formalized the idea that societies should organize around growth – must have a theory about how growth can solve sustainability problems.

It does!

It is called the Environmental Kuznets Curve (EKC) hypothesis (sometimes presented as ‘decoupling’).

It offers little comfort.

It suffers from multiple problems:

- Roughly half the empirical evidence doesn’t support the theory.
- It ignores the possibility of irreversible tipping points, which increasingly define climate and biodiversity challenges.
- It is conceptually flawed in failing to appreciate two-way causation between economy and environment.

Notwithstanding these failures, the EKC theory and ‘decoupling’ depictions are being uncritically propagated to inspire confidence that economic growth can solve global sustainability problems.

This feeds an unwarranted complacency that defuses urgency for a serious debate about the potential dangers of economic growth.

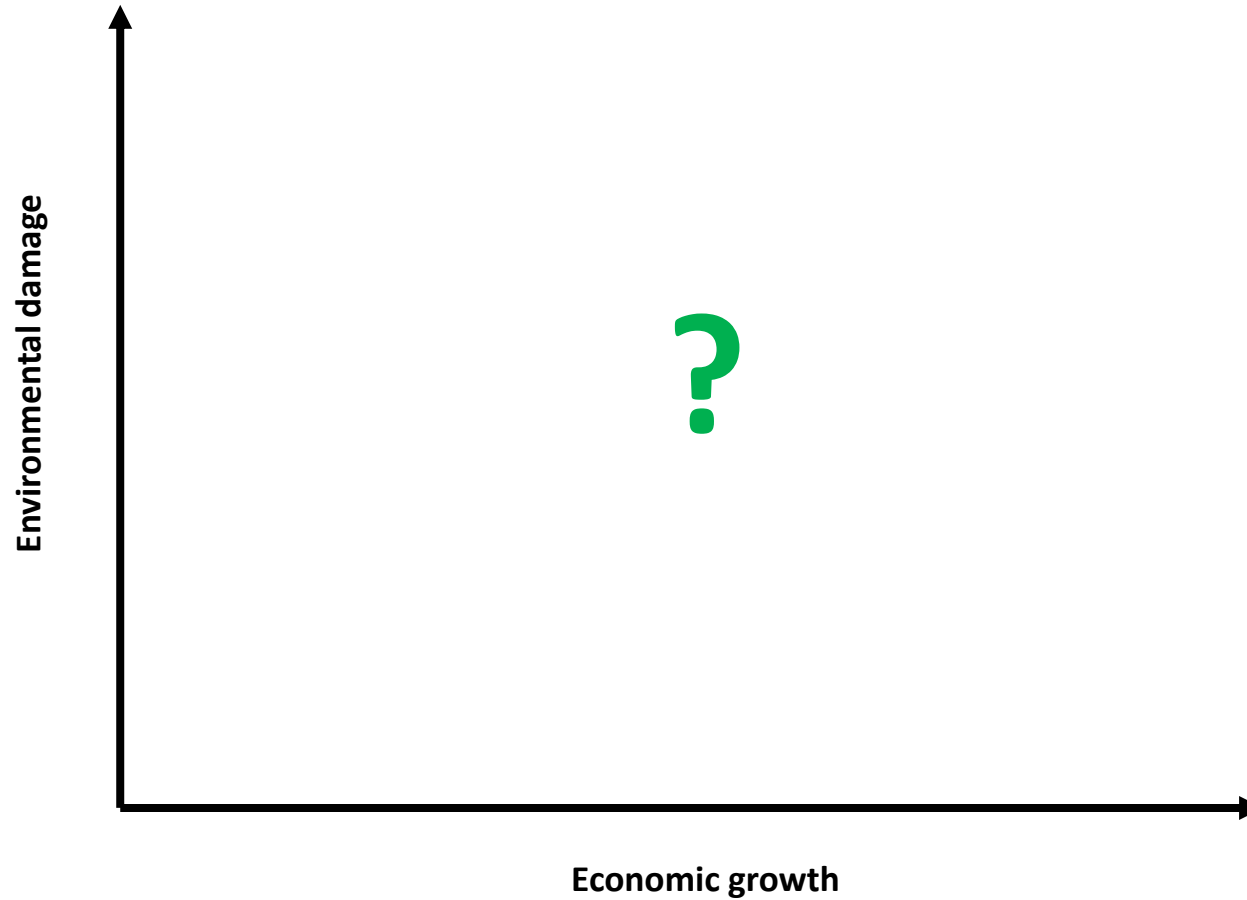
It leads to widespread support for CSR- and ESG-style business and investment strategies and ‘green growth’ economic policies that, as growth-reinforcing strategies, are every day becoming more problems than solutions.

In contrast, growth-slowing strategies that might powerfully be applied in wealthier, developed countries that are the main drivers of global ecological problems, continue to be marginalized and dismissed.

2. Environmental Kuznets Curve (EKC) basics

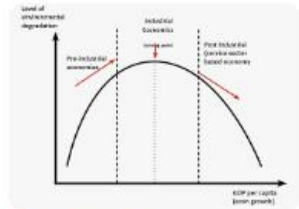
The EKC space

Economists explore the relationship between economic growth and the environment in the familiar X-Y space, which seems reasonable enough on first inspection.

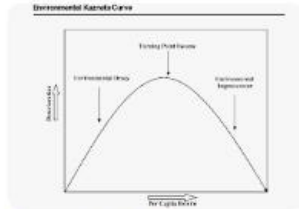


Google Image Search: 'Environmental Kuznets Curve' (1)

An online image search quickly reveals the conventional inverted U-shape of the EKC.



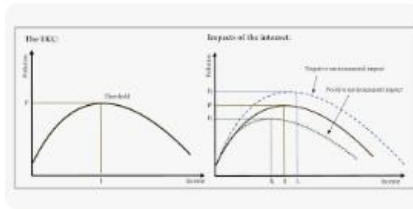
Economics Help
Environmental Kuznets curve - Economics ...



The Earthbound Report
The Environmental Kuznets Curve - The ...



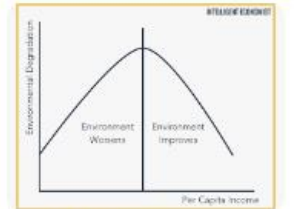
Wikipedia
Kuznets curve - Wikipedia



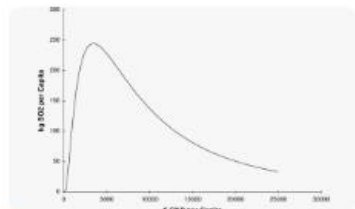
MDPI
Environmental Kuznets Curve ...



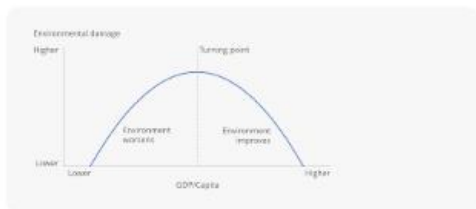
ScienceDirect.com
Environmental Kuznets curve ...



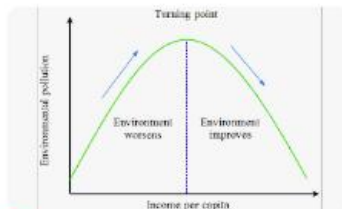
Intelligent Economist
The Environmental Kuznets Curve ...



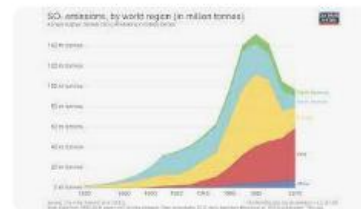
ScienceDirect.com
Environmental Kuznets Curve - an ...



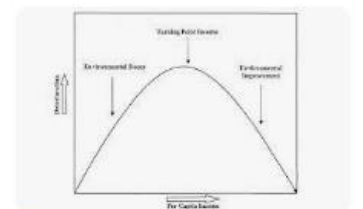
Office for National Statistics
economic growth from carbon emissions ...



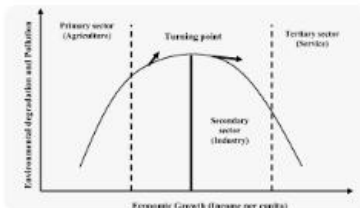
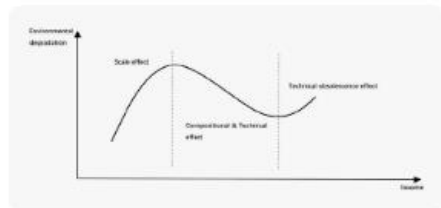
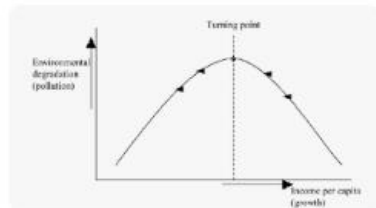
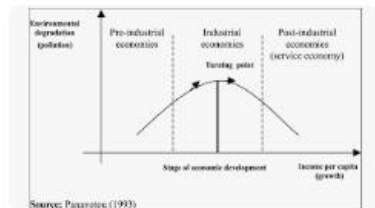
ResearchGate
Environmental Kuznets curve | Download ...



International Growth Centre
Environmental Kuznets curve ...

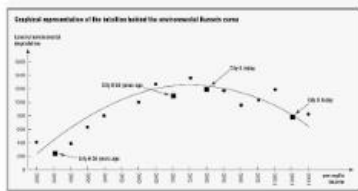


The Property and Environment Research Center
Mexico and the Environmental Kuznets Curve

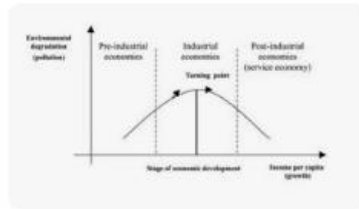


Google Image Search: 'Environmental Kuznets Curve' (2)

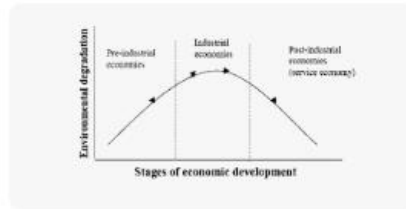
Endless pages of the same basic shape confirm widespread dissemination of the concept.



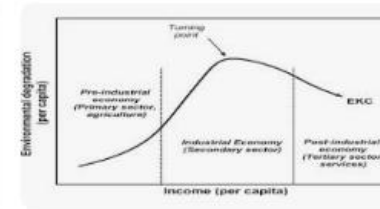
what-when-how - In Depth Tutorials and Informati...
ENVIRONMENTAL KUZNETS CURVES (Social ...



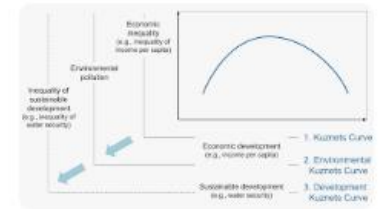
Quizlet
Environmental Kuznets Curve Flashcards ...



ResearchGate
The Environmental Kuznets Curve ...



ScienceDirect.com
The Environmental Kuznets Curve (EKC ...



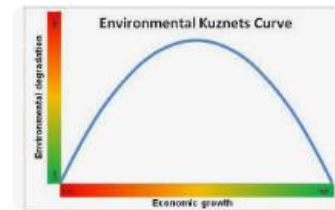
Nature
Inequality of household water security ...



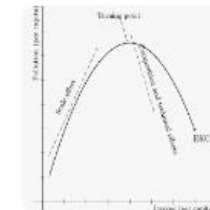
Springer Link
environmental Kuznets curve ...

Related searches

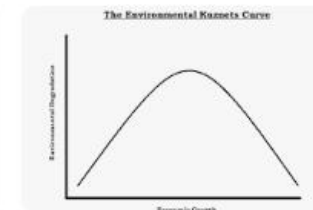
- j curve
- sustainable development
- environmental degradation



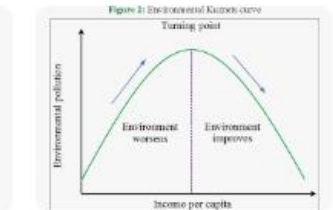
Vskills
Environmental Kuznets Curve



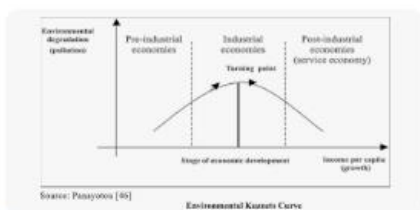
ResearchGate
Environmental Kuznets curve...



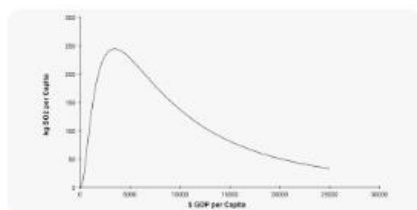
CORE
Environmental Kuznets Curve ...



Semantic Scholar
Environmental Kuznets Curve ...



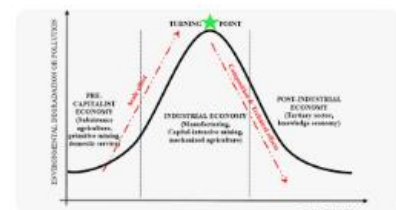
ScienceDirect.com



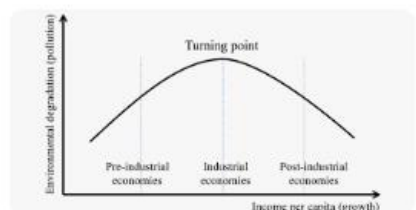
Oxford Research Encyclopedias



The Green Market Oracle



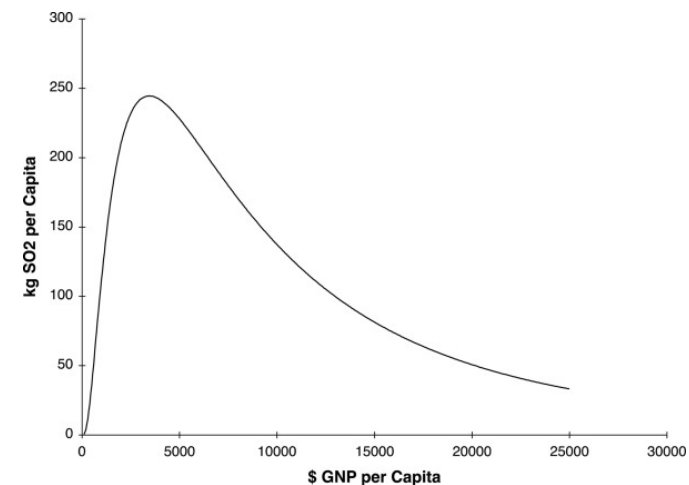
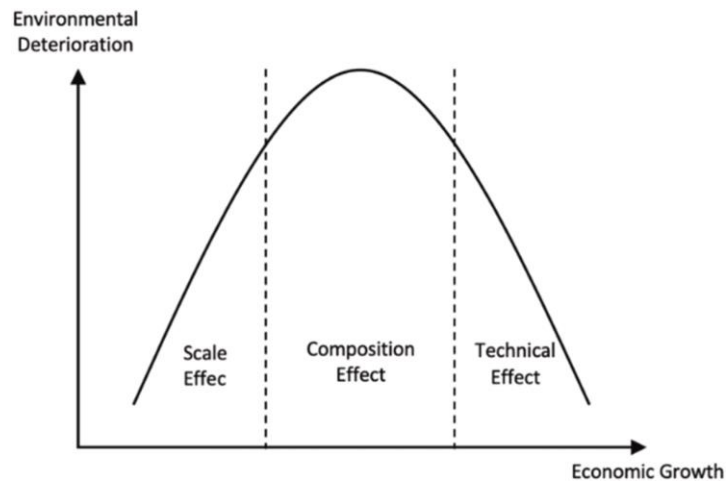
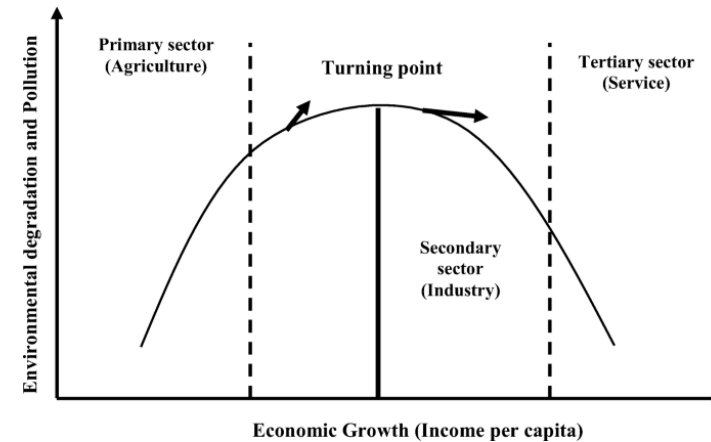
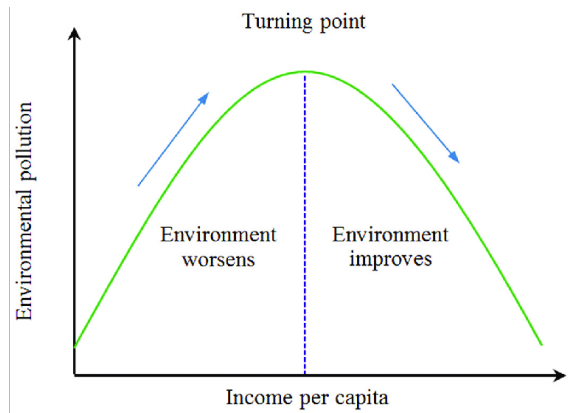
Springer Link



Wiley Online Library

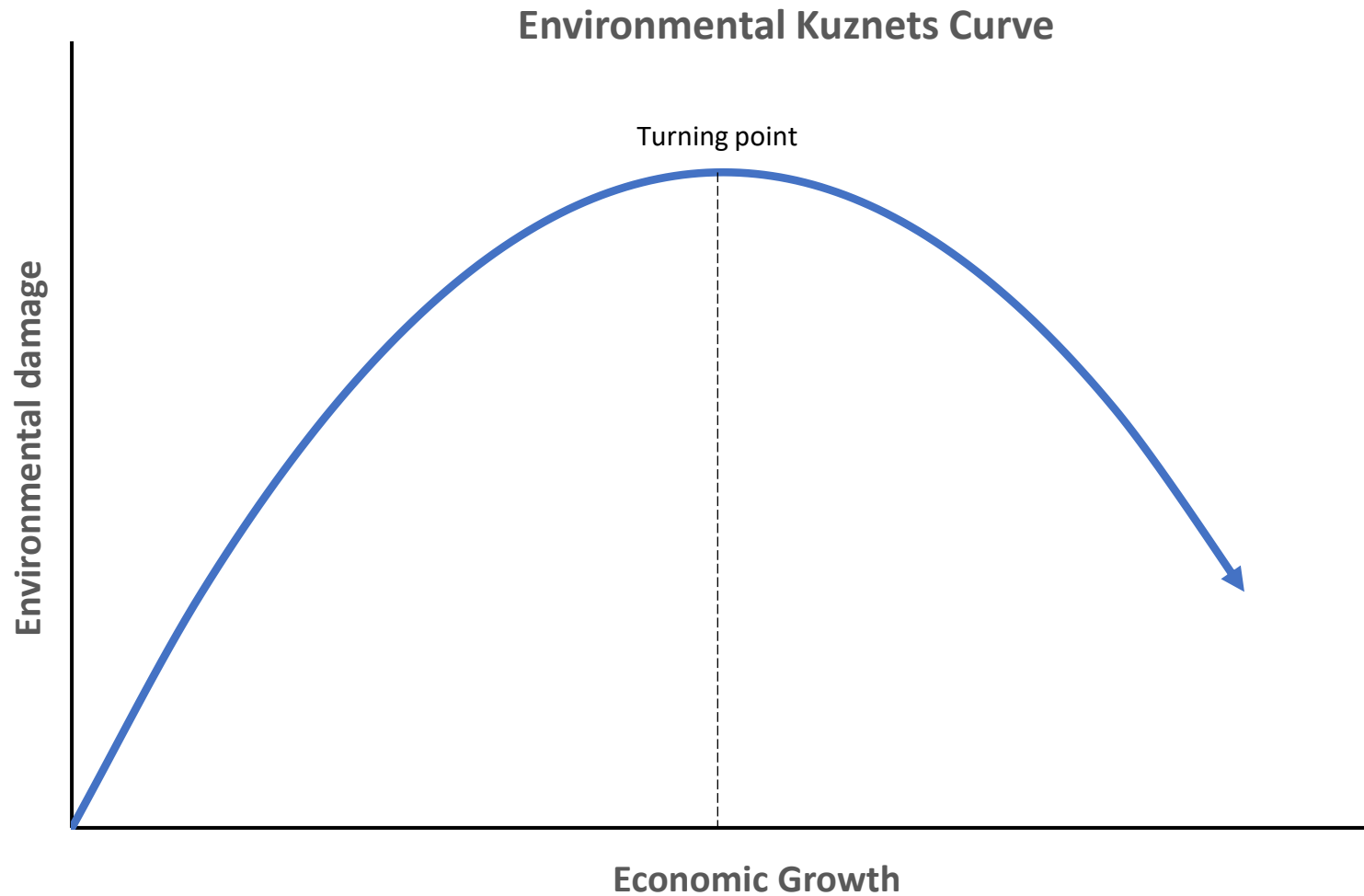
Various depictions of EKC

Different depictions highlight the idea of a 'turning point', offer explanations for the underlying dynamics of the curve, and suggest slightly different forms (more on this later).



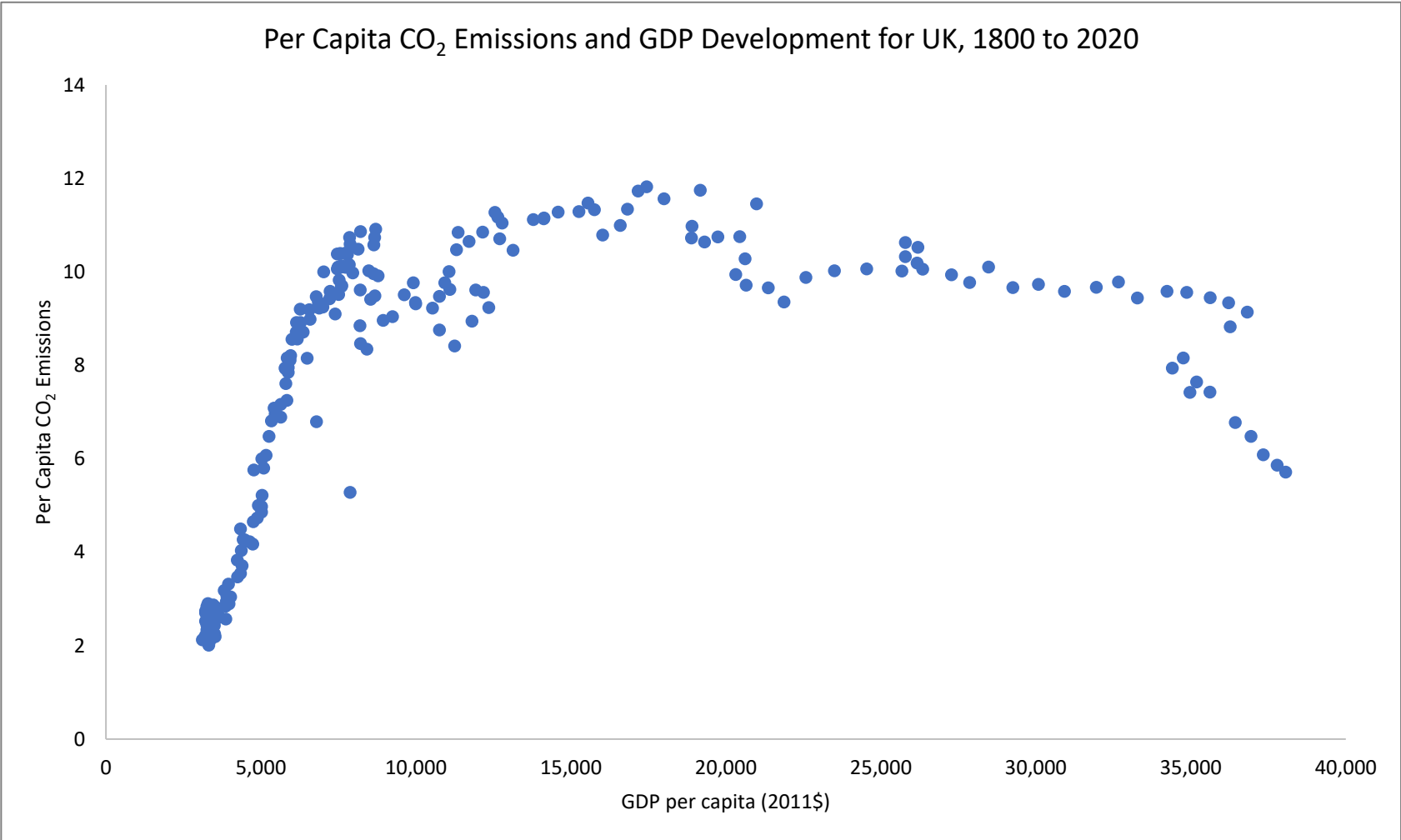
Conventional EKC shape

Fundamentally the EKC tells an optimistic and reassuring story: yes, economic growth may 'break things' at first, but it generates the wealth, technology and appetite to repair things subsequently. It is economics' formal depiction of the idea that the price of progress may be some unintended consequences along the way, but worth it in the end. "Growth is the solution! Keep going!"



UK EKC for CO₂ Emissions

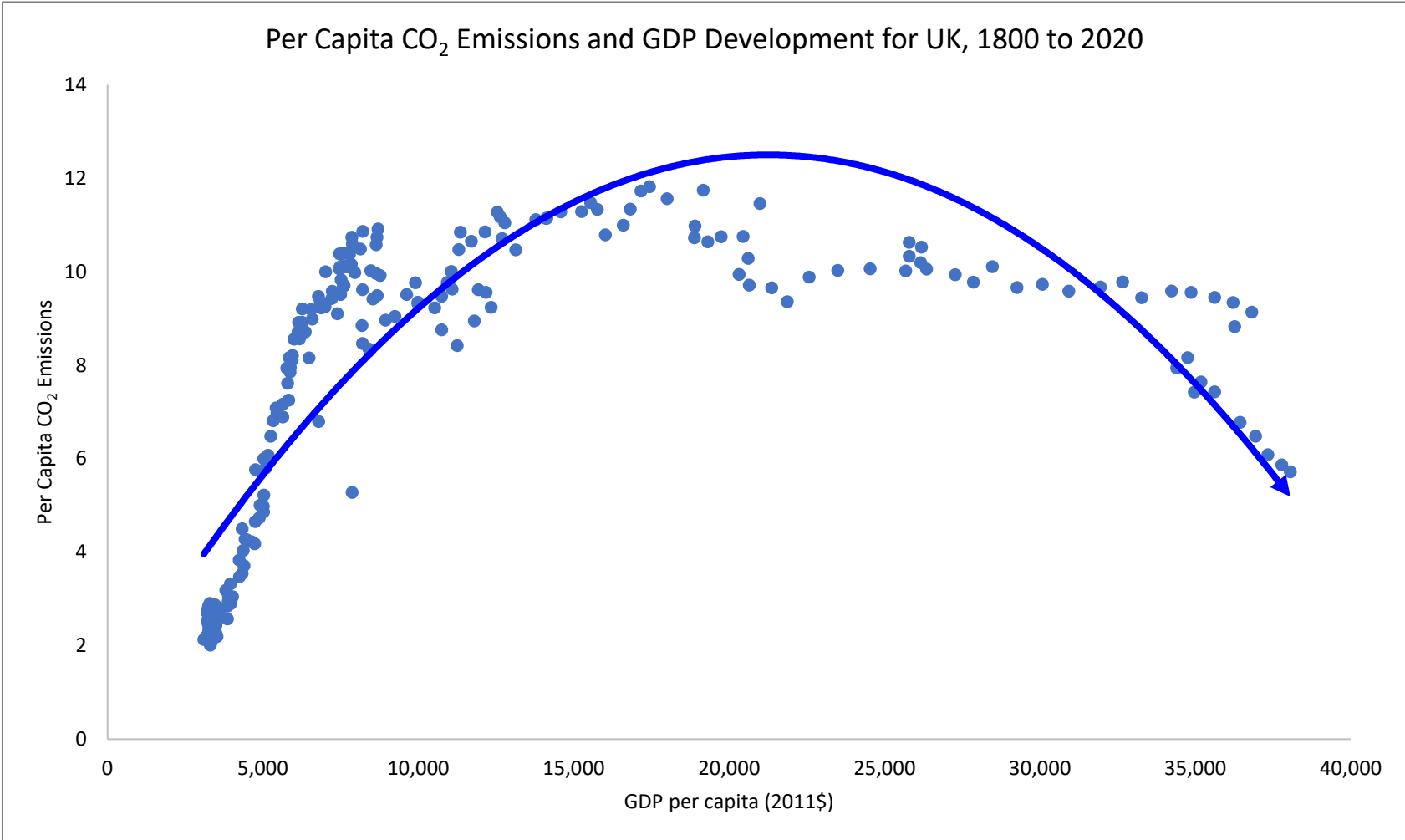
The UK's long record of CO₂ emissions is often used as an example of the conventional EKC pattern.



Source: Our World in Data

UK EKC for CO₂ Emissions

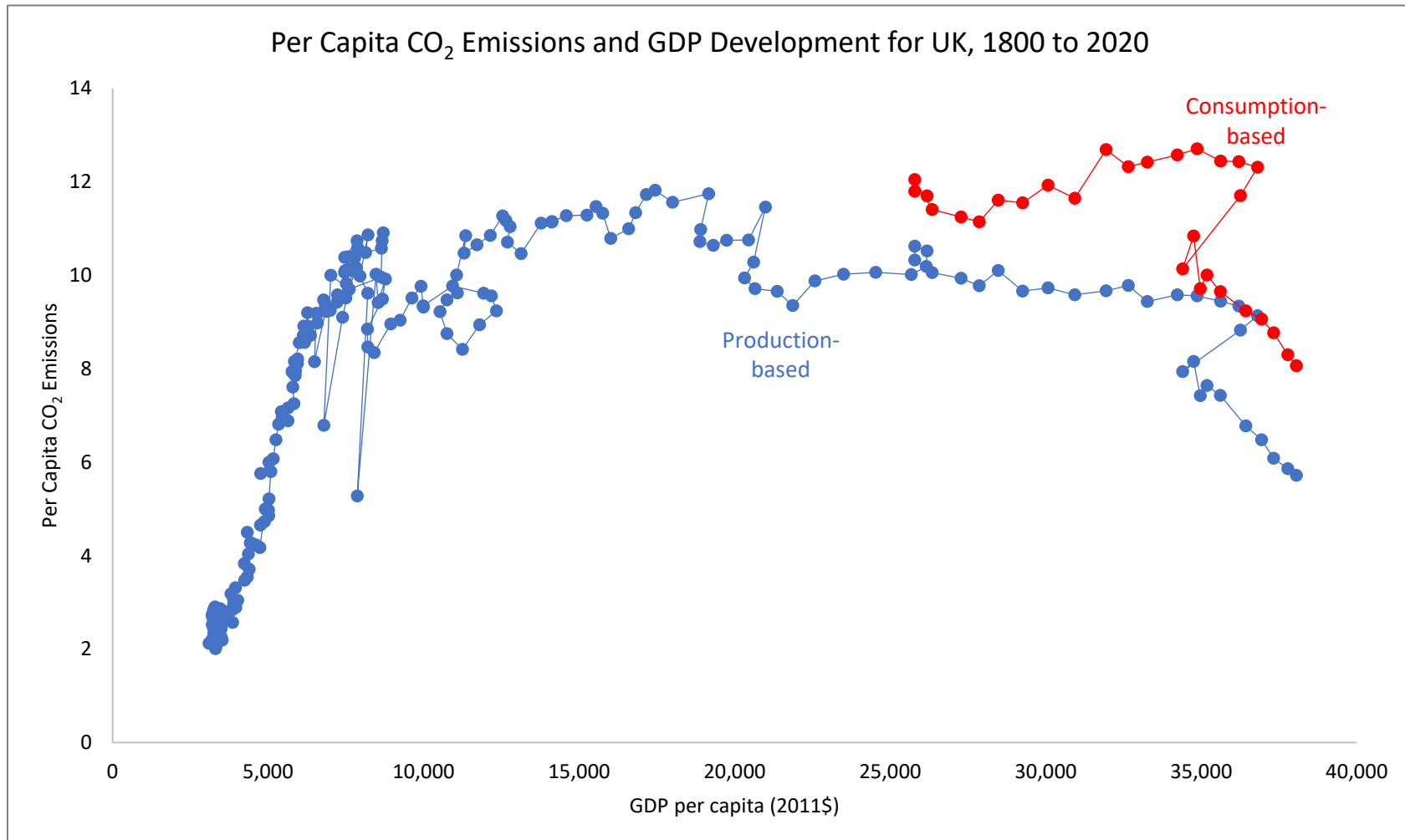
Per capita emissions first rose but are now falling as the UK has become economically wealthier.



Source: Our World in Data

UK EKC for CO₂ Emissions

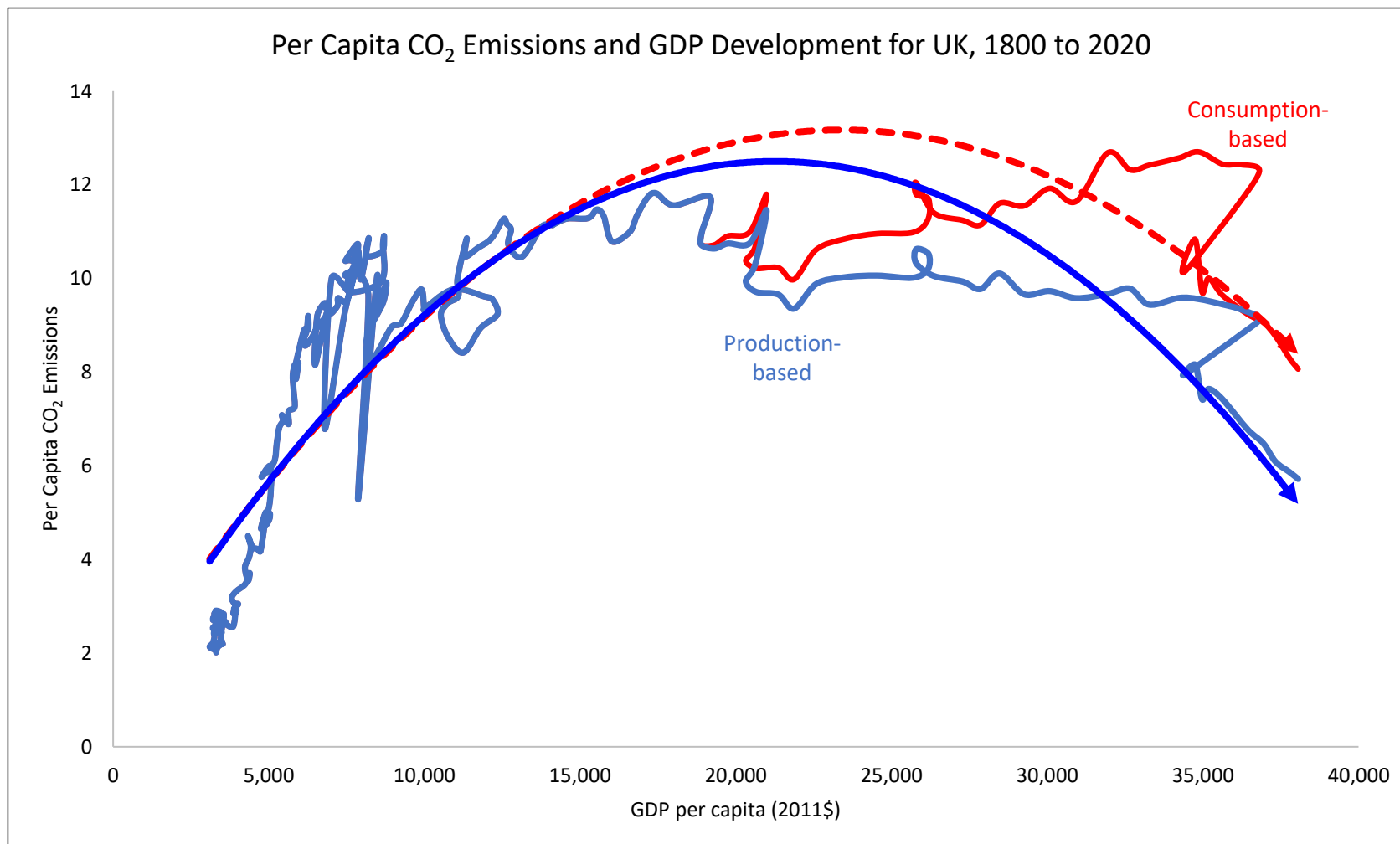
In fact, part of the downward turn in emissions is due to the UK outsourcing some production to other countries. If we add outsourced emissions back for a fairer attribution of UK responsibility, the red line is higher (but data only goes back to 1990).



Source: Our World in Data

UK EKC for CO₂ Emissions

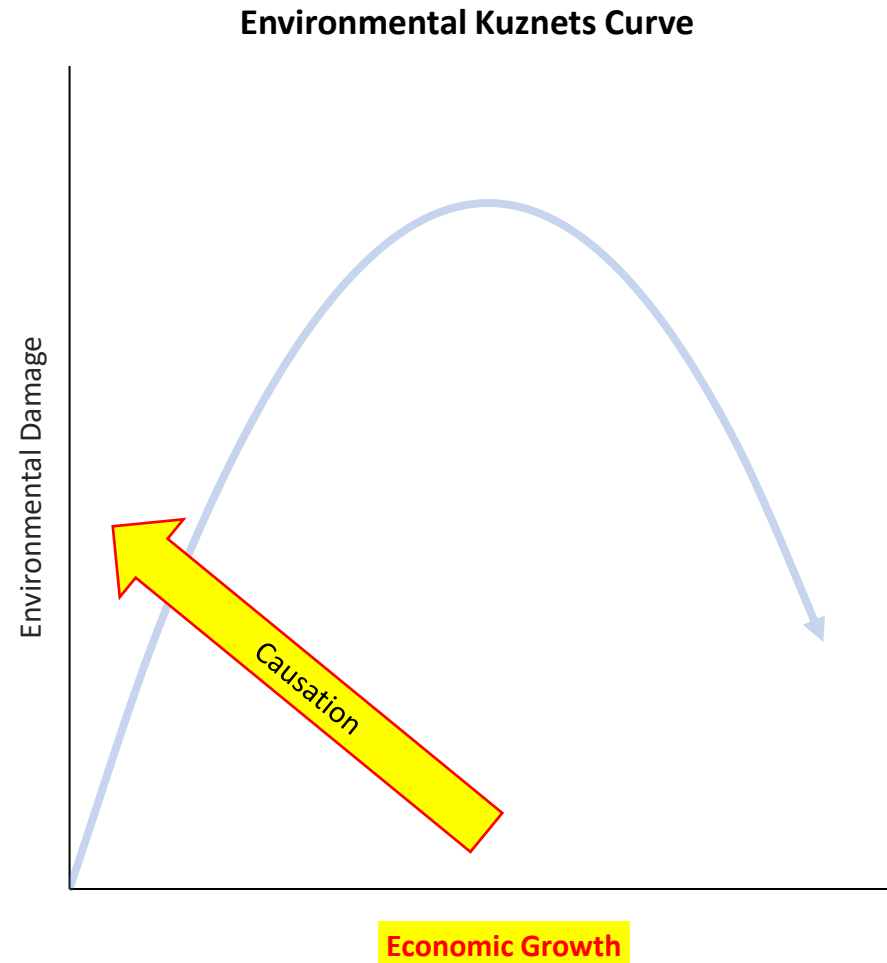
With some simple extrapolation for illustrative purposes, one can see that a consumption-based EKC peaked later and is turning more slowly than one based on domestic production emissions, though both now appear to be on a downward trajectory.



Source: Our World in Data

EKC and Causation

For now, notice that the seemingly innocuous choice of X-Y axes smuggles in a presumptive causation. The 'rules' of X-Y graphs are that the x-axis is the independent variable and the y-axis the dependent variable. Hence, the assumption is that the economy determines the environment. (We'll come back to this later).



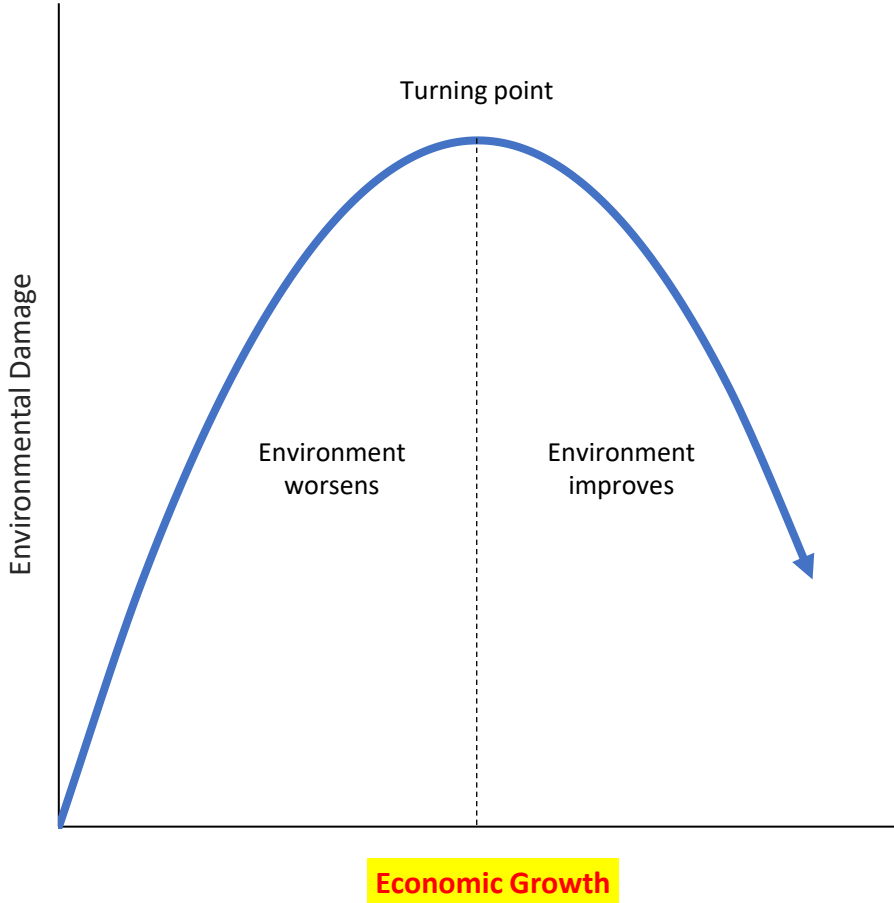
3. 'Decoupling': the EKC by another name (and slightly different form)

- Outside of academic literature, the EKC is often depicted as a 'decoupling' of economic growth and environmental damage. They are equivalent.

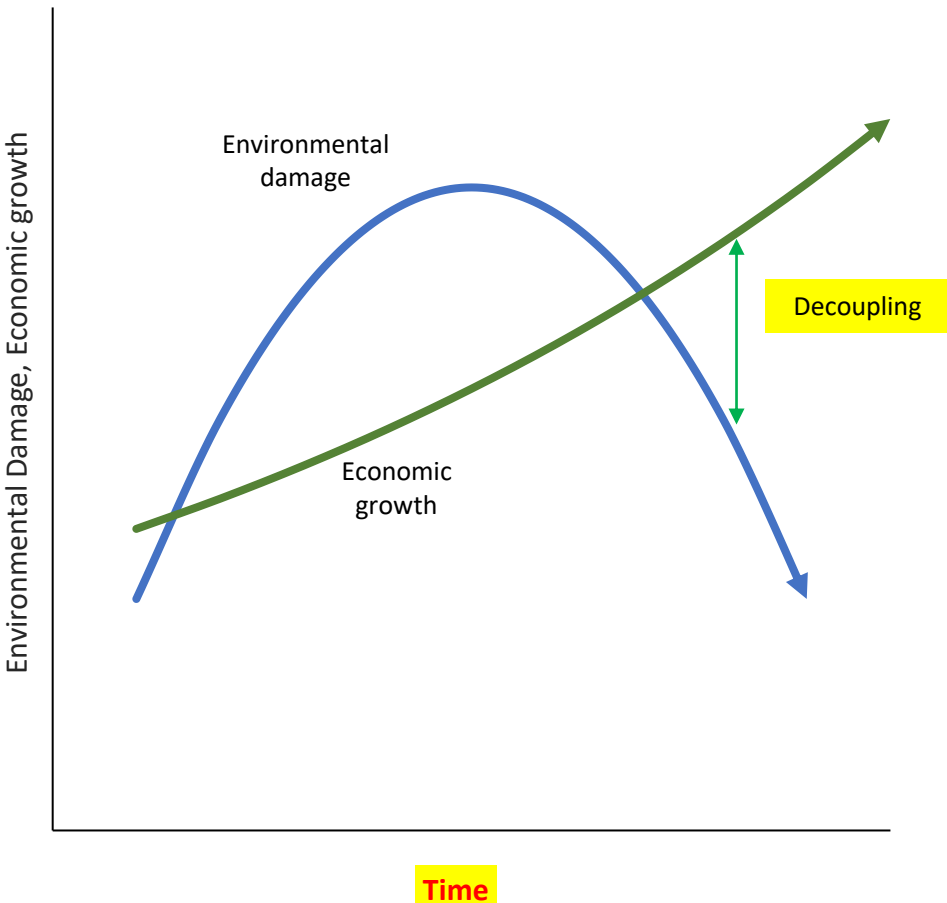
EKC and Decoupling Presentations

The EKC concept is often presented as a 'decoupling' of environmental impact from economic growth (i.e. damage declines while economic growth continues). The key difference is the EKC uses *economic growth*, not *time*, as the x-axis. This means 'decoupling' is the divergence of 'damage' and 'growth' lines over time. (The blue lines are often visually similar as economic growth has risen fairly steadily in recent periods.)

Environmental Kuznets Curve



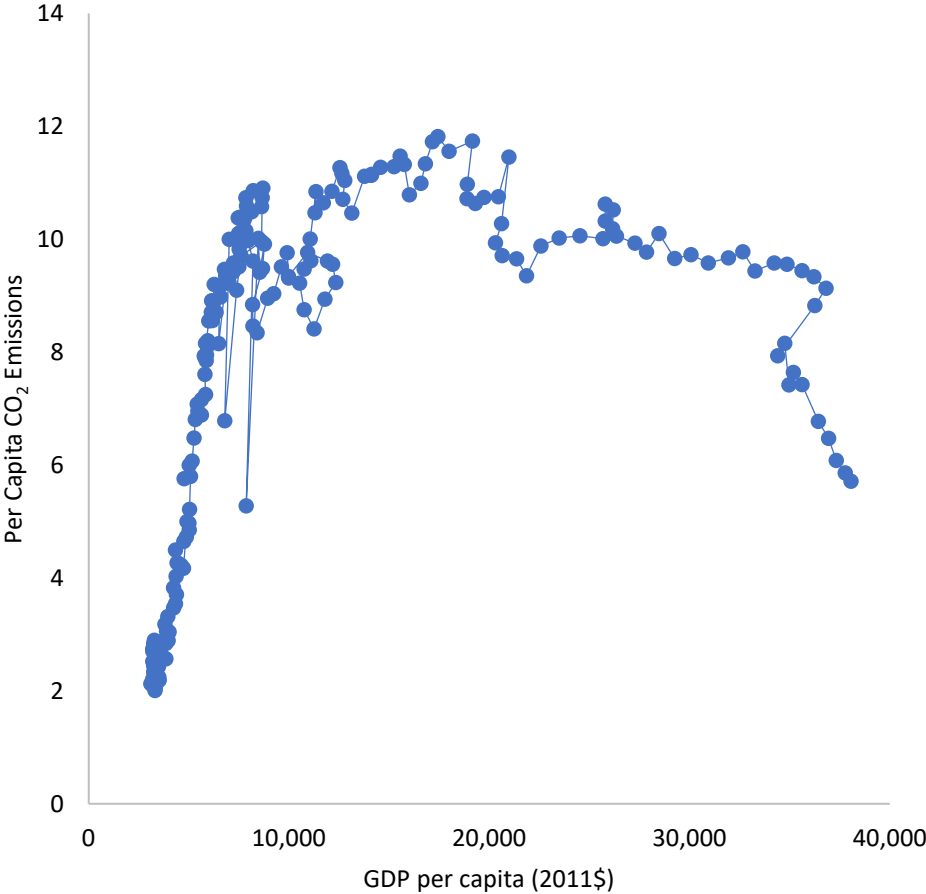
'Decoupling' of Damage from Growth



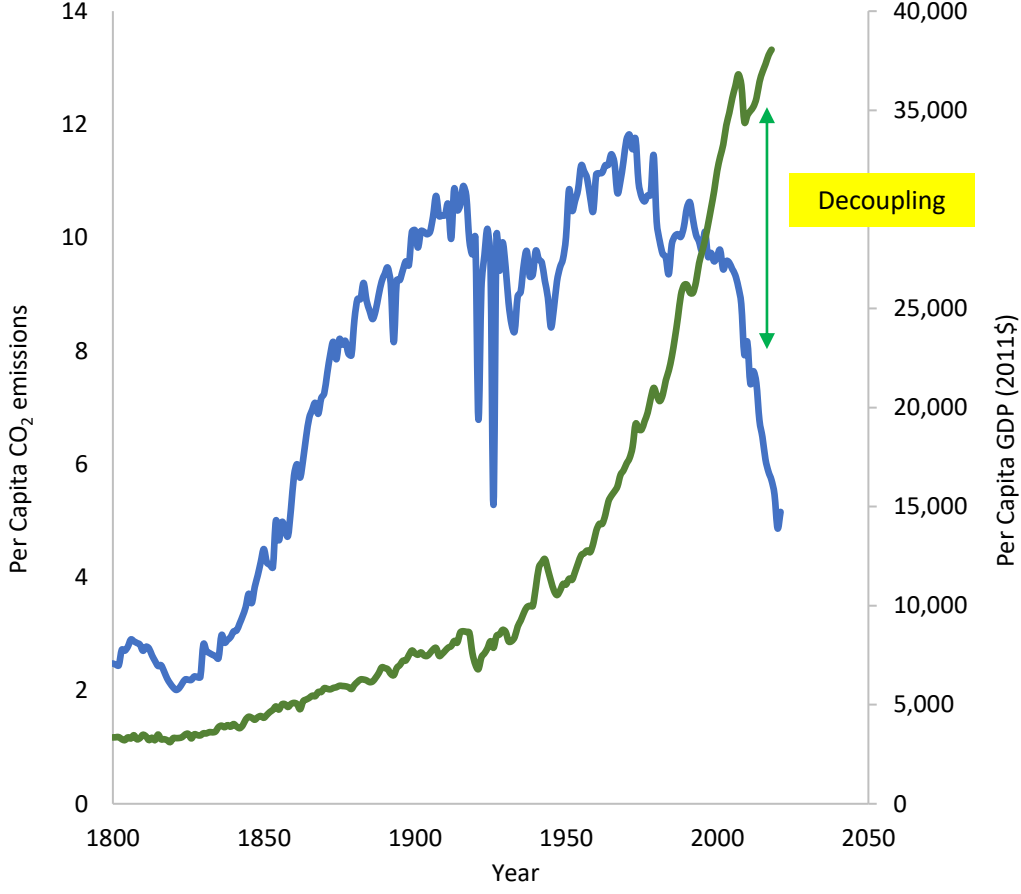
EKC and Decoupling Equivalence

Hence, UK emissions data can be illustrated in EKC (left) or decoupling form (right). The economics literature tends to use the EKC formulation on the left, while the (less intimidating?) 'decoupling' terminology seems preferred by more generalist media. Decoupling portrayal requires two lines to the EKC's single line.

EKC Depiction



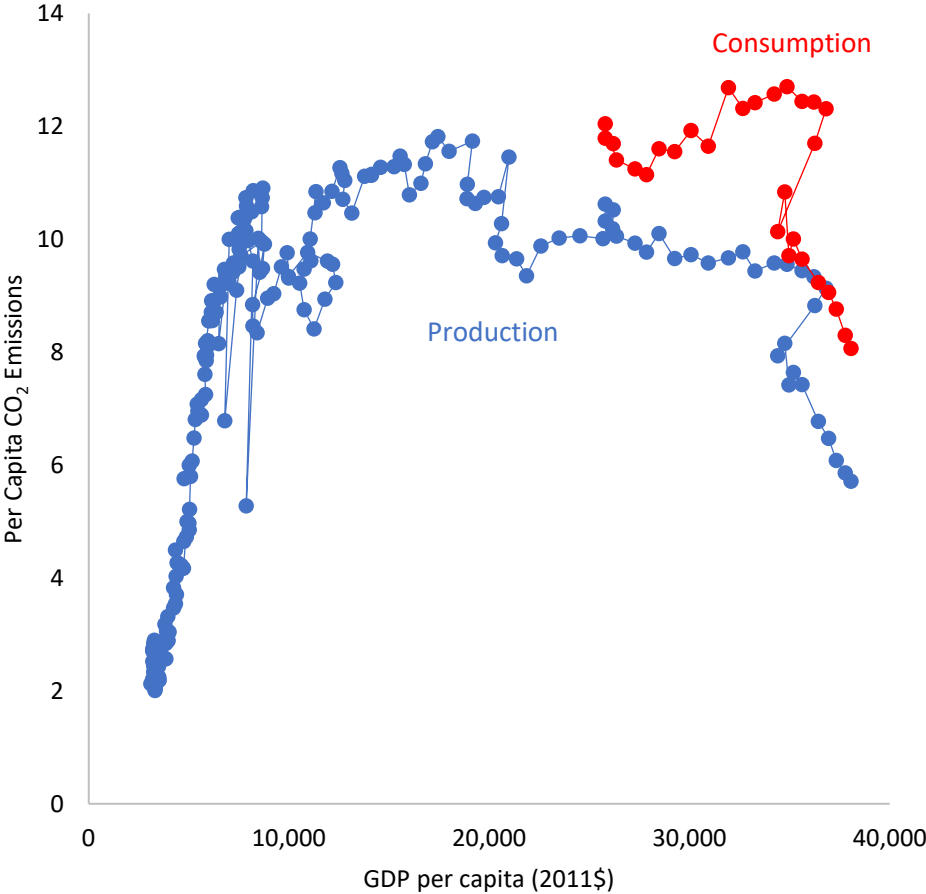
Decoupling Depiction



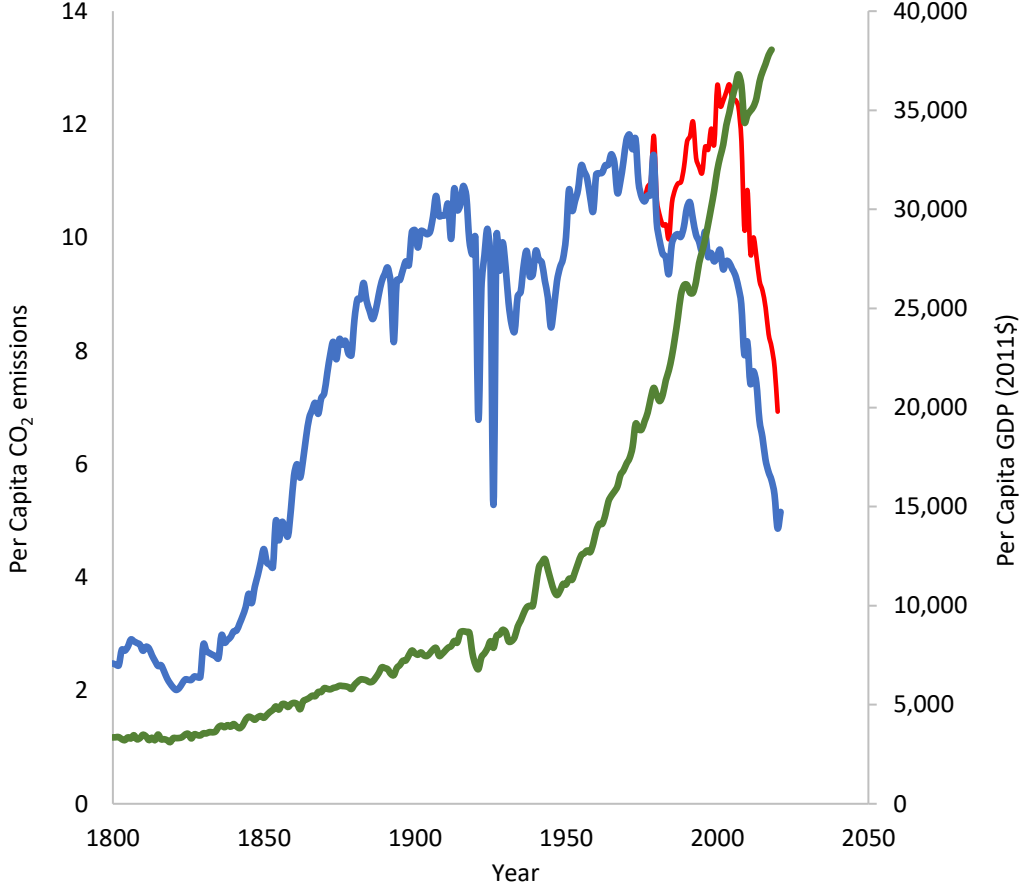
EKC and Decoupling Equivalence

To show the equivalence, the consumption-based turn in UK emissions has been slower or the decoupling has taken a bit longer to get started (red lines).

EKC Depiction



Decoupling Depiction



4. What is the evidence for the Environmental Kuznets Curve?

- Short answer: very mixed.
- Let's start with the original – social – Kuznets Curve...

The Original (Social) Kuznets Curve

The American Economic Review

VOLUME XLV

MARCH, 1955

NUMBER ONE

ECONOMIC GROWTH AND INCOME INEQUALITY*

By SIMON KUZNETS

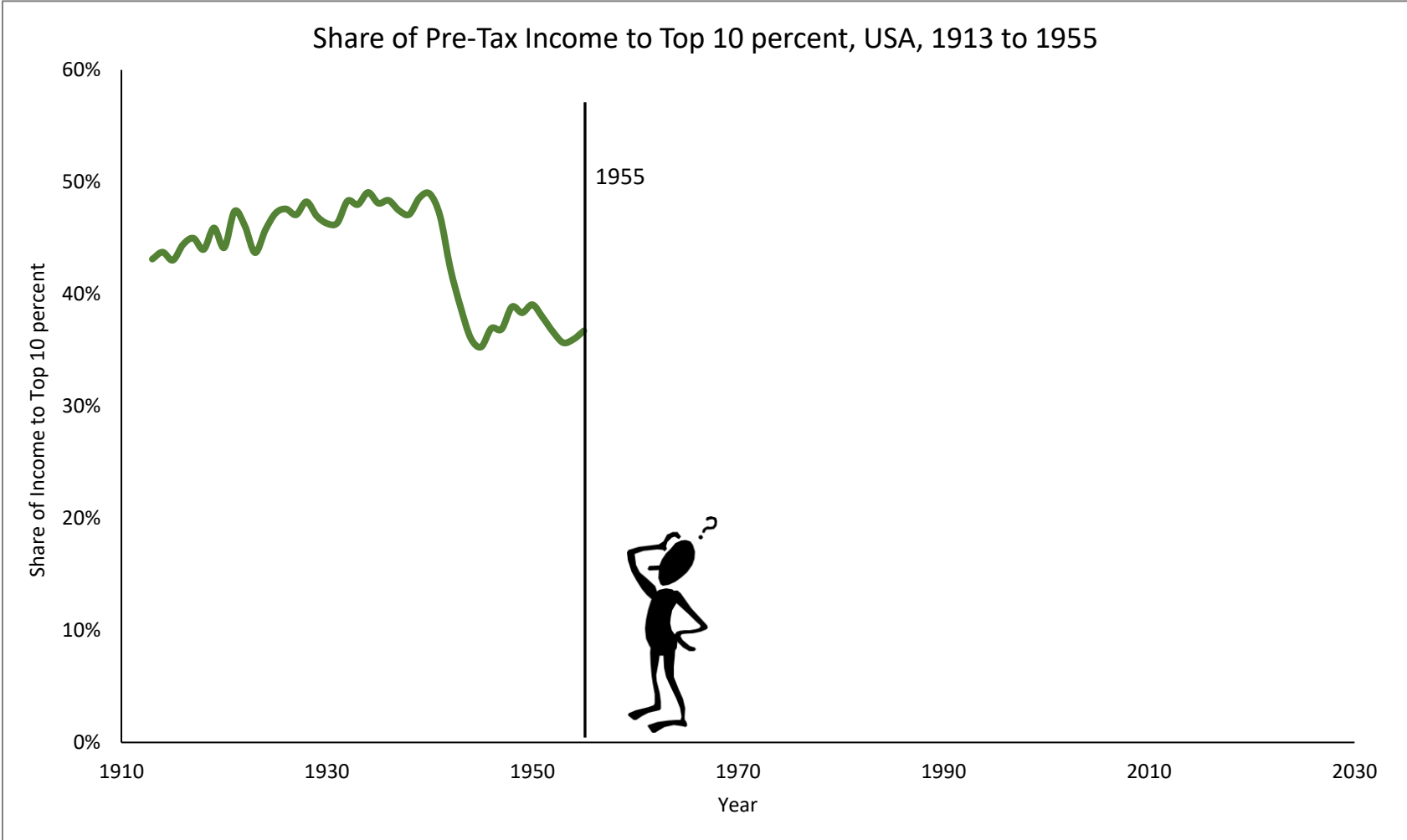
V. *Concluding Remarks*

In concluding this paper, I am acutely conscious of the meagerness of reliable information presented. The paper is perhaps 5 per cent empirical information and 95 per cent speculation, some of it possibly tainted by wishful thinking. The excuse for building an elaborate structure on such a shaky foundation is a deep interest in the subject and a wish to share it with members of the Association. The formal and no less genuine excuse is that the subject is central to much of economic analysis and thinking; that our knowledge of it is inadequate; that a more cogent view of the whole field may help channel our interests and work in intellectually profitable directions; that speculation is an effective way of presenting a broad view of the field; and that so long as it is recognized as a collection of hunches calling for further investigation rather than a set of fully tested conclusions, little harm and much good may result.

- The EKC is named for its similarity to a prior curve hypothesized by Simon Kuznets for the relationship between economic growth and income inequality (1955).
- A central *social* question for economics has been the relationship between economic growth and income inequality as one key measure of *fairness*.
 - Does economic growth increase or decrease fairness in society?
- Kuznets' paper is very transparent about its speculative nature, but he notes:
 - "One might assume a long swing in inequality... widening in the early phases of economic growth... becoming stable for a while... then narrowing in the later phases."
- Critically, his conclusion was heavily hedged:
 - **"This paper is perhaps 5 percent empirical information and 95 per cent speculation, some of it possibly tainted by wishful thinking."**

US Income Inequality

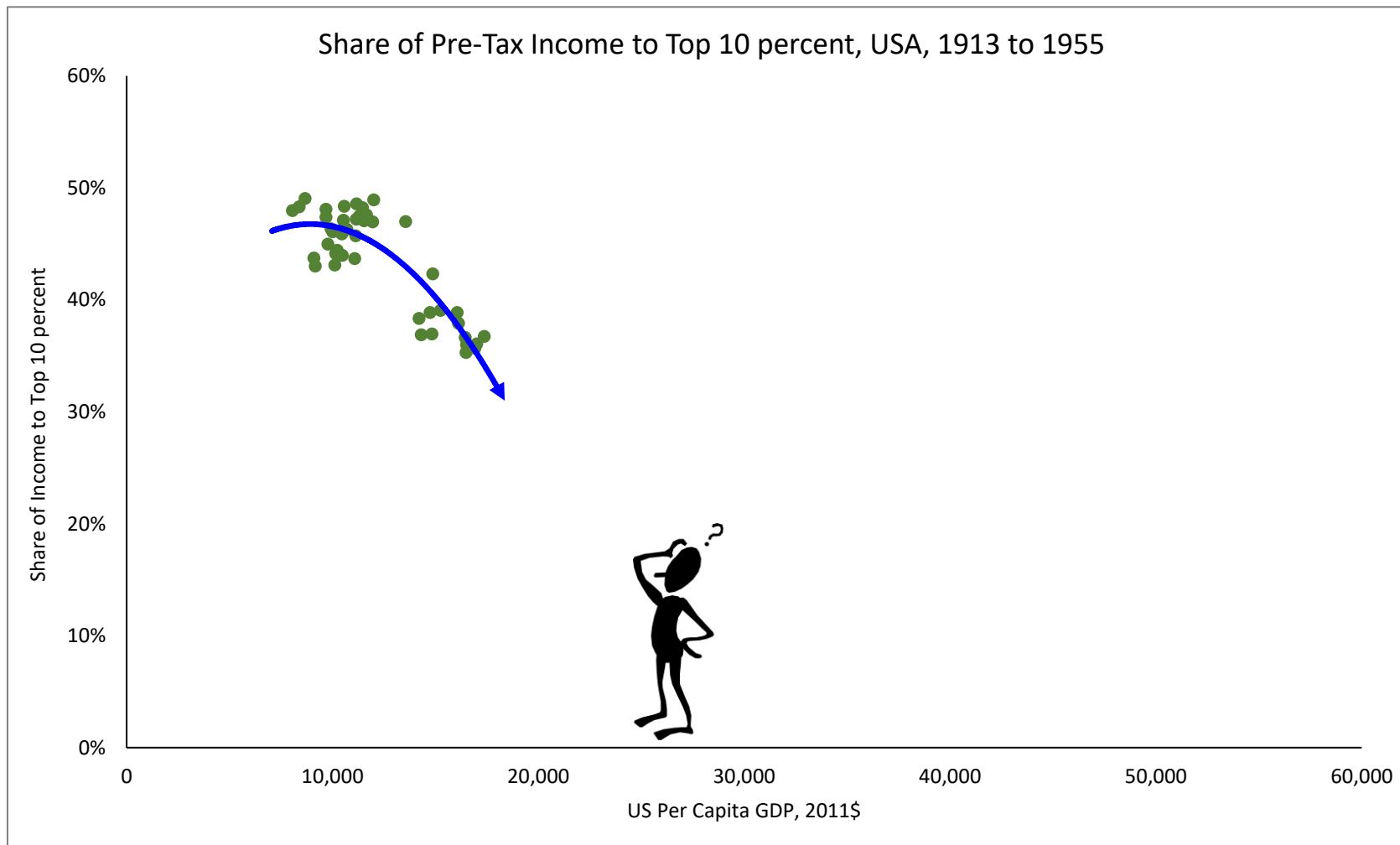
Writing in 1955, this was the view Simon Kuznets would have had of the prior 40 years of US inequality...



Source: World Inequality Database

US Income Inequality

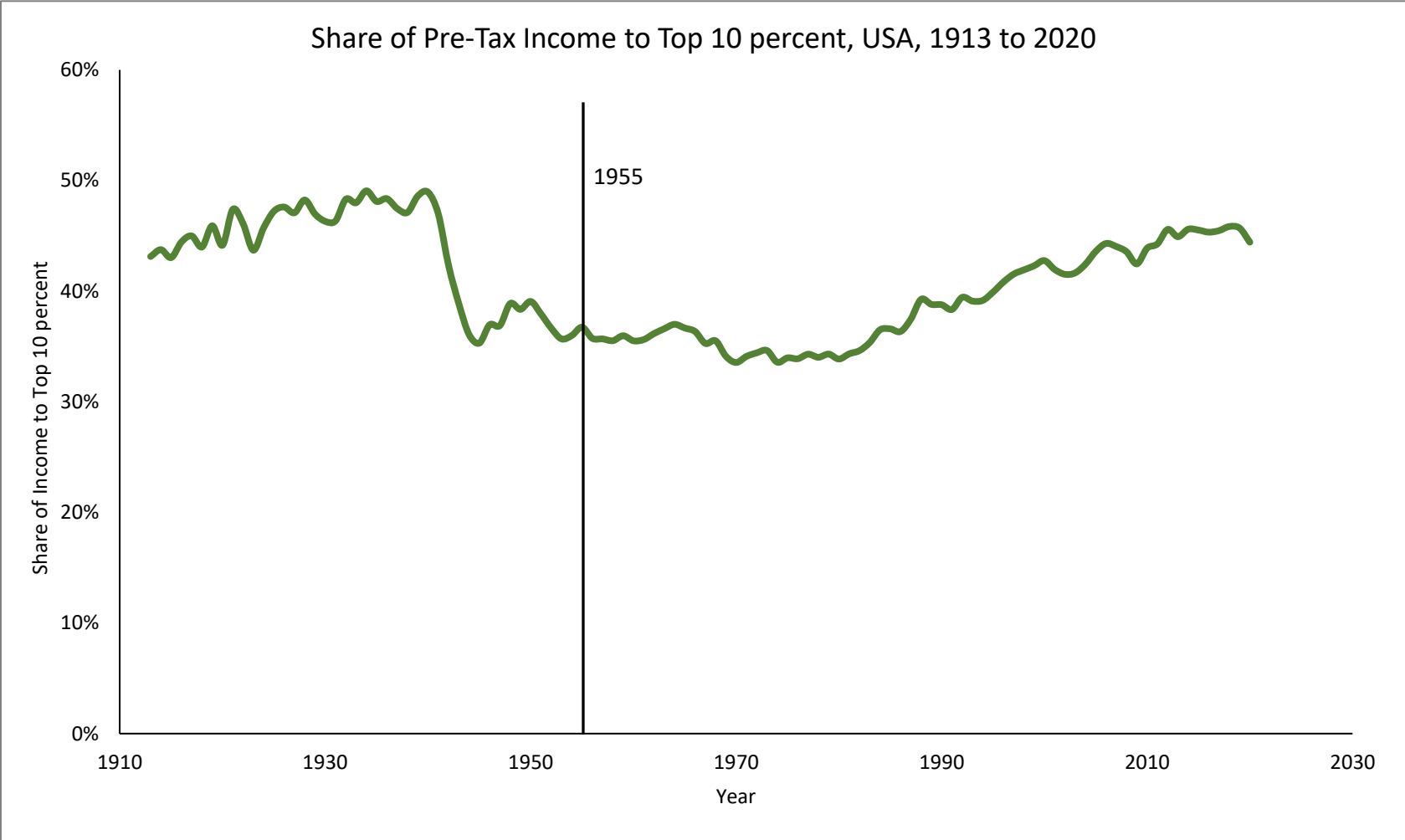
...which suggests a downward trajectory when plotted against economic growth. (Kuznets also conjectured – though offered no data – that the period prior to this graph would have seen rising inequality in the US, i.e. suggesting a complete inverted U-shape)



Source: World Inequality Database

US Income Inequality

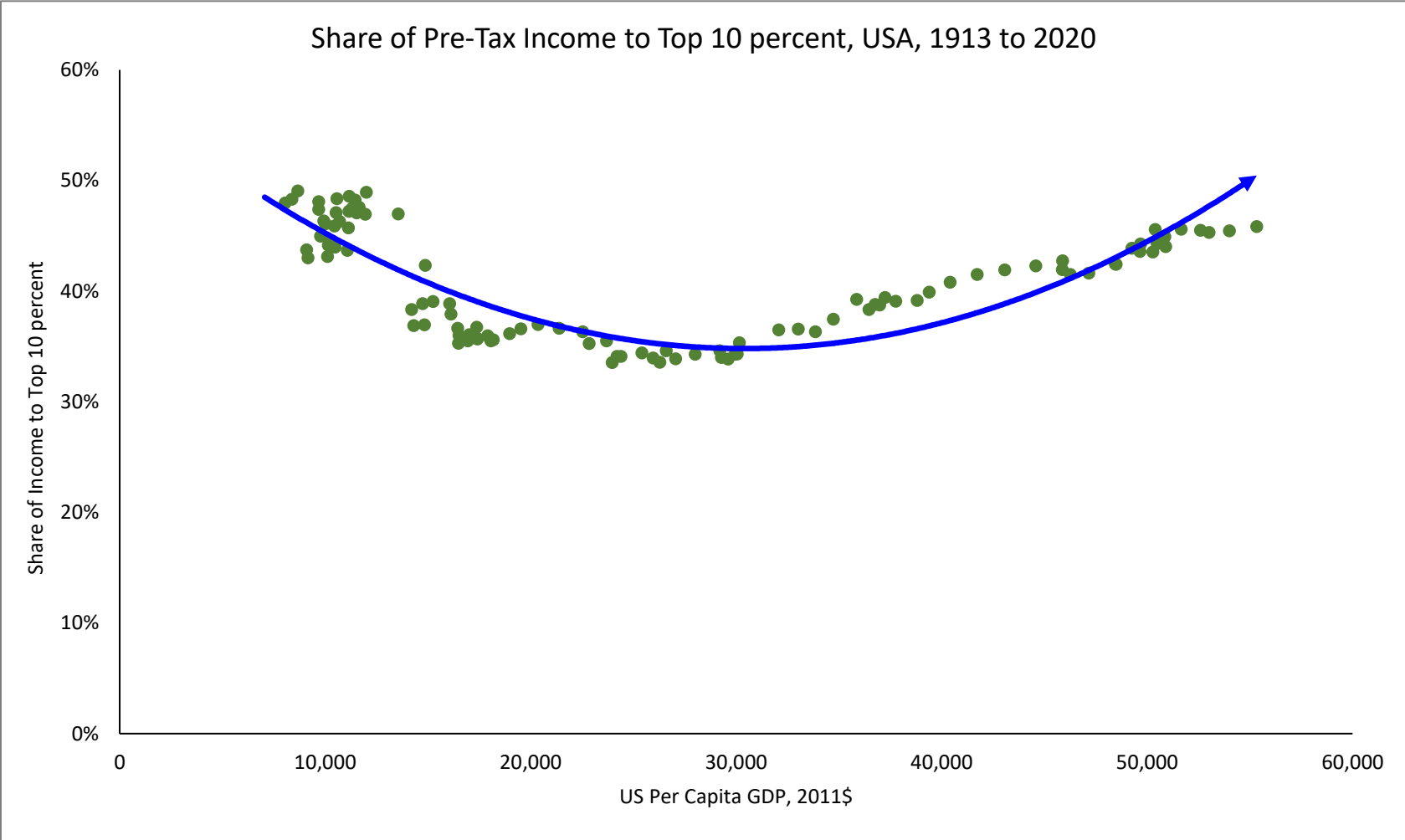
This is how US income inequality developed post 1955...



Source: World Inequality Database

US Income Inequality

... which, if anything, lends itself to the opposite trajectory of a conventional U-shape. As the US has become wealthier, it has become more unequal.



Source: World Inequality Database

Mixed evidence for original Kuznets Curve

To cut a long story short, the general conclusion for whether the (social) Kuznets Curve holds is 'sometimes it has (RHS), sometimes it hasn't' (LHS). It is certainly not a law of the universe.

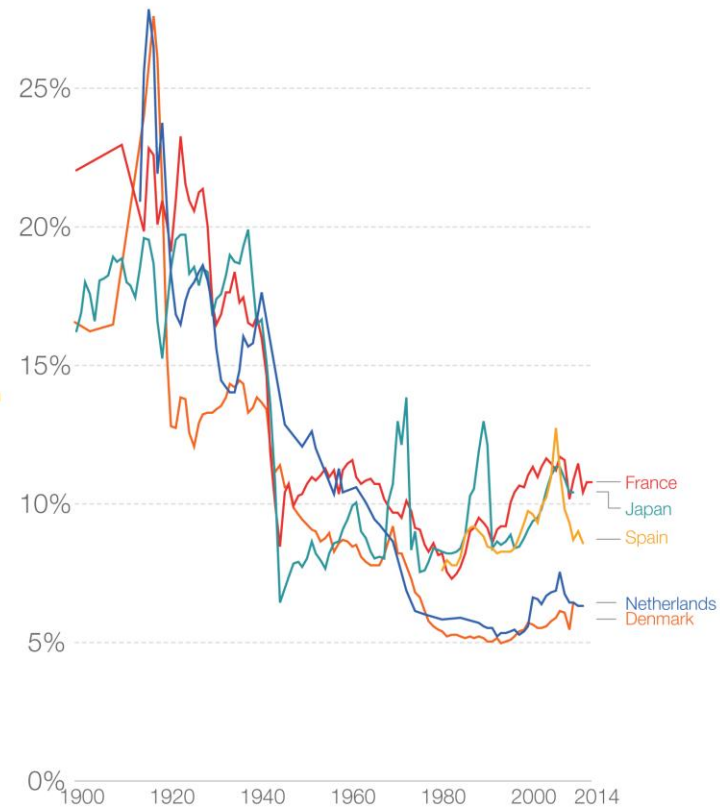
Our World
in Data

Share of Total Income going to the Top 1% since 1900

The evolution of inequality in English speaking countries followed a U-shape



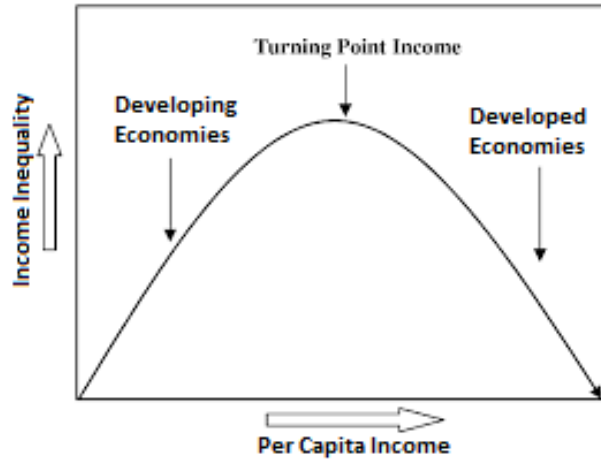
The evolution of inequality in continental Europe and Japan followed an L-shape



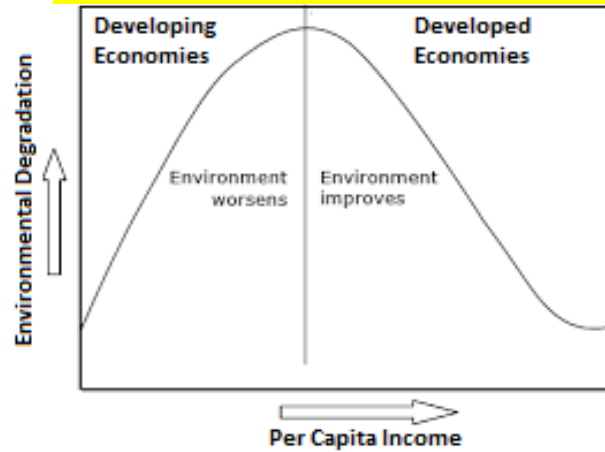
Data source: World Wealth and Income Database (2018). This is income before taxes and transfers. This data visualisation is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualisations on inequality and how the world is changing. Licensed under CC-BY-SA by the author Max Roser.

What about the *Environmental* Kuznets Curve?

(SOCIAL) KUZNETS CURVE



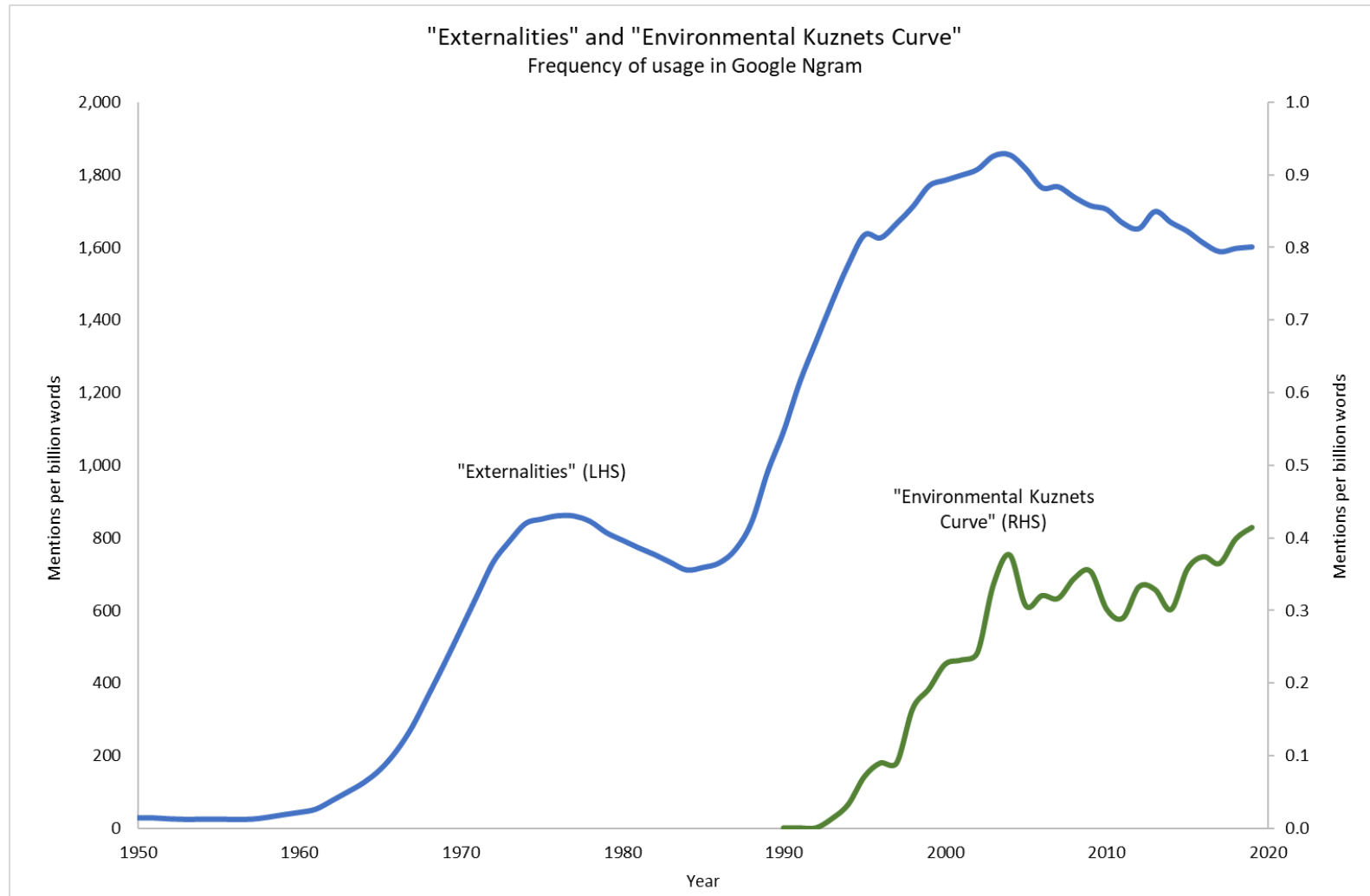
ENVIRONMENTAL KUZNETS CURVE



- Of course, the *environmental* Kuznets Curve hypothesis must be evaluated on its own evidence.
- It might not be as poorly substantiated as the social version...
- ... but unfortunately, it's just as bad...

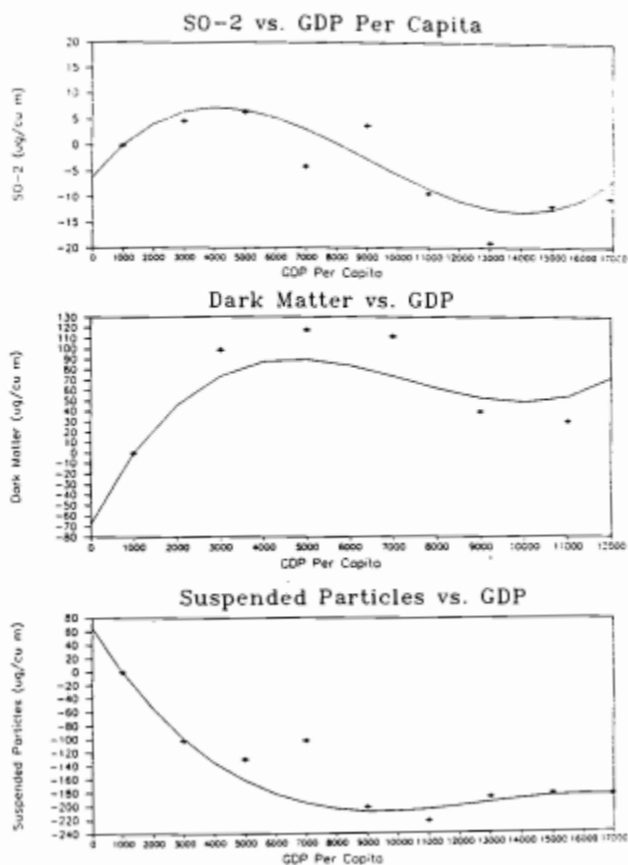
Relatively new piece of economics theory

The EKC is a relatively new economic concept (1991), prompted by economists being forced to contemplate environmental damage and 'externalities' more seriously from 1960s onwards, in response to real-world events. (As a technical term, it is used much less than 'externalities' in absolute terms, hence right-hand scale).



Grossman and Krueger, 1991

Figure 2: Fitted Cubic and Unrestricted Dummies



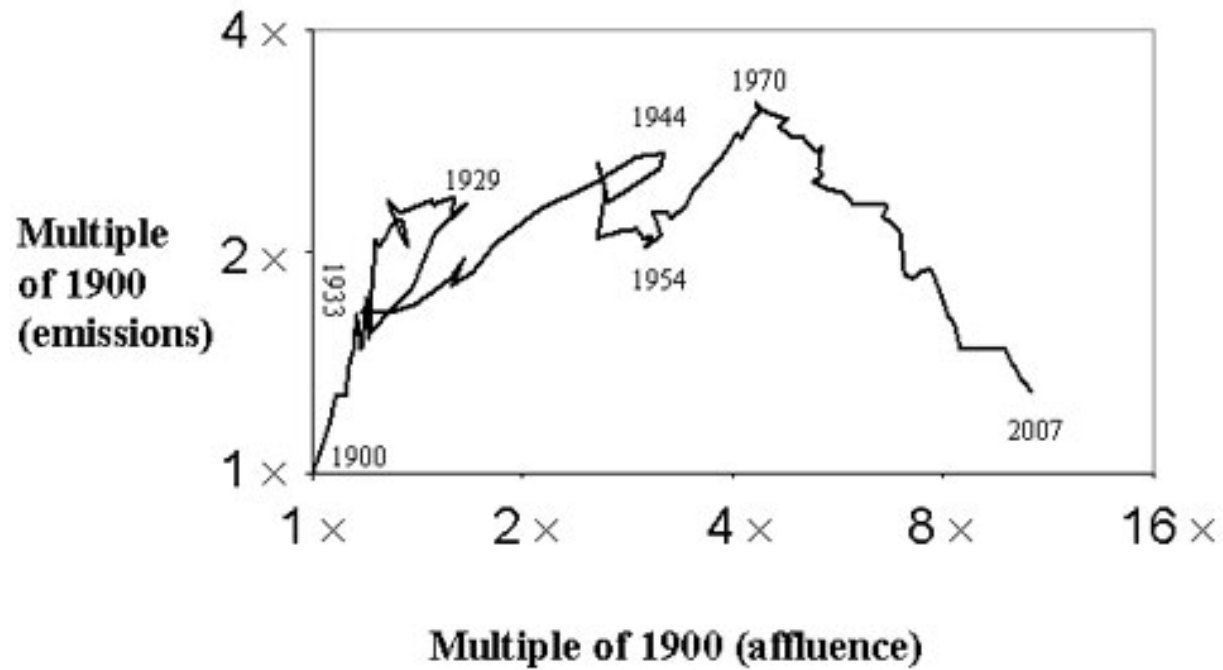
- The first formulation of an EKC pattern was by Grossman and Krueger, “Environmental Impacts of a North American Free Trade Agreement”, 1991
- They explored whether free trade within North America would exacerbate Mexican pollution from presumed increased manufacturing activity.
- “We have found, through an examination of air quality measures in a cross-section of countries, that economic growth tends to alleviate pollution problems once a country’s per capita income reaches about \$4,000 to \$5,000 US dollars.”
- Mexico was then at about \$5,000 per capita, suggesting a spur to growth from NAFTA would alleviate its pollution.
- Figure 2 showed 3 air pollutants declining at relatively low levels of GDP per capita.
- But SO₂ and dark matter also seemed to start increasing again at higher levels of income(?) Authors argued that as only two countries in their sample had incomes at such high levels, the upward turns “should not be viewed as strong evidence for a renewed positive relationship.”
- [However...] **“Our findings must remain tentative until better data becomes available.”**

Source: Grossman & Krueger, 1991

Early corroboration of EKC

The idea of the EKC found important support from some early success stories (e.g., SO₂ emissions in the USA show a clear inverted U-shape EKC pattern).

Environmental Kuznets Curve for USA sulfur dioxide emissions



Ausubel and Waggoner, 2009; Tierney 2009

Explosion in EKC studies

Interest in the concept has prompted a boom in EKC studies, increasingly from less developed countries understandably eager to identify whether the EKC will hold in their regions as they grow.

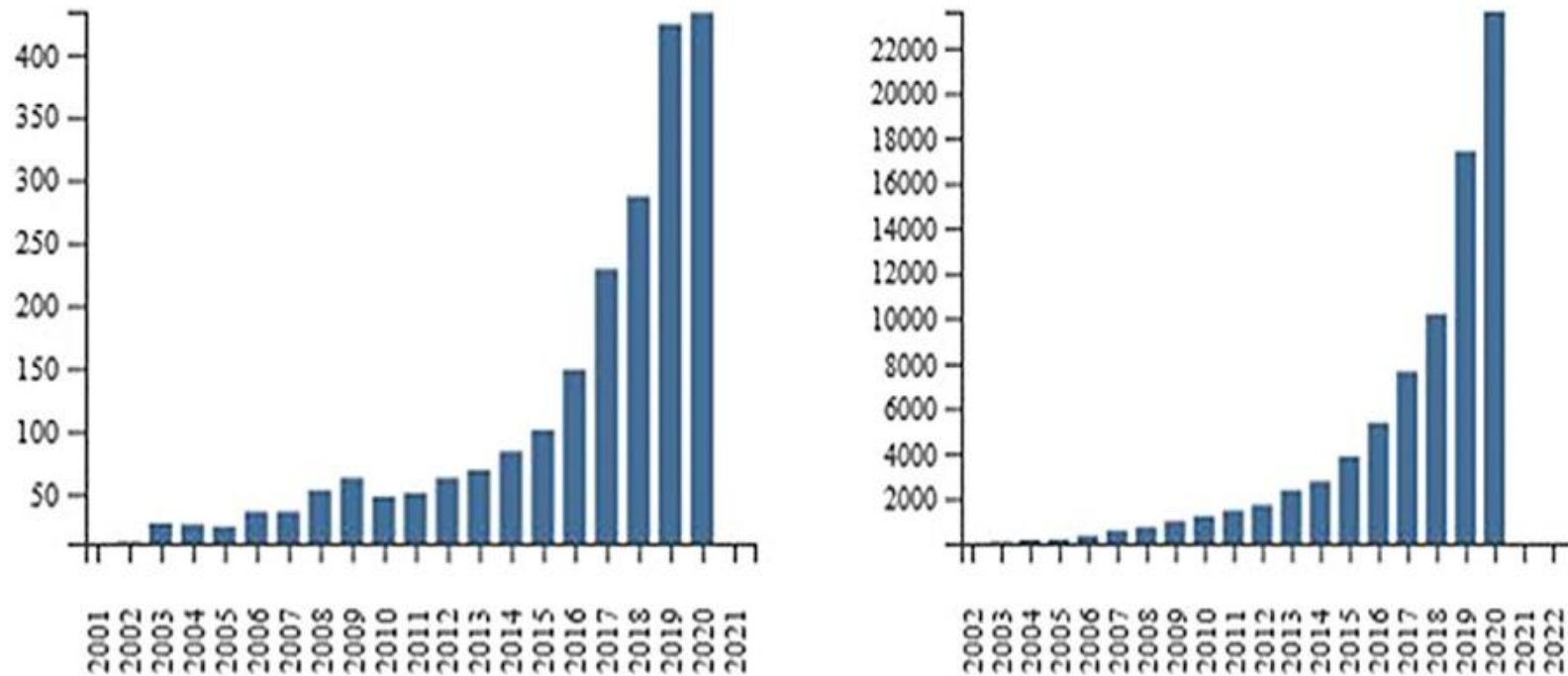


Fig. 1. (1) Yearly publications on the EKC and (2) citation counts for 2000–2020.

Very mixed evidence on EKC...

The ten most cited EKC papers show mixed results on whether it holds or not. 5 papers confirm the EKC hypothesis, 4 do not, with 1 offering mixed conclusions. (These papers date from 2014 to 2016 as it takes time for citations to accumulate to make a 'top 10' list as of 2022.)

<u>Author</u>	<u>Year</u>	<u>Scope</u>	<u>Time period</u>	<u>Conclusion</u>
Apergis & Ozturk	2015	14 Asian countries	1990 to 2011	Supports
Kasman & Duman	2015	EU countries	1992 to 2010	Supports
Dogan & Turkekul	2016	USA	1960 to 2010	Does not support
Al Mulali etc	2015	Vietnam	1981 to 2011	Does not support
Bilgili etc	2016	17 OECD countries	1977 to 2010	Supports
Ozturk & Mulali	2015	Cambodia	1996 to 2012	Does not support
Lau et al	2014	Malaysia	1970 to 2008	Supports
Kang et al	2016	China	1997 to 2012	Does not support
Tang & Tan	2016	Vietnam	1971 to 2011	Supports
Alam et al	2016	Brazil, China, India, Indonesia	1970 to 2012	Mixed

Source: (Anwar et al, 2022) for list of top 10 most cited papers; Appendix for full references

Very mixed evidence on EKC...

More recent meta-analyses, often of hundreds of separate studies, confirm an absence of consensus regarding the EKC hypothesis.

<u>Authors</u>	<u>Date</u>	<u>Comment</u>
Alkhars et al.,	2022	“Of 119 observations, only 62 (52%) supported the EKC hypothesis whereas the remaining 57 (48%) did not support the hypothesis.”
Churchill et al.	2018	“Country-specific results, however, only provide mixed support for the EKC hypothesis. Specifically, we find evidence of an EKC for nine of the 20 countries (45%)”
Leal and Marques	2022	“... absence of consensus throughout the EKC literature [200+ articles] on the existence and shape of the curve... The same geographic region, country or countries can generate opposing arguments regarding the existence and shape of the EKC.”
Anwar et al.	2022	“ No consensus exists on the existence, shape, and turning points of the EKC among researchers. The same geographic region can produce opposing arguments on the existence and shape of the EKC, resulting from the data set, the selection of variables, and the choice of methodology.”
Frodyma et al.	2022	“... in most [European Union] countries, the EKC models fail to explain the relationship between income and emissions in the period 1970–2017.”
Saqib & Benhmad	2021	Around 57% of literature confirms the empirical validity of EKC hypotheses...On the contrary, there are also various studies (43% literature) that found no or very weak relationship.

See Appendix for full references

Multiple forms of EKC in practice

Researchers fitting curves to the data end up publishing diagrams like this to indicate that the EKC can be relied on to take one or other of these forms...

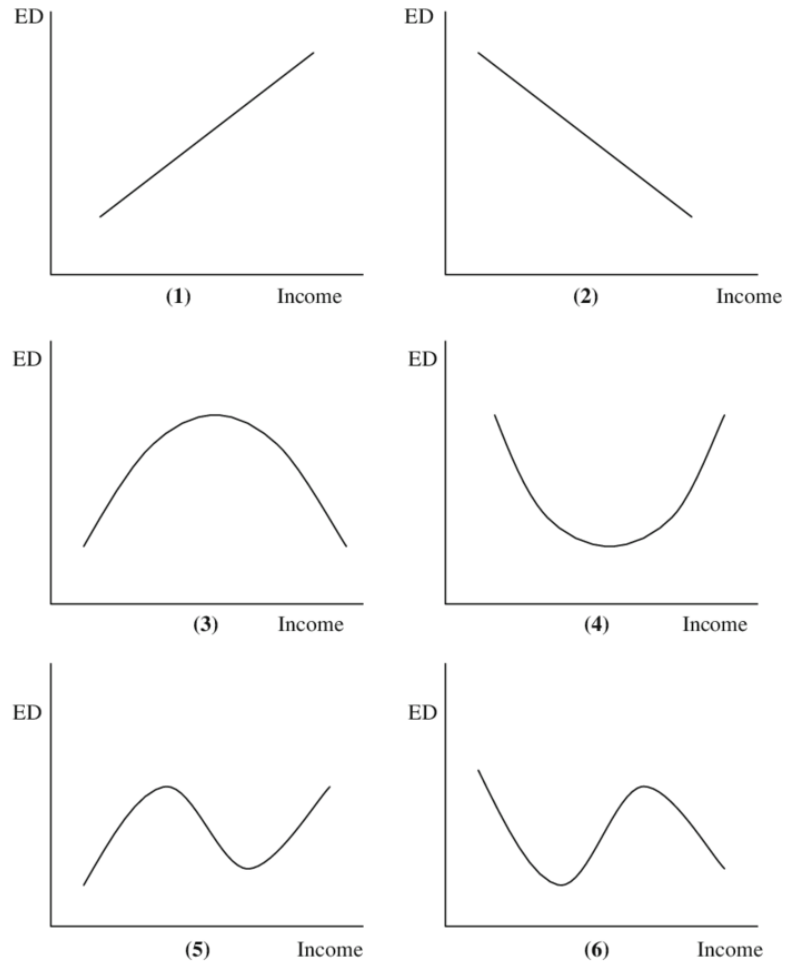
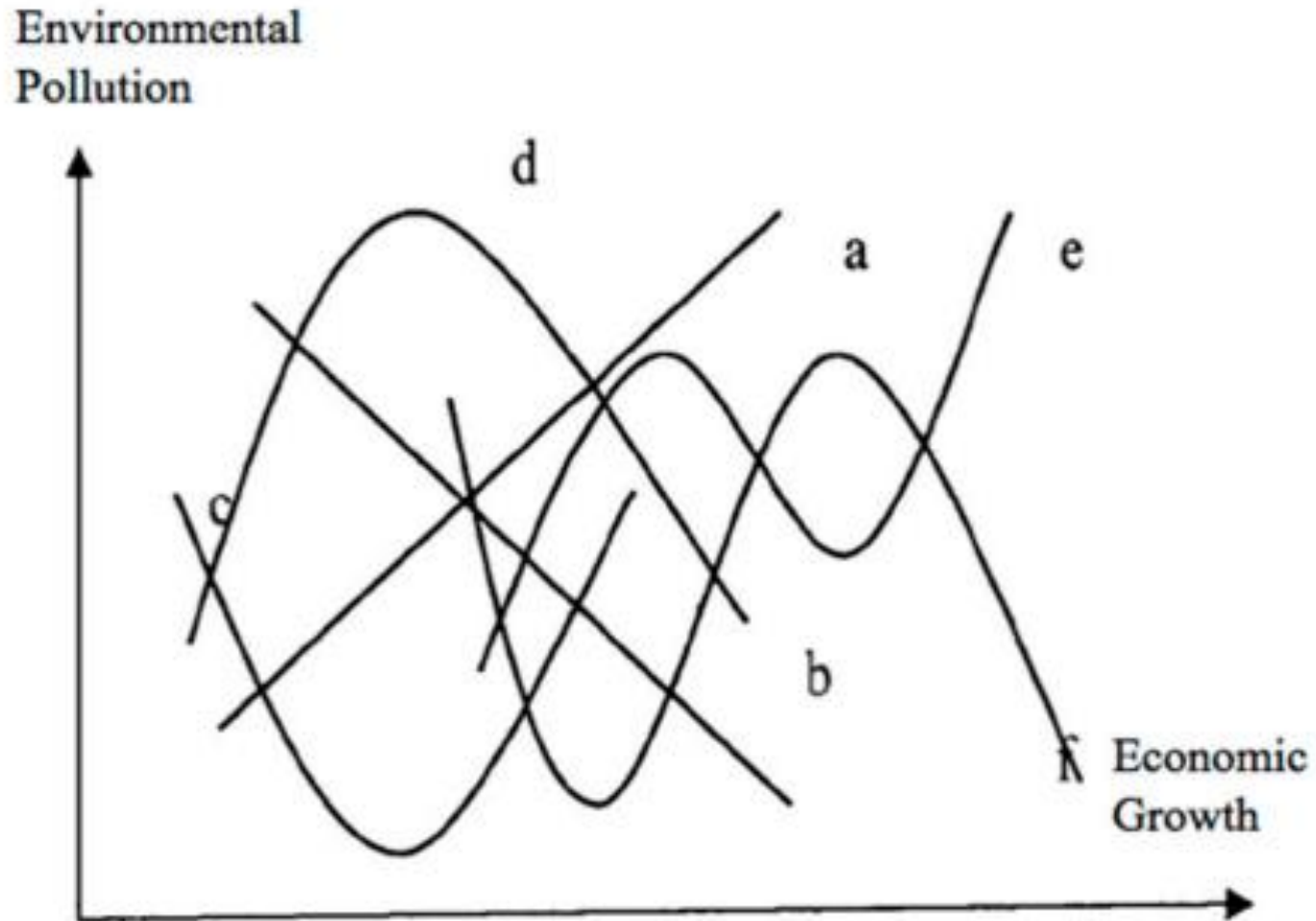


Illustration: Gurumurthy and Mukherjee, 2011 (LHS)

Multiple forms of EKC in practice

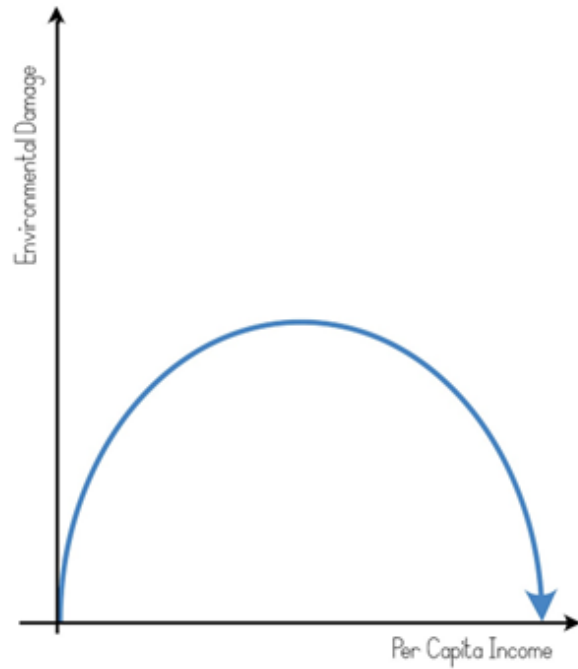
Doubtless unintentional, but this chart serves as an ironic statement of the meta-conclusion of thousands of studies into the EKC.



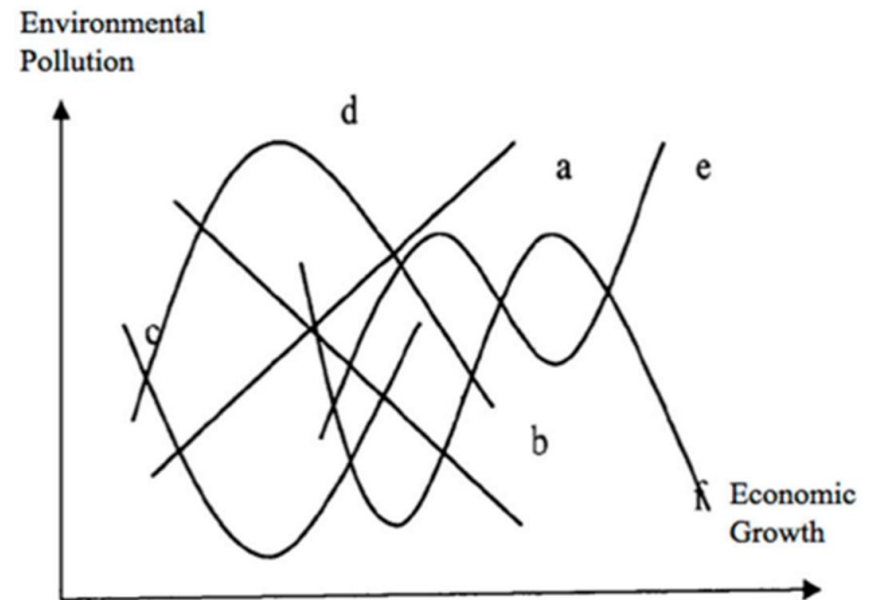
Hmmm...

There is a troubling discrepancy between theory and evidence.

Theory...



... Evidence



Very mixed evidence on ‘decoupling’ too...

The mixed findings are echoed in a smaller number of studies that focus on the slightly different ‘decoupling’ frame. In particular, while there is evidence of piecemeal decoupling what emerges is that **‘fast-enough’ decoupling of global problems seems unlikely.**

<u>Authors</u>	<u>Date</u>	<u>Comment</u>
Vaden et al.	2020	The reviewed 179 articles contain evidence of absolute impact decoupling, especially between CO ₂ (and SO _x) emissions and evidence on geographically limited (national level) cases of absolute decoupling of land and blue water use from GDP, but not of economy-wide resource decoupling, neither on national nor international scales. Evidence of the needed absolute global fast-enough decoupling is missing.
Haberl et al.	2020	Examples of absolute long-term decoupling are rare, but recently some industrialized countries have decoupled GDP from both production- and, more weakly, consumption-based CO₂ emissions;....;We conclude that large rapid absolute reductions of resource use and GHG emissions cannot be achieved through observed decoupling rates, hence decoupling needs to be complemented by sufficiency-oriented strategies and strict enforcement of absolute reduction targets.
Parrique et al.	2019	...not only is there no empirical evidence supporting the existence of a decoupling of economic growth from environmental pressures on anywhere near the scale needed to deal with environmental breakdown, but also, and perhaps more importantly, such decoupling appears unlikely to happen in the future.
Hickel & Kallis	2019	...absolute decoupling of GDP from <u>resource</u> use (a) may be possible in the short-term in some rich nations...; (b) is not feasible on a global scale, even under best-case scenario policy conditions; and (c) is physically impossible to maintain in the longer-term.... ...While absolute decoupling from <u>emissions</u> is possible and is already happening in some regions, it is unlikely to happen fast enough to respect the carbon budgets for 1.5°C and 2°C against a background of continued economic growth.

See Appendix for full references

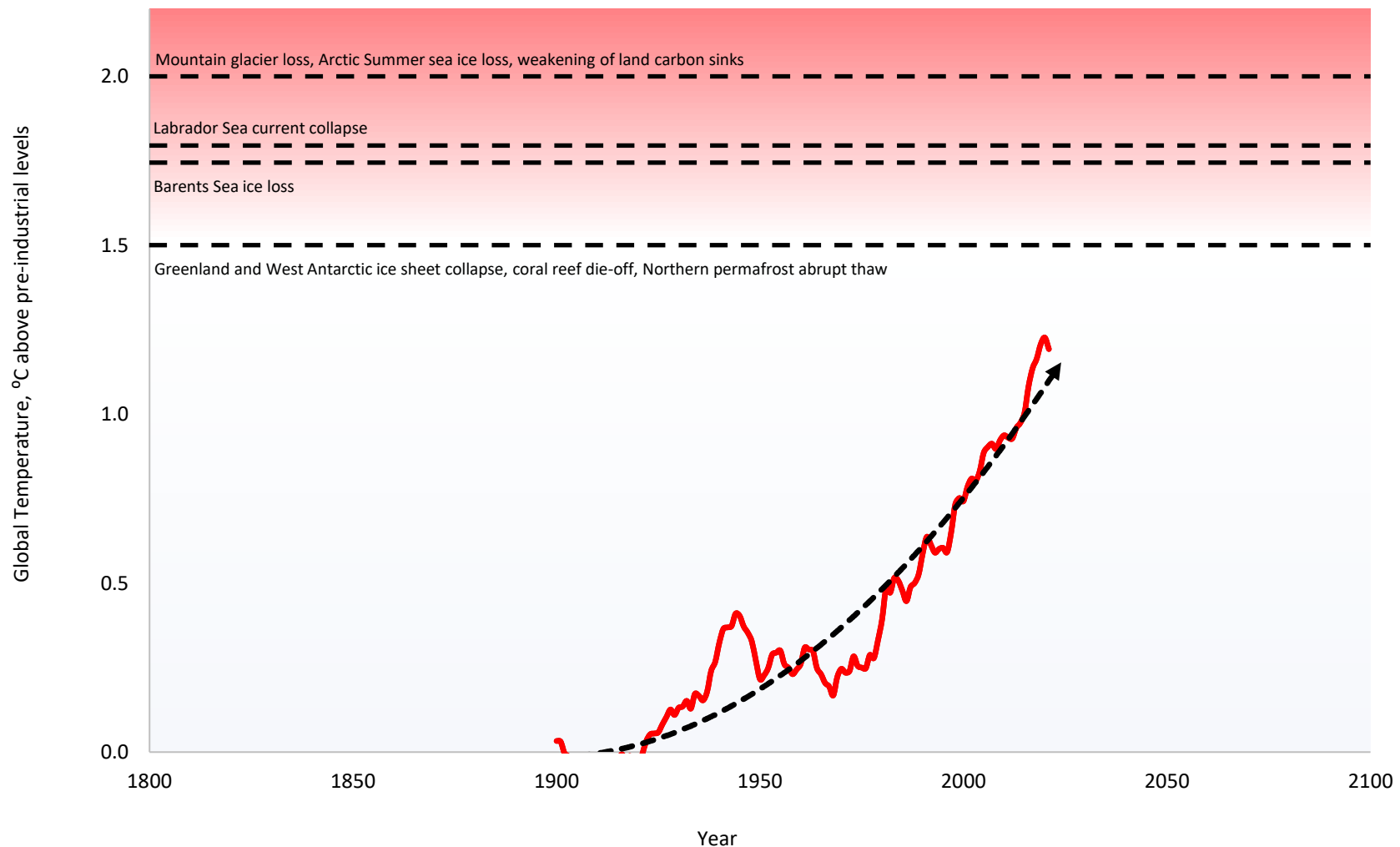
5. Conceptual problems of the EKC model... or why the EKC may be able to bend backwards

- Besides the lack of evidence, the EKC is conceptually flawed in failing to adequately grasp key dynamics of global ecological problems that scientists believe define the problem, namely tipping points and thresholds.

Global Temperature and Tipping Points

This is the 'big picture' view of the climate change problem: global temperature is rising towards various tipping points or thresholds in the climate system, which may prove irreversible.

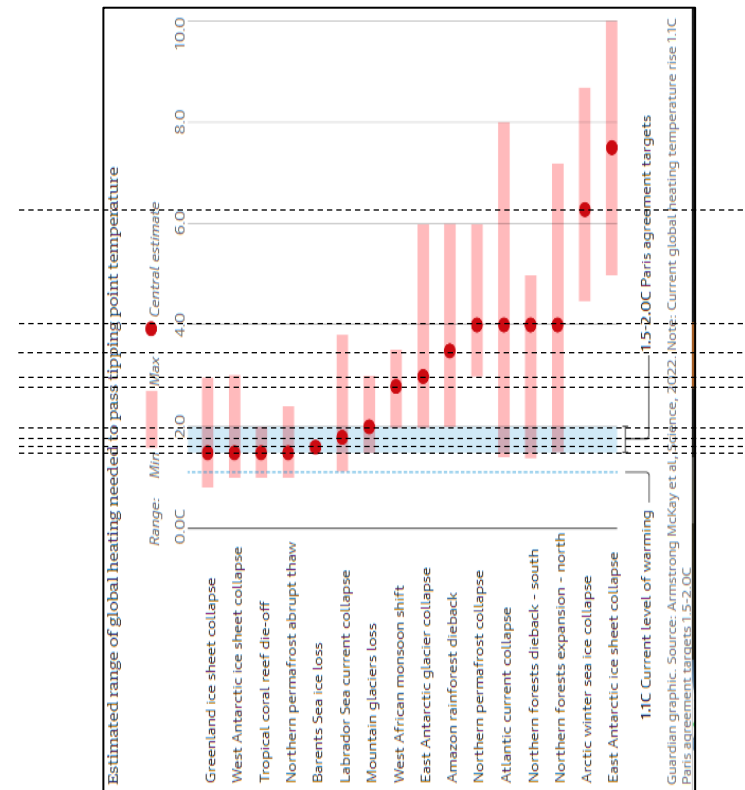
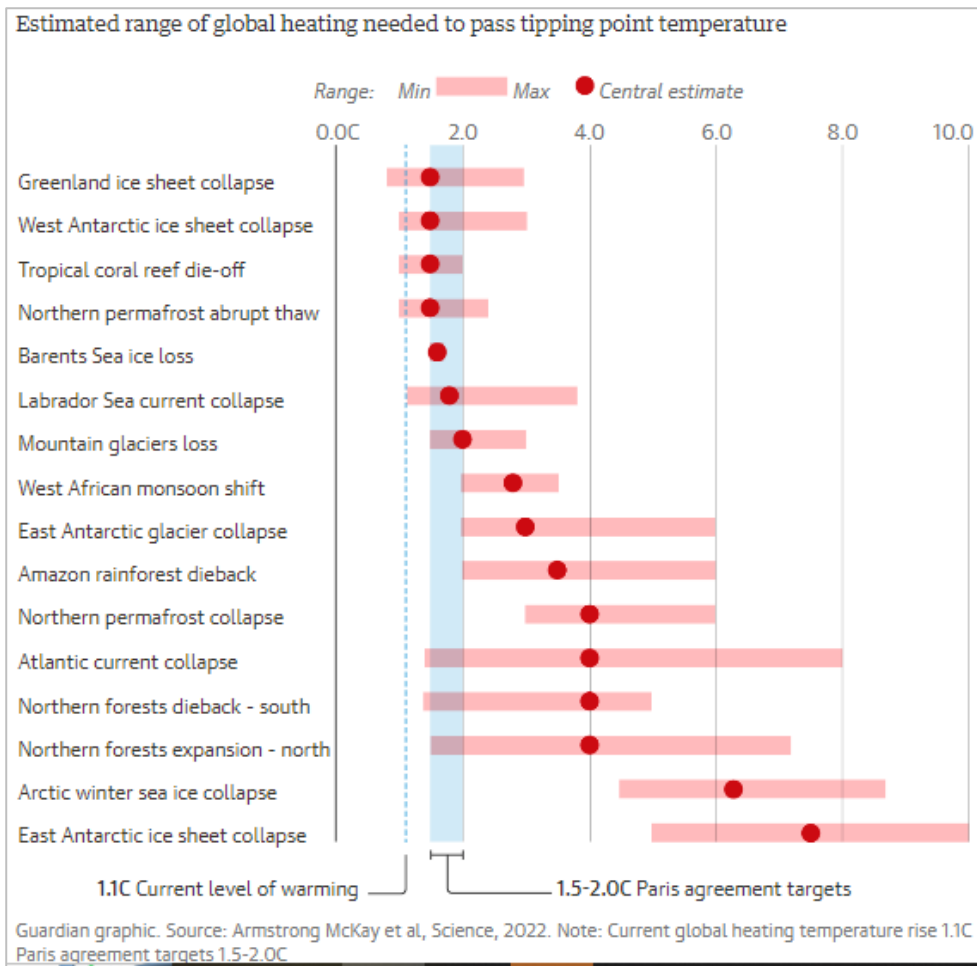
Global Temperature Change and Climate Tipping Points



Source: Tipping point data from Armstrong McKay et al, Science, 2022; Temperature data from HadCRUT5

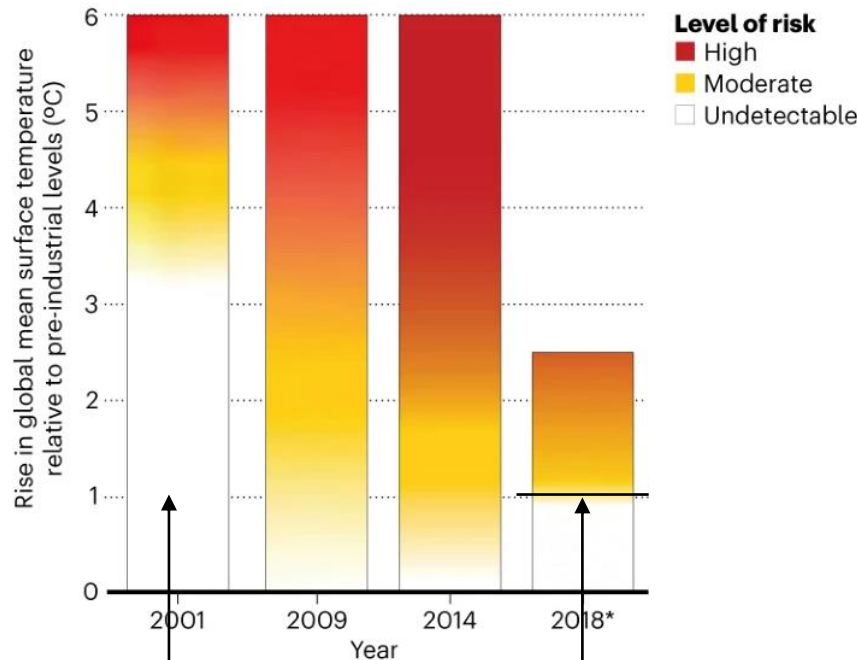
Key 'tipping points' for climate change

The crossing of irreversible 'tipping points' may trigger runaway heating. A Summer 2022 study documented 16 major tipping elements possible from 1.5°C onwards. (One can rotate through 90° to depict thresholds horizontally).



Armstrong McKay et al., 2022, Table S4 (tipping points).

Climate tipping points are nearer than we first thought



*The 2018 IPCC Special Report: *Global Warming of 1.5 °C* focuses on the temperature range up to 2.5 °C.

Compared to 2001 analysis, reports produced in 2018 (temperatures already at 1°C above pre-industrial levels) show moderate risk events are imminent.

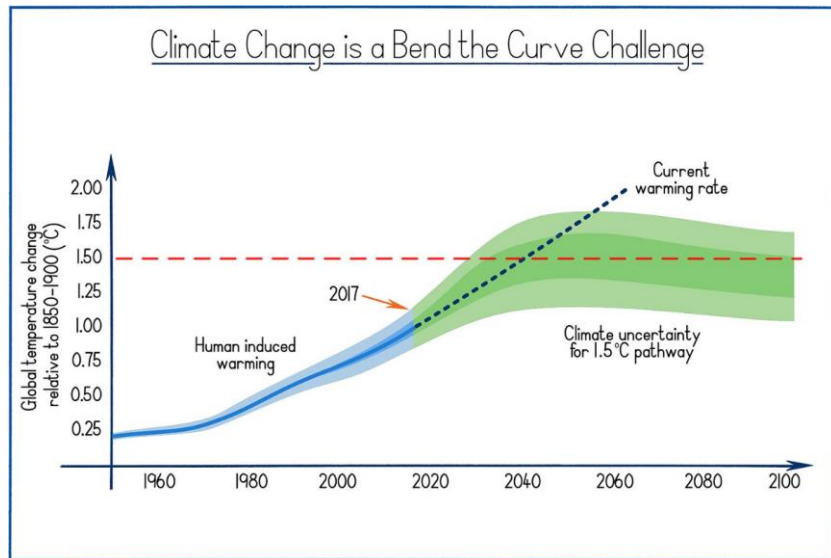
- The deliberative IPCC process has gradually been elevating the risk of irreversible ‘tipping points.’
- Recent IPCC reports indicate tipping points present **higher risks at lower temperatures than first thought:**
- “The IPCC introduced the idea of tipping points two decades ago. At that time, these ‘large-scale discontinuities’ in the climate system were considered likely only if global warming exceeded 5 °C above pre-industrial levels. Information summarized in the two most recent IPCC Special Reports (2018 and 2019) suggests that tipping points could be exceeded even between 1 and 2 °C of warming.”

Lenton et al, 2019, ‘Climate tipping points – too risky to bet against’, Nature; Kemp et al, 2022, ‘Climate Endgame’, PNAS

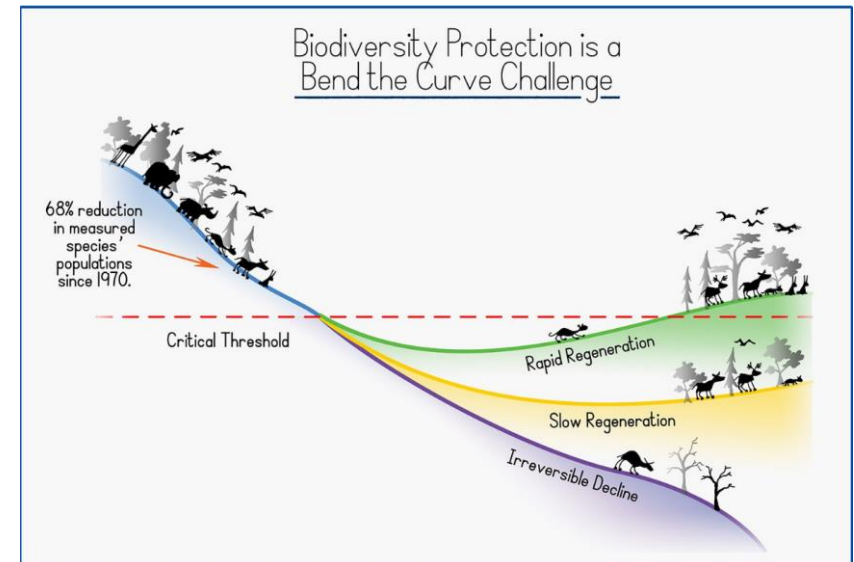
Thresholds relevant for other challenges

The notion of 'thresholds' also defines sustainability challenges beyond climate change. If climate change is a 'bend the curve down' challenge, biodiversity protection is more of a 'bend the curve up' challenge to avoid transgressing minimum viable population levels.

In both cases a horizontal line defines the key challenge.



IPCC, 2018



Based on IIASA (2020) and WWF (2020)

Deforestation tipping points

Protection of ecosystems such as the Amazon can be viewed as the effort to avoid going below ‘tipping points’. For the Amazon, the key horizontal line may be at 80% of original forest cover.

EDITORIAL

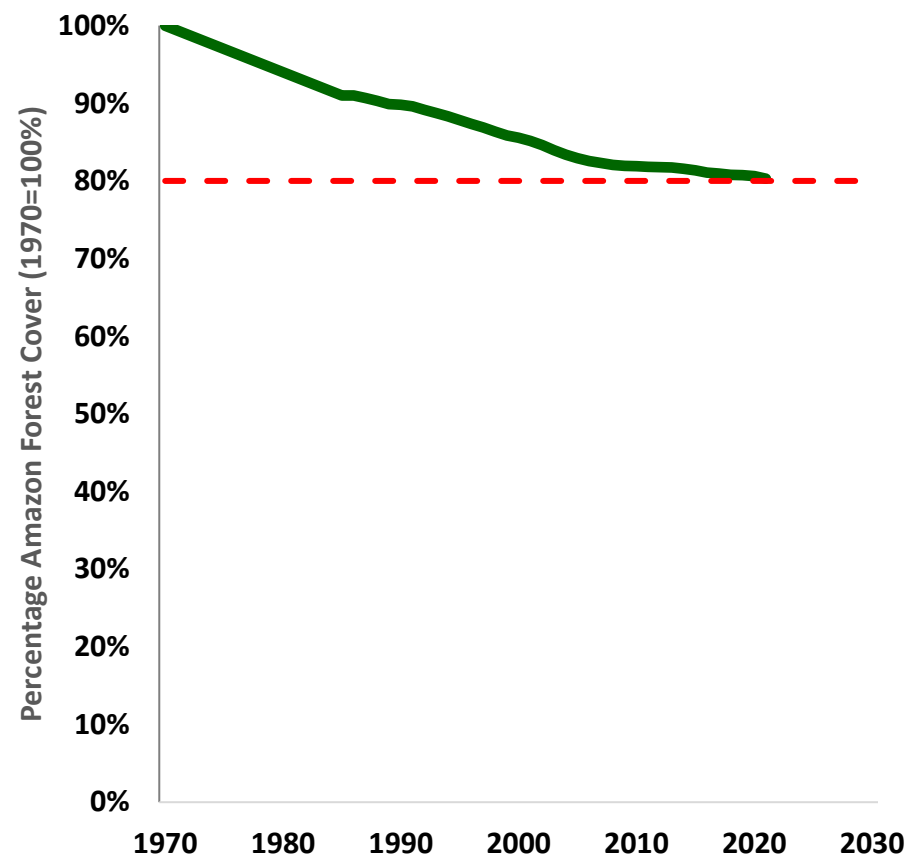
Amazon Tipping Point

THOMAS E. LOVEJOY AND CARLOS NOBRE [Authors Info & Affiliations](#)

SCIENCE ADVANCES • 21 Feb 2018 • Vol 4, Issue 2 • DOI: 10.1126/sciadv.aat2340

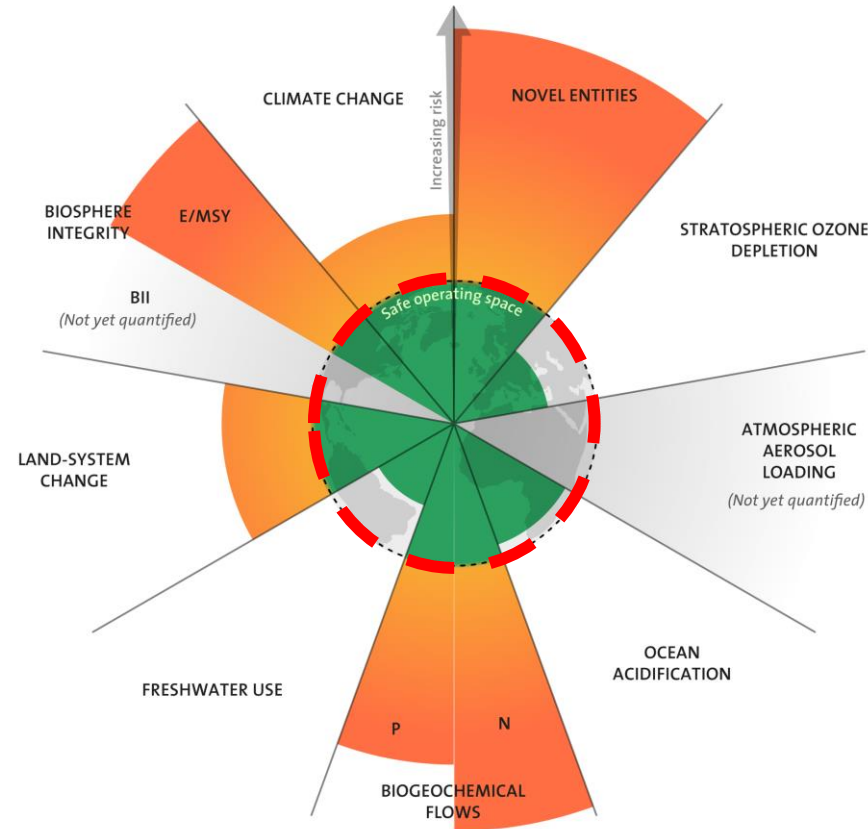
- “We believe that negative synergies between deforestation, climate change, and widespread use of fire indicate a tipping point for the Amazon system to flip to non-forest ecosystems in eastern, southern and central Amazonia at **20-25%** deforestation.”
- “We believe that the sensible course is not only to strictly curb further deforestation, but also to build back a margin of safety against the Amazon tipping point, by reducing the deforested area to less than **20%**, *for the common sense reason that **there is no point in discovering the precise tipping point by tipping it.***” (emphasis added)

Amazon Forest Coverage



Also 'boundaries' terminology

The 'planetary boundaries' work of Stockholm Resilience Centre is driven by the same understanding of thresholds. Their illustration combines boundaries – i.e. tipping points – of 9 ecological systems into a circle (inspiring Kate Raworth's 'Doughnut Economics')

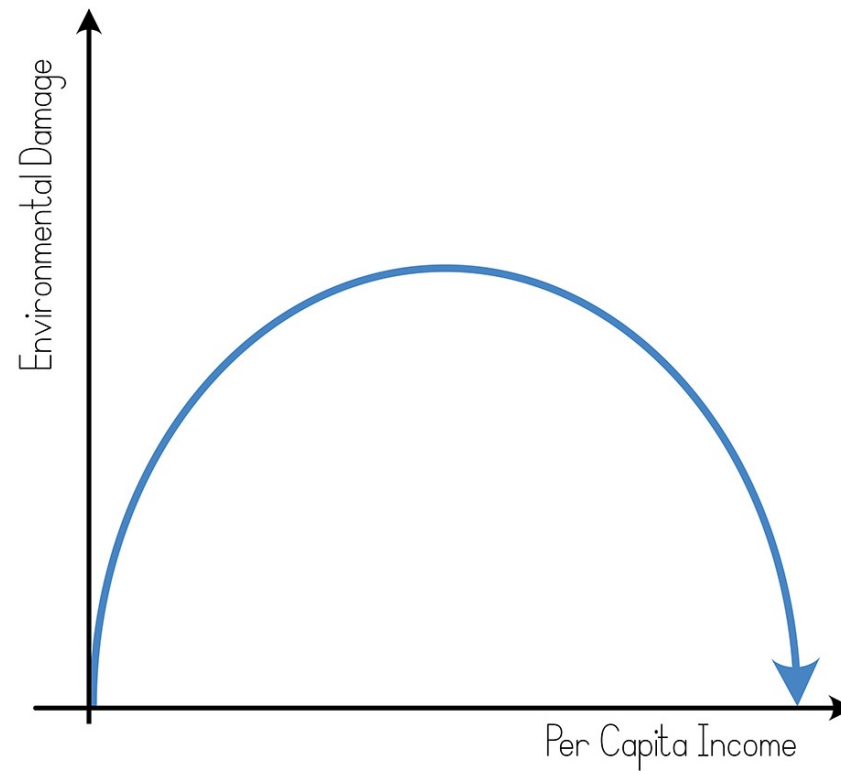


The 'planetary boundaries' concept of Stockholm Resilience Centre identifies 9 major ecological boundaries which we must live within or else risk 'pushing the Earth system into a new state'.

"Azote for Stockholm Resilience Centre, based on analysis in Wang-Erlandsson et al 2022".

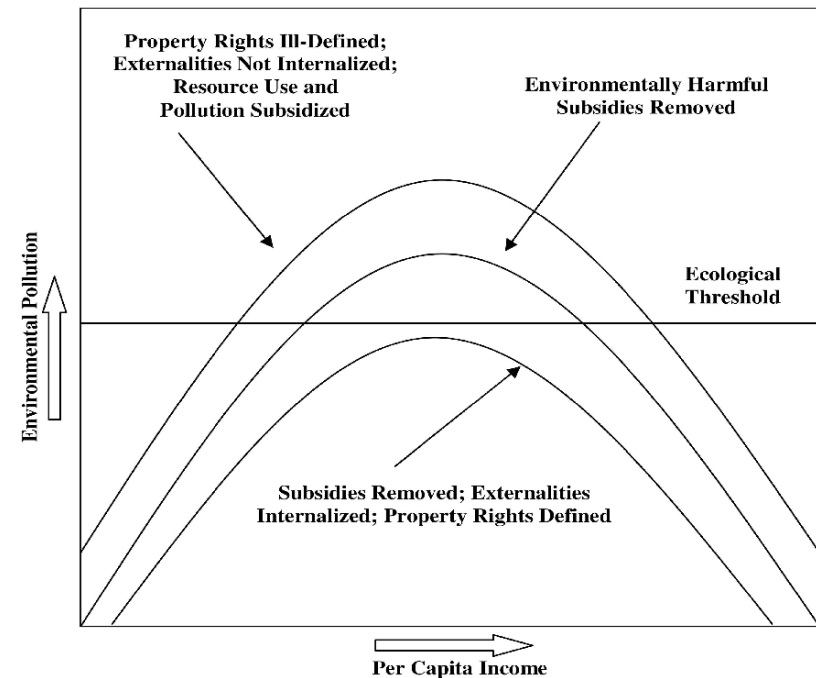
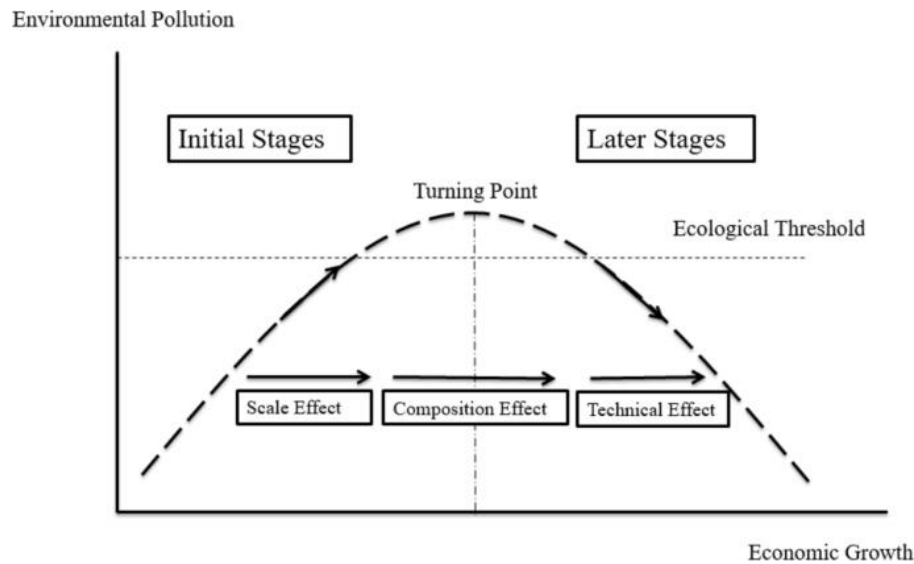
But there's no horizontal line on the EKC...?

Scientists define global environmental problems with respect to thresholds and boundaries, but there is no horizontal line on the conventional EKC...?



Occasional depiction of thresholds

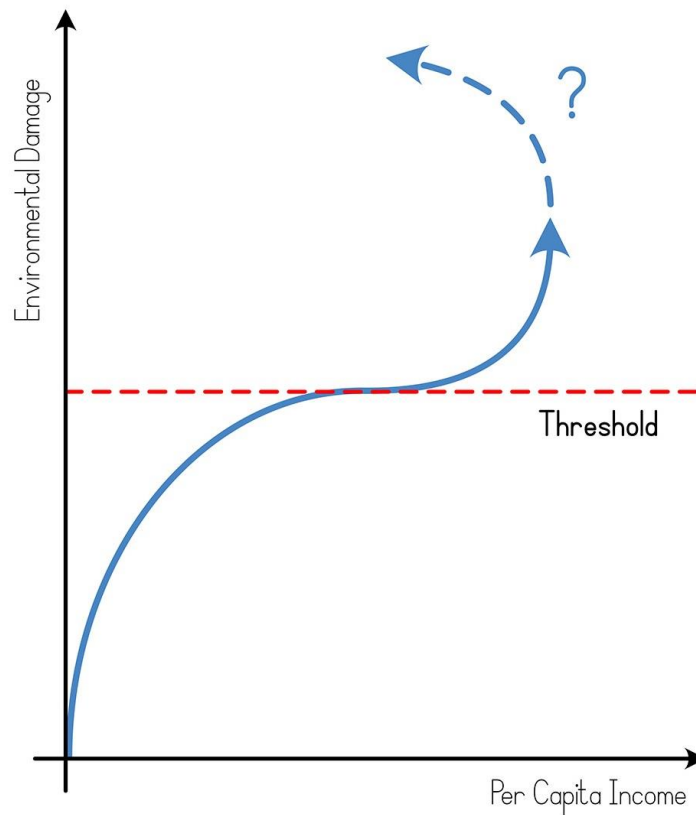
One can find (relatively rare) examples of EKC curves drawn with horizontal 'ecological thresholds', though the thresholds do not appear particularly 'threshold-like' because the EKC curve seems completely unaffected by their addition! Yet the reason scientists focus on thresholds is because they think something critically different happens once you cross them – a phase change or a state change.



Thresholds that matter

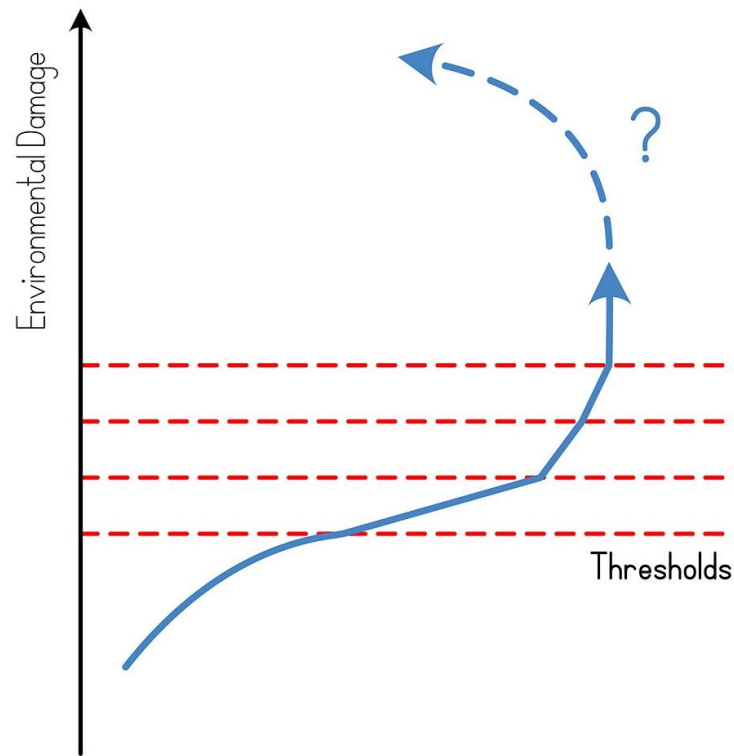
What scientists are trying to point out about irreversible thresholds is that if they are crossed, **we will not be able to get back!** Instead, we will have tripped 'runaway' self-sustaining heating or ecology-collapsing dynamics which may generate ongoing adverse effects on economic variables from crop yields to property destruction to disruptive and costly refugee dynamics to morbidity and mortality effects.

A Backward-Bending EKC ?



Multiple tipping points can trigger a 'tipping cascade'

EKC and a 'Tipping Cascade' Effect



- In fact, tipping points present a twofold risk when they are multiple in nature:
 1. They may be **irreversible** on human timescales.
 2. They act as **accelerants** in that breaching first thresholds will accelerate warming and so raise the probability of crossing subsequent thresholds to initiate a self-reinforcing 'tipping cascade'.
- While any individual irreversible change (e.g. melting of Arctic sea ice) may take decades or centuries to unfold when considered in isolation, the growing concern is that multiple coincident irreversible changes will combine to create such a 'tipping cascade' effect.
- “[A]brupt and/or irreversible changes may be triggered at a temperature threshold. Such changes are evident in Earth’s geological record, and their impacts cascaded across the coupled climate–ecological–social system. **Particularly worrying is a ‘tipping cascade’ in which multiple tipping elements interact in such a way that tipping one threshold increases the likelihood of tipping another.**” (Kemp et al, 2022)

Natural feedback loops look set to accelerate heating

Of 41 physical and biological feedback loops identified for the global climate system, 27 are 'reinforcing' loops that will accelerate heating (red), 7 are 'balancing' loops that will moderate heating (green), while 7 have a mixed/unknown effect (yellow).

Physical Feedback Effects

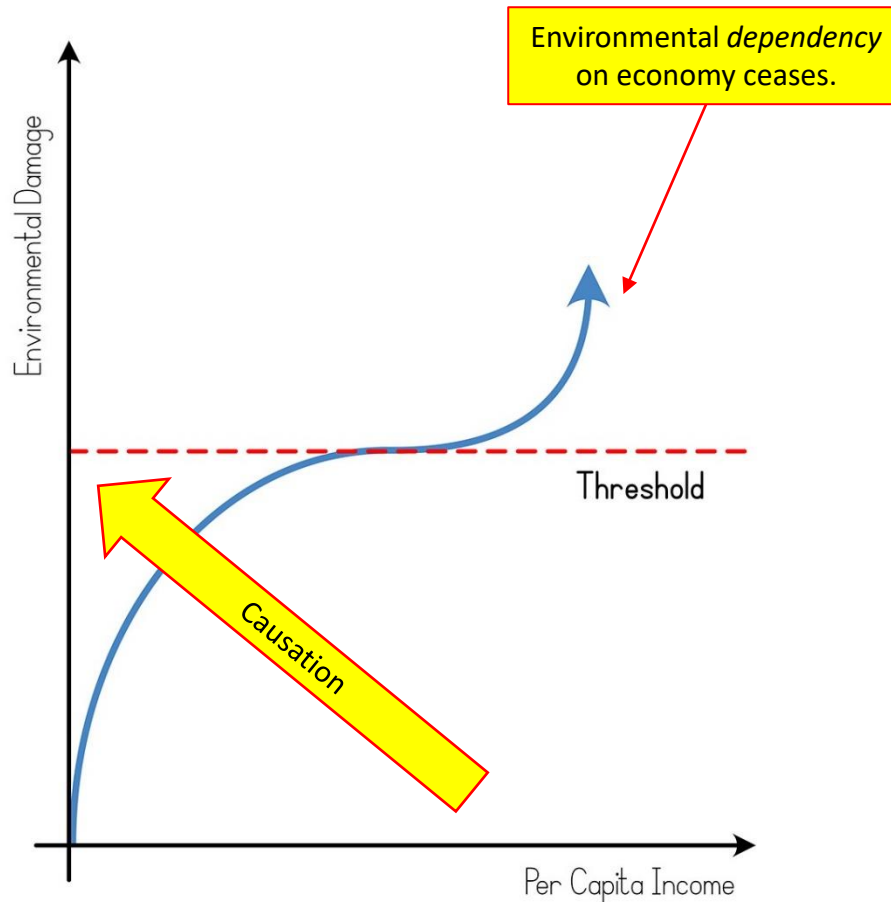
Planck effect	↑ Heat loss (radiation)	Green
Water vapor	↑ Greenhouse effect	Red
Sea ice albedo	↓ Albedo	Red
Ice sheets	↓ Albedo	Red
Sea level rise	↓ Albedo (↑ coastal submergence)	Red
Snow cover	↓ Albedo	Red
Clouds	Δ Cloud albedo & greenhouse effect	Red
Dust	Δ Albedo & greenhouse effect	Yellow
Other aerosols	Δ Albedo & greenhouse effect	Yellow
Ocean stratification	↓ Carbon uptake by ocean	Red
Ocean circulation	Δ Surface temperature	Yellow
Solubility pump	↓ CO2 absorption by ocean	Red
CH4 hydrates	↑ Release of CH4 into atmos.	Red
Lapse rate	↓ Global mean temperature	Green
Ice elevation	↑ Glacier & ice sheet melting, ↓ albedo	Red
Antarctic rainfall	↓ Albedo, ↑ deep ocean warming	Red
Sea ice growth	↑ Thin ice growth rate	Green
Ozone	↓ Tropical lower stratospheric ozone	Yellow
Atmospheric reactions	Δ Greenhouse effect	Yellow
Chemical weathering	↑ CO2 taken out of atmosphere	Green

Biological Feedback Effects

Peatlands	↑ Release of CO2 into atmos.	Red
Wetlands	↑ CO2 seq., ↑ CH4 emissions	Red
Freshwater	↑ CH4 emissions	Red
Forest dieback	↓ CO2 seq., Δ albedo	Red
Northern greening	↑ CO2 seq., ↓ albedo	Red
Insects	↓ CO2 seq., Δ albedo	Red
Wildfire	↑ CO2 emissions, Δ albedo	Red
BVOCs	↓ Greenhouse effect, ↑ tropospheric O3	Green
Soil carbon (other)	↑ CO2 emissions	Red
Soil nitrous oxide	↑ Nitrous oxide emissions	Red
Permafrost	↑ CO2 and CH4 emissions	Red
Soil and plant ET	↓ Latent heat flux	Red
Microbes (other)	↑ CO2 and CH4 emissions	Red
Plant stress	↑ Plant mortality, ↓ CO2 seq.	Red
Desertification	↓ CO2 seq., Δ albedo	Red
Sahara/Sahel greening	↑ CO2 seq. by vegetation	Green
CO2 fertilization	↑ Carbon uptake by vegetation	Green
Coastal productivity	↓ Coastal ecosystem carbon seq.	Red
Metabolic rates	↑ CO2 released into atmos.	Red
Ocean bio.	Δ Ocean carbon sink	Yellow
Phytoplankton-DMS	Δ Cloud albedo	Yellow

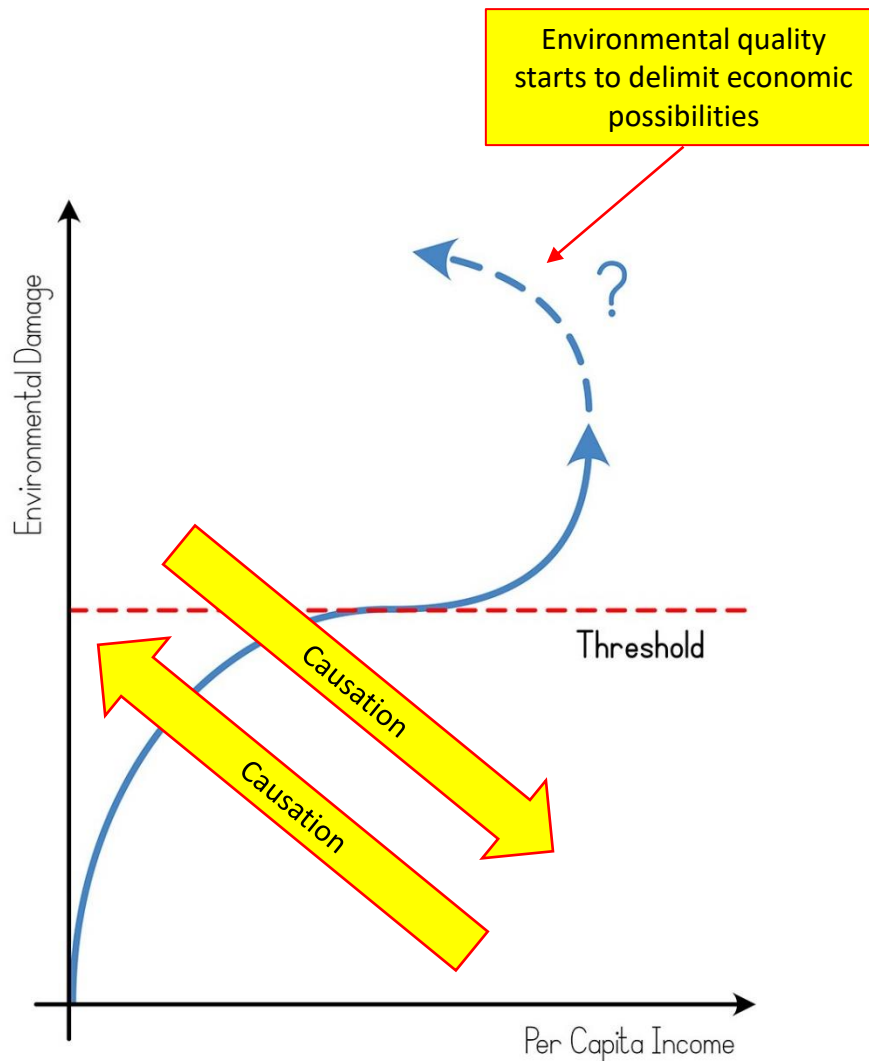
Tipping point dynamics: (i) causation breaks down

The addition of a meaningful threshold to an EKC diagram introduces critical new dynamics.



- In the event of 'runaway' effects – (e.g. release of methane from thawing permafrost generates more heating which leads to more methane release etc.) – 'environmental damage' loses its causative dependency on economic growth.
- Instead, it becomes a self-sustaining dynamic of the climate system, independent of human economic activity.
- The presumed causation from economy to environment, with its implication that economic behaviour can control - or remediate or 'turn off' – an environmental problem, breaks down.

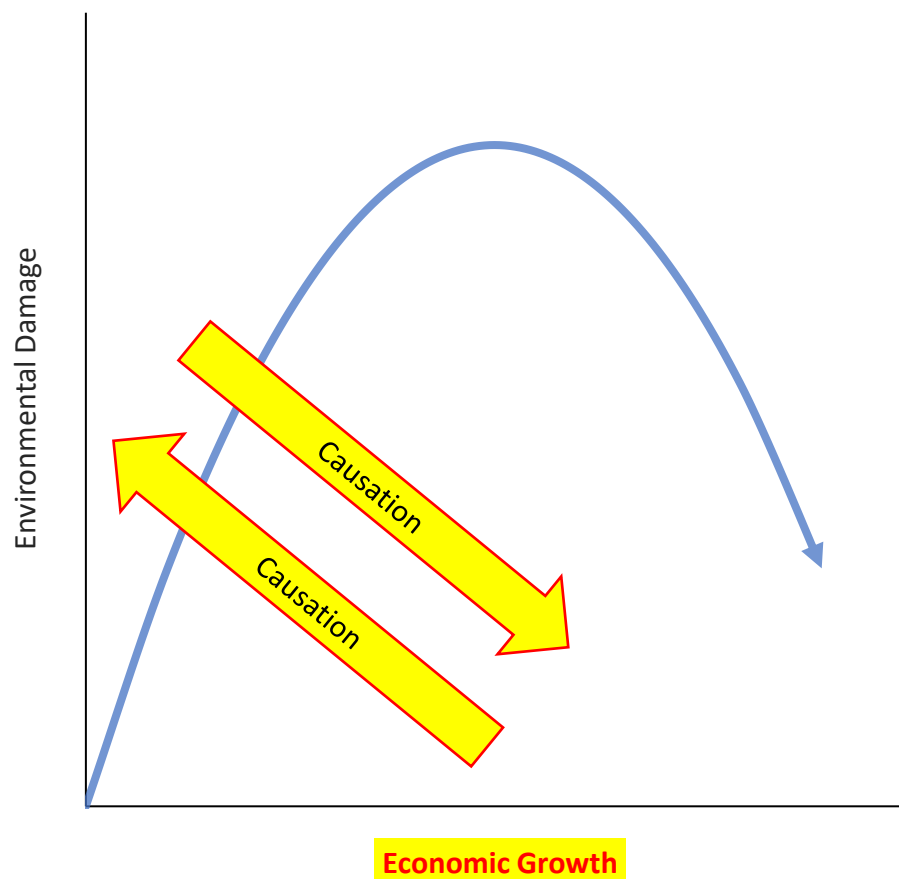
Tipping point dynamics: (ii) causation reverses



- Moreover, if runaway effects take hold, the economy becomes increasingly shaped by the environment.
- The more important causation may reverse from y-axis to x-axis, contradicting the default interpretation of x-y space.
- In other words, the economy and the environment co-evolve and exhibit reciprocal causation, but the EKC conventionally plotted in X-Y space denies the possibility of interdependency and of negative impacts on growth.
- This may be an inadvertent legacy of the EKC having been developed for localized air pollution issues (SO₂ etc) that are 'sub-system' flow problems not 'whole system' stock problems.
- For urban air pollution, it may be acceptable to assume that airsheds and lungs clear with negligible permanent effects. (Of course, lungs and cardiovascular systems can bear long-lasting irreversible damage even after air pollution is resolved).
- However, climate change and biodiversity challenges are defined by stock dynamics and long lags between emissions and the build up of concentrations and changes in temperature, etc. The application of an EKC to these issues amounts to a neglect of these fundamental dynamics.
- [Technical note: some EKC studies use 'Granger causality' tests to distinguish whether economic growth drives emissions or emissions drive *positive* economic growth, but these tests do not envisage that emissions may induce *negative* growth.]

EKC and two-way causation

Environmental Kuznets Curve



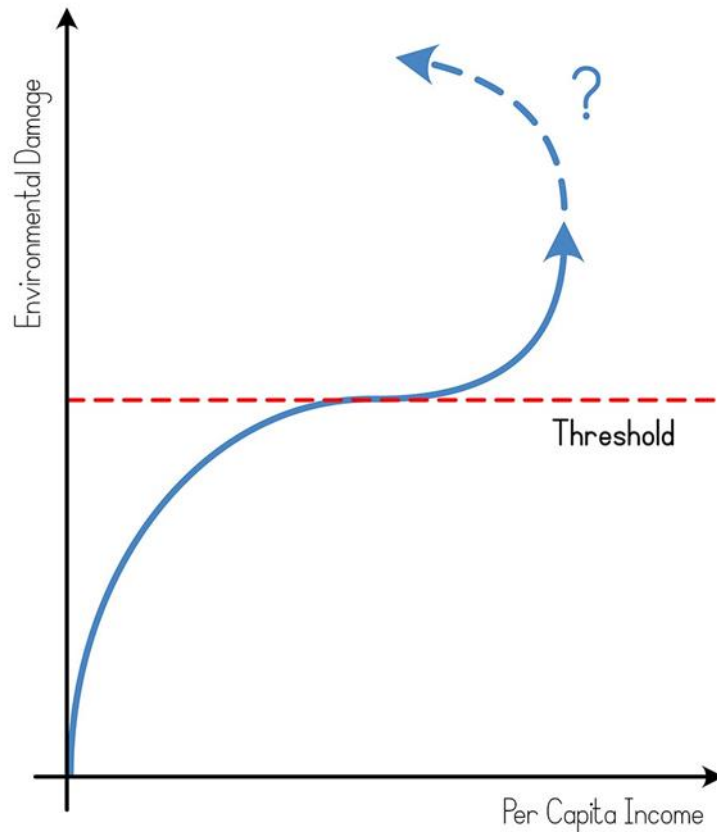
- What is happening is that the conventions of the familiar X-Y graphing space are breaking down.
- The rules of these graphs are that X is independent and Y is dependent, or X causes Y.
- To suggest there is two-way causation transcends what the familiar X-Y space is designed to accommodate.
- **Or, put another way, the problem with the EKC is not just the mixed data, but the axes and plot space too!**
- In a sense, the EKC went wrong when Grossman and Krueger drew up the axes – almost certainly without giving it much thought. It prefigured the way in which they – and many subsequent others – would think about the relationship between environment and economy.
- The mass application of the EKC formulation in thousands of studies speaks volumes for the ‘sort of thinking’ economics is built on, namely reductionist, abstract, ‘ceteris paribus’ thinking that has now run amok... and taken real-world institutions and behaviours with it.
- ‘Ceteris paribus’ thinking has led to ‘ceteris paribus’ behaviour at scale.

6. OK, but is there any evidence for a backward-bending EKC?

- Economists haven't been looking very hard...

What would evidence look like?

A Backward-Bending EKC ?

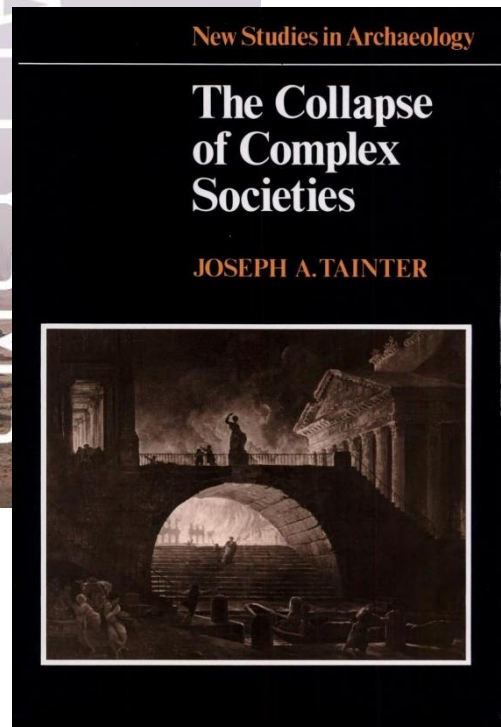


- If one plotted data that formed a backward-bending EKC curve, one would essentially be plotting the story of a society that grew economically for a period and then ran into some sort of threshold ecological event such that the economy reversed and even collapsed.
- But where is the evidence for such an event?
- None of the hundreds of data-fitting EKC curves seem to have identified or advanced the idea of a backward-bending curve (at least not that I can find?)
- Answer: data-dependent economists have ignored considerable evidence that just happens not to be data.

Not all evidence is data



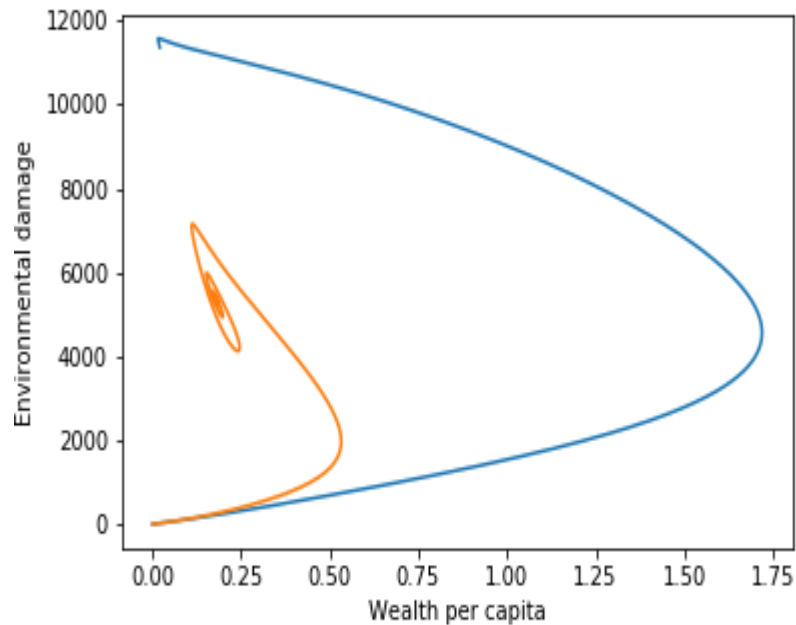
Not all evidence is data



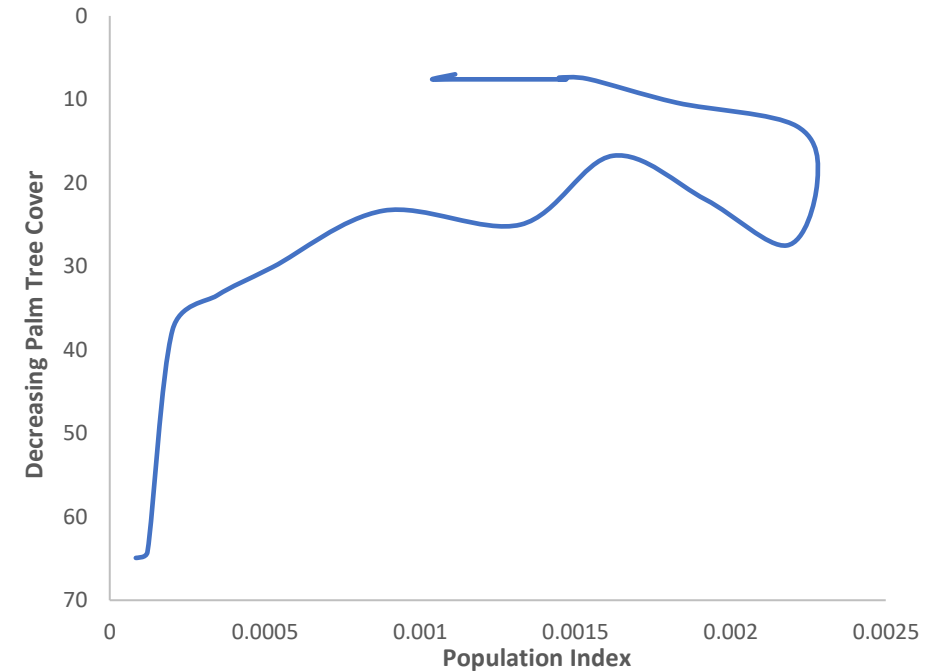
- **Collapsed societies don't leave data so much as ruins.**
- The EKC notion is not being properly tested against the enormous evidence base of human history, which provides repeated examples of societies succumbing to 'whole system' ecological challenges.
- From the Maya to Ancestral Pueblo to Rapa Nui of Easter Island, many earlier human societies, often of considerable complexity, collapsed by outgrowing their resource base.
- Whether the ecological collapse was solely or only partially attributable to their behaviour, the key fact is they were not able to alter their collective behaviour fast enough to a change of ecological condition.
- The implication is not that we are fated to repeat the mistake but that there are ample precedents for complex human societies proving unable to sustain their resource base – presumably with some eventual recognition of what they were doing.
- Indeed complex societies seem susceptible to it – possibly because the 'attentional pull' of managing surface complexity eventually distracts from respecting and stewarding ecological foundations. Gradually, and inexorably, complexity 'drags up' – or disembeds – perception, values and behaviour from underlying physical fundamentals.
- *"The process of rise-and-collapse is actually a recurrent cycle found throughout history...The fall of the Roman Empire and the equally (if not more) advanced Han, Mauryan, and Gupta Empires, as well as so many advanced Mesopotamian Empires, are all testimony to the fact that advanced, sophisticated, complex, and creative civilizations can be both fragile and impermanent."* (Motescharri, 2014)

Collapse researchers plot 'backward C' graphs

While there is no 'income' or 'GDP' data for collapsed societies, collapse researchers habitually work with 'backward C' graphs in contrast to the 'inverted U' graphs of the EKC – whether in modelling societal dynamics (left) or in plotting estimated population trajectories (right)



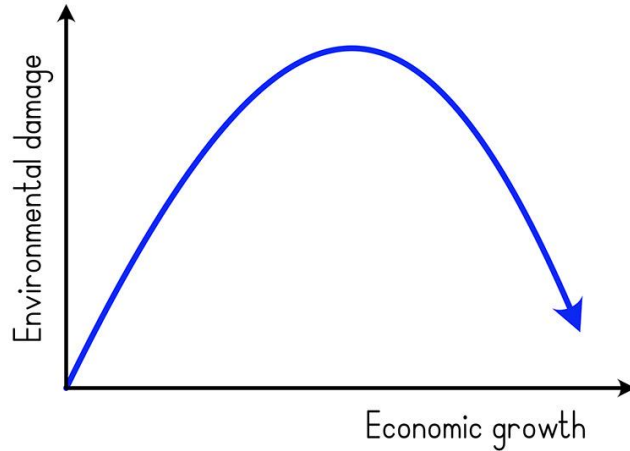
Theoretical model of Easter Island 'wealth' and damage dynamics (blue) and possible steady state dynamics (orange). From "Dynamic and game theoretic modelling of societal growth, structure and collapse", Sabin Roman (2018); personal correspondence



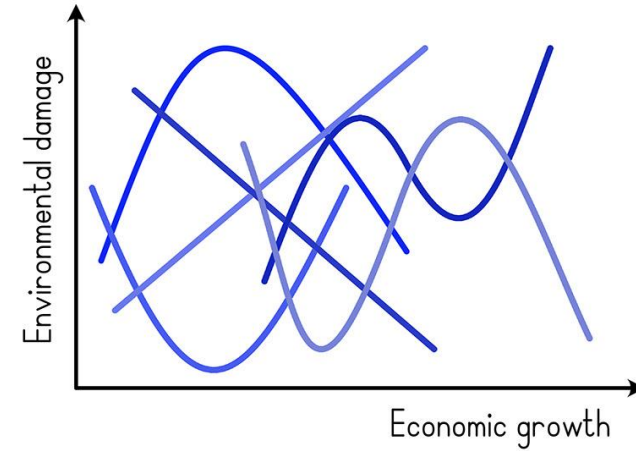
Estimated population and ecological dynamics of Easter Island. From "Ecology of the Collapse of Rapa Nui society", Lima et. al. (2020); personal correspondence.

From 'inverted U' to 'backwards C'

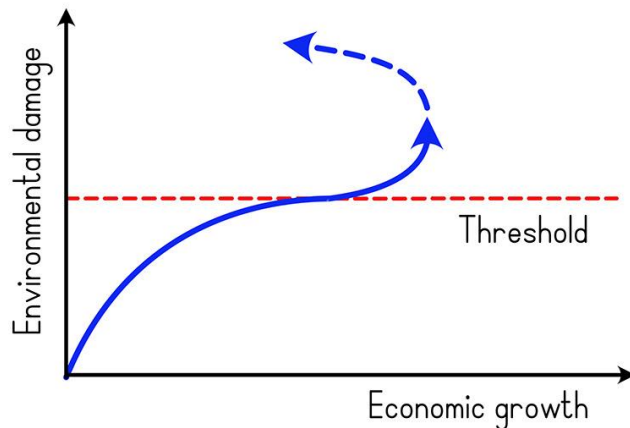
- 1 The EKC is economics' hypothesis that growth typically causes environmental damage to start before reliably reducing damage subsequently. Hence 'growth is the solution'! 'Decoupling' will save the day!



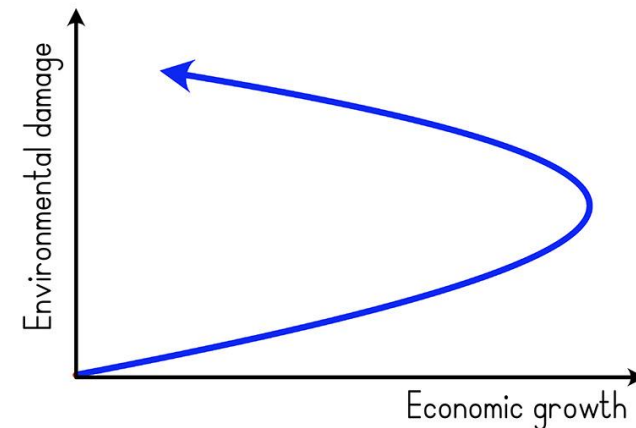
- 2 But the empirical support is very weak. The meta-conclusion from thousands of studies is that the EKC reliably takes one of these 6 forms...



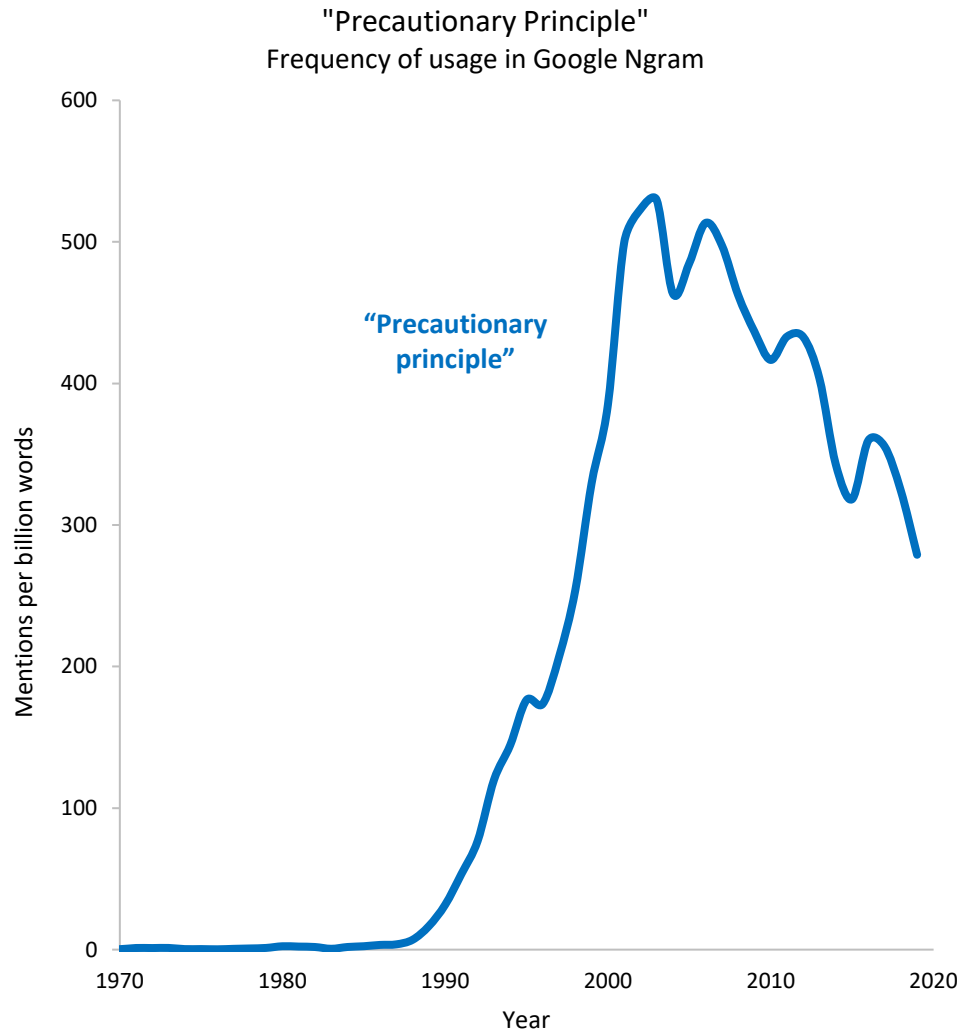
- 3 Worse, EKC conventions deny the possibility of climate and ecological 'tipping points' that scientists are frantically pointing out define global challenges and which may induce a backward-bending curve.



- 4 Indeed, researchers who investigate the collapse of complex societies such as the Maya and Rapa Nui habitually plot not an inverted 'U' but a backwards 'C', as growth induces ecological overshoot and then decline.



We ARE the experiment...

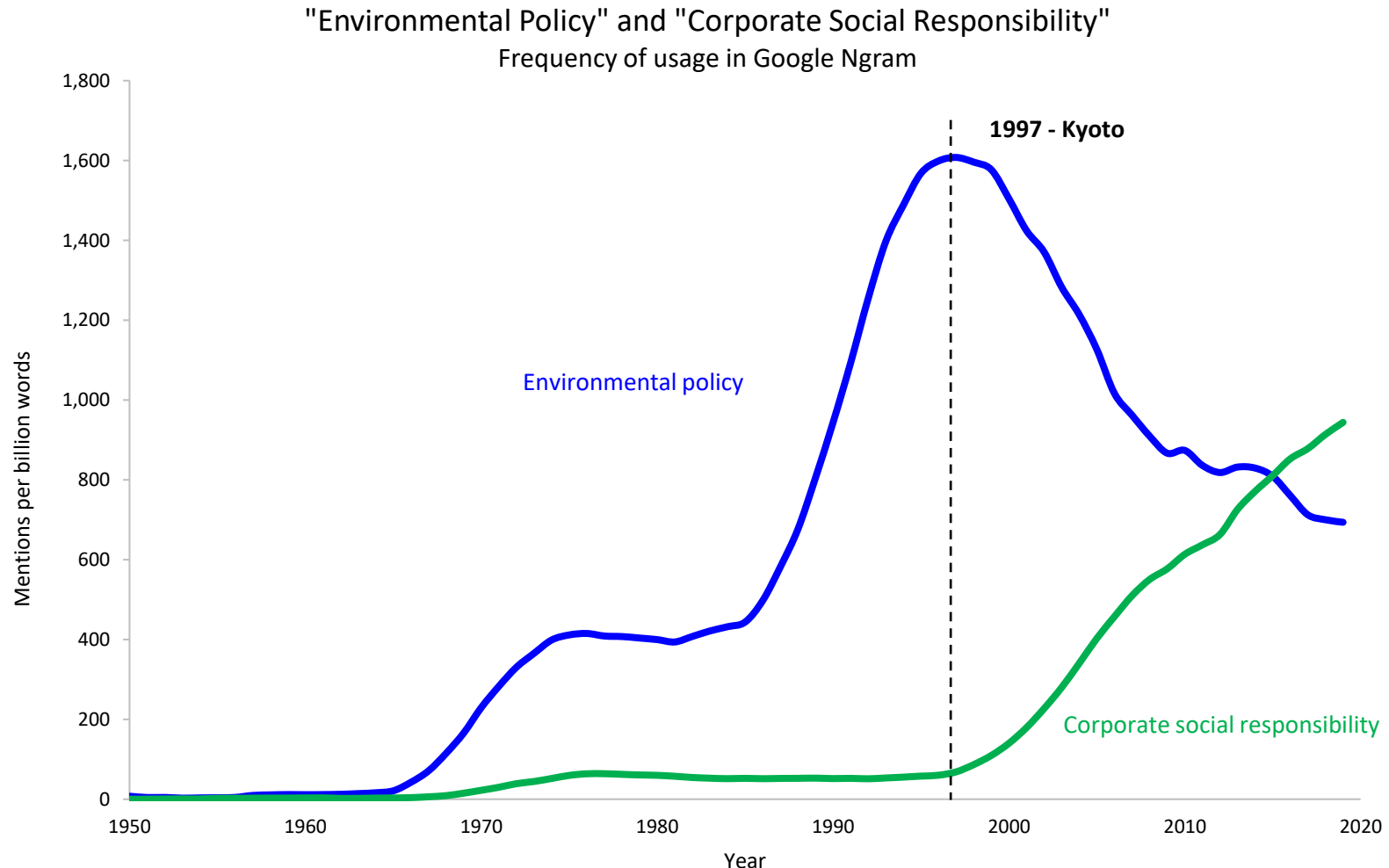


Source: Google Ngram

- Ideally, to settle the debate about the validity of the EKC, we could run the ‘global climate change experiment’ a few times to see whether economic growth solves climate change or not.
- ***But for climate change and other global-scale ecological problems, we are the experiment.***
- ***The experiment is global and there is nowhere to stand that is not part of the experiment.***
- An easily overlooked condition for the scientific method to be valuable is that its beneficiaries must survive the evidence-gathering phase...
- A culture grown used to the fruits of scientific advance and hence infused with a powerful sense of its technological prowess may become complacent about the existential danger of large-scale experimentation.
- This is why the ‘precautionary principle’ was formulated early on in the investigation of global environmental problems – as a reminder that if you cannot step out of the experimental frame and there is a risk of the experiment failing, proceed very carefully.
- Curiously, Google Ngram shows the term gained significant traction to the early 2000s, though has declined subsequently – almost as if we threw caution to the wind during that period...

We effectively did throw caution to the wind...

In fact, we effectively did throw caution to the wind at that stage as the late 1990s/early 2000s was when the early instinct to tackle environmental problems through binding policy was replaced by the view that responsible corporate behaviour might suffice instead.



Source: Google Ngram; bothbrainsrequired.com

7. High-profile misuse of the EKC feeds unwarranted complacency about our progress on sustainability

- The EKC – via a ‘decoupling’ narrative – is being uncritically propagated to exaggerate progress on climate change, which fosters a dangerous sense of complacency. In turn, this defuses urgency for a wider public debate about the potential dangers of current economic growth.

'Decoupling' narrative

High-profile news outlets and websites have been reporting 'good news' stories of 'decoupling' of CO₂ emissions from economic growth
E.g, 'Economics may take us to net zero all on its own' ...?

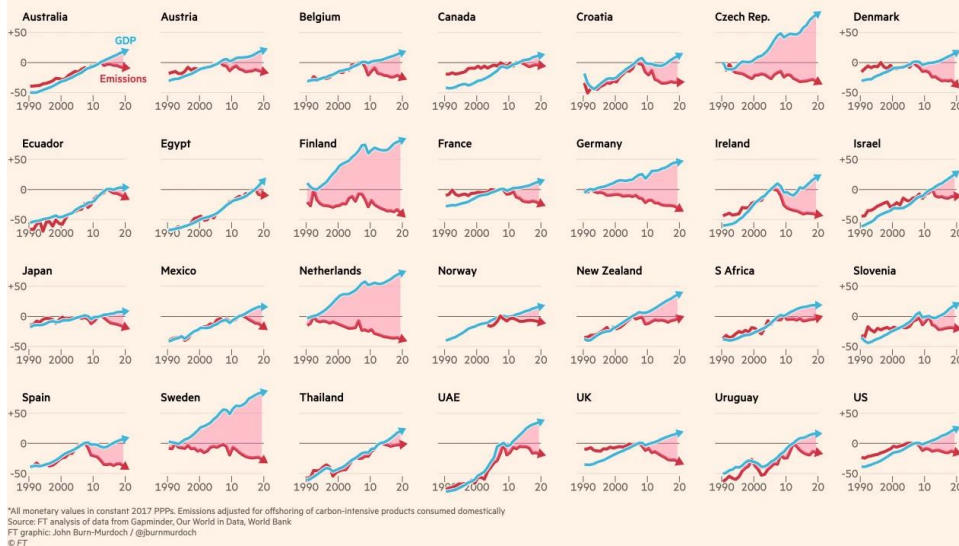
Economics may take us to net zero all on its own

The plummeting cost of low-carbon energy has already allowed many countries to decouple economic growth from emissions

JOHN BURN-MURDOCH + Add to myFT

Dozens of countries are now seeing a steady decline in CO₂ emissions alongside economic growth

Recent trend in emissions and GDP, expressed as % change since divergence began

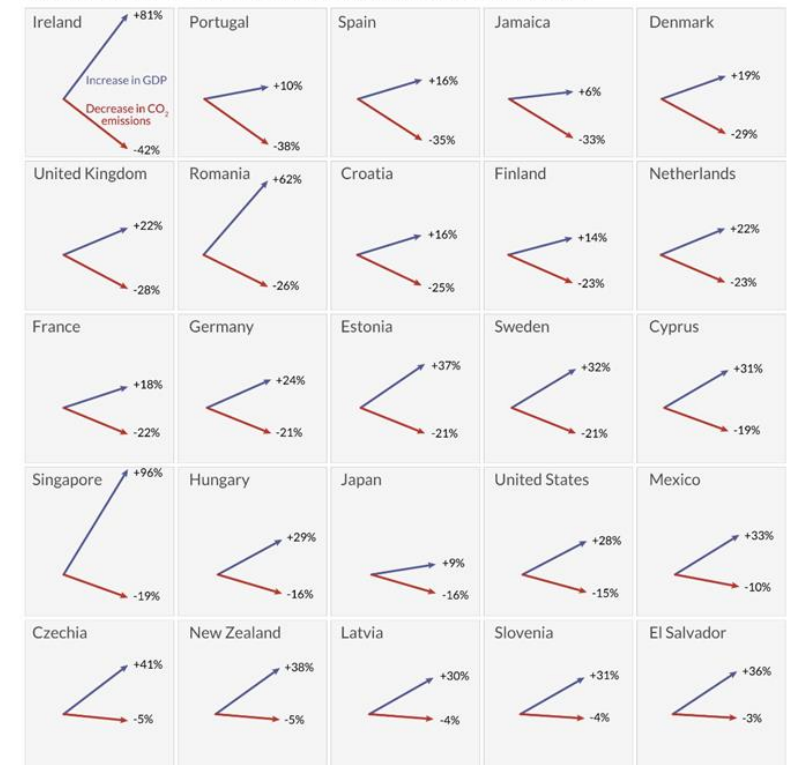


Source: Financial Times;
28 countries representing 29% of global CO₂ emissions and 16% of global population.

Decoupling: Countries that achieved economic growth while reducing CO₂ emissions, 2005-19

Our World in Data

Emissions are adjusted for trade. This means that CO₂ emissions caused in the production of imported goods are added to its domestic emissions – and for goods that are exported the emissions are subtracted.



Data: Global Carbon Project & World Bank. There are more than these 25 countries that achieved the same. OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser

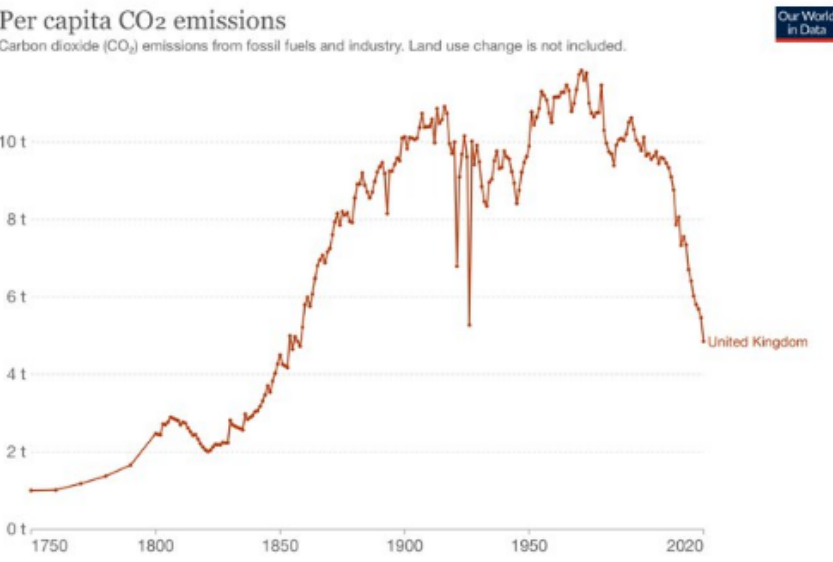
Source: Our World in Data;
25 countries representing 24% of global CO₂ emissions and 12% of global population.

“Folks, here’s a chart...”

 **Paul Krugman** ✓
@paulkrugman

On the margins of actual policy debate, there's a bit of harassment from "degrowthers" who insist that environmental protection requires an end to growth. Folks, here's a chart 1/

Per capita CO₂ emissions
Carbon dioxide (CO₂) emissions from fossil fuels and industry. Land use change is not included.



Source: Our World in Data based on the Global Carbon Project
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ · CC BY

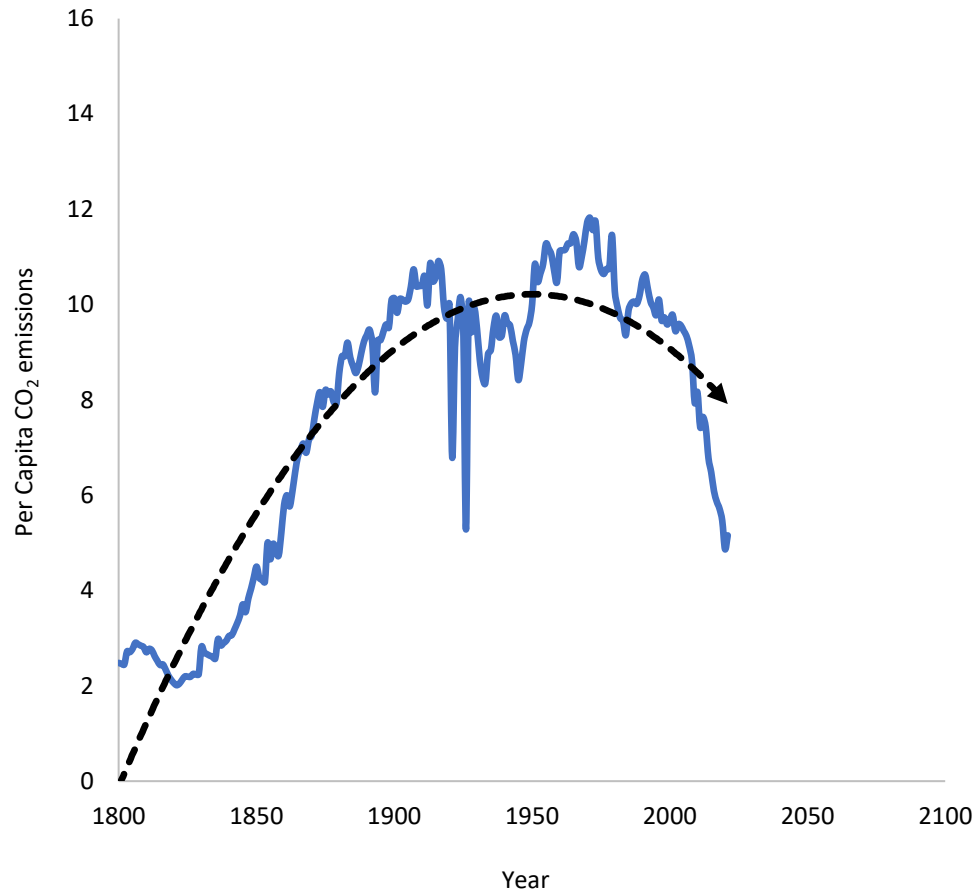
12:38 PM · Aug 4, 2022

- Paul Krugman, the Nobel-Prize winning economist has done the same using this graph both on Twitter (here) and in NY Times (March 2023).
- Alas, this is a perfect example of uncritical but influential misuse of EKC/decoupling thinking.
- It is not that UK decoupling (1% of global emissions) is directionally unhelpful, but that selectively presenting a very small positive development masks the still-worsening situation of the big picture and invites complacency about economic growth.
- This graph is misleading in four different ways:
 - Small detail: it uses **production** emissions not **consumption** emissions; see earlier slides
 - Climate change is dependent on **total global** activity not **national per capita** activity.
 - **Emissions** are a driver or lead indicator of damages for which **temperature** is a much closer proxy.
 - Ecologists and scientists are increasingly stressing the **‘tipping point’** nature of the climate challenge, which remains entirely absent from EKC/decoupling depictions.
- **We can build up a truer picture by changing the variables one by one...**

Towards the Bigger Picture (1 of 5)

First, to substitute a clearer version of Krugman's chart (same data; longer forward timeframe). The chart aims to convey an optimistic story that economic growth is consistent with reduction in CO₂ emissions (turning down is good).

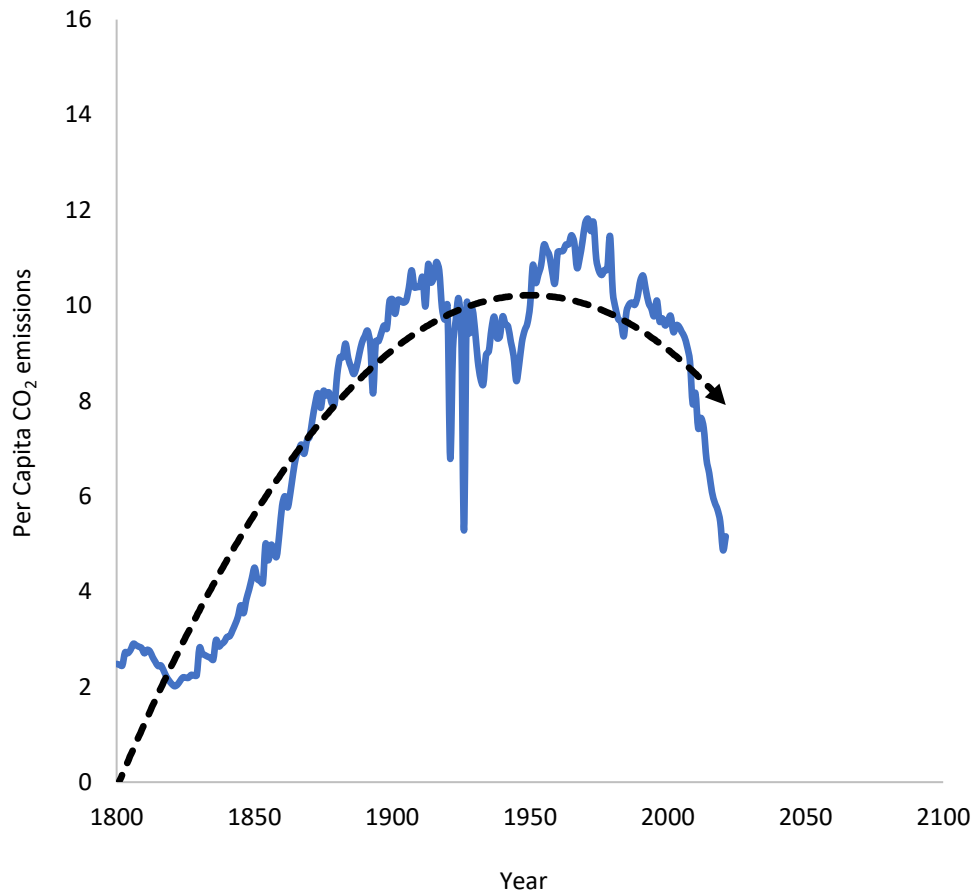
UK/Per Capita/Production-based/Emissions



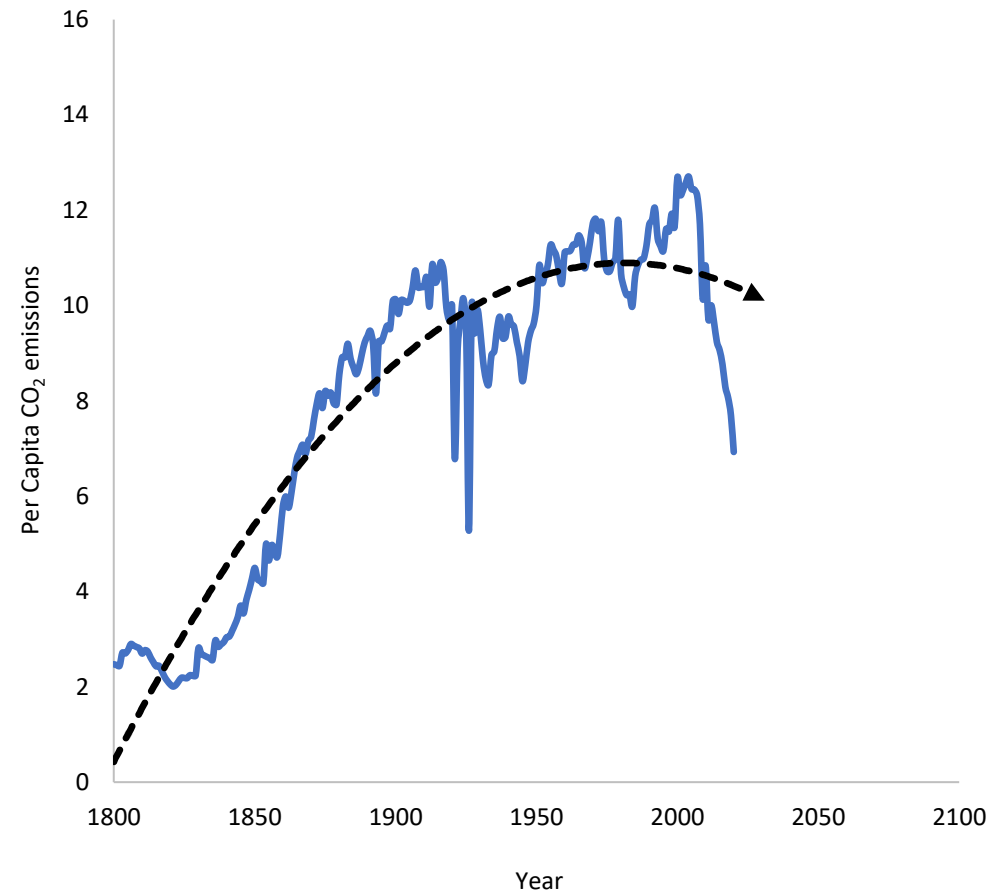
Towards the Bigger Picture (2 of 5)

A small detail – as mentioned earlier – is that a production-based picture of UK emissions (left) is slightly more flattering than a consumption-based view (right) which is arguably a truer measure of UK 'responsibility' (black arrow has not rolled over as much).

UK/Per Capita/Production-based/Emissions



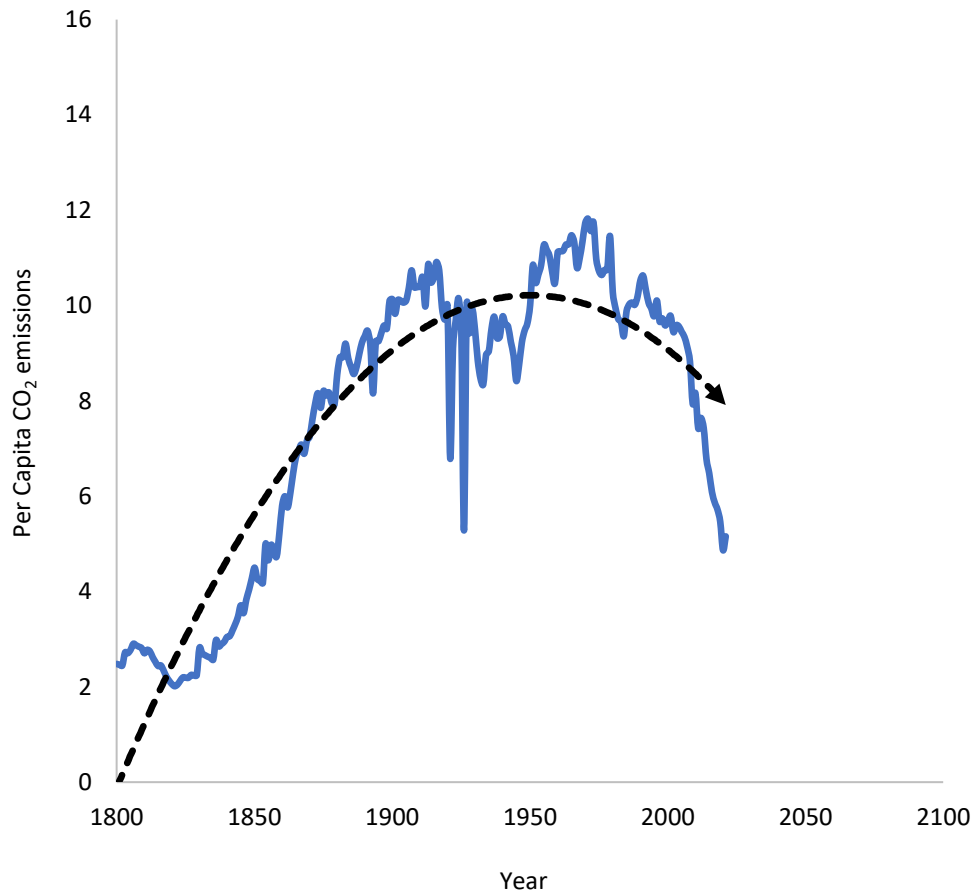
UK/Per capita/Consumption-based/Emissions



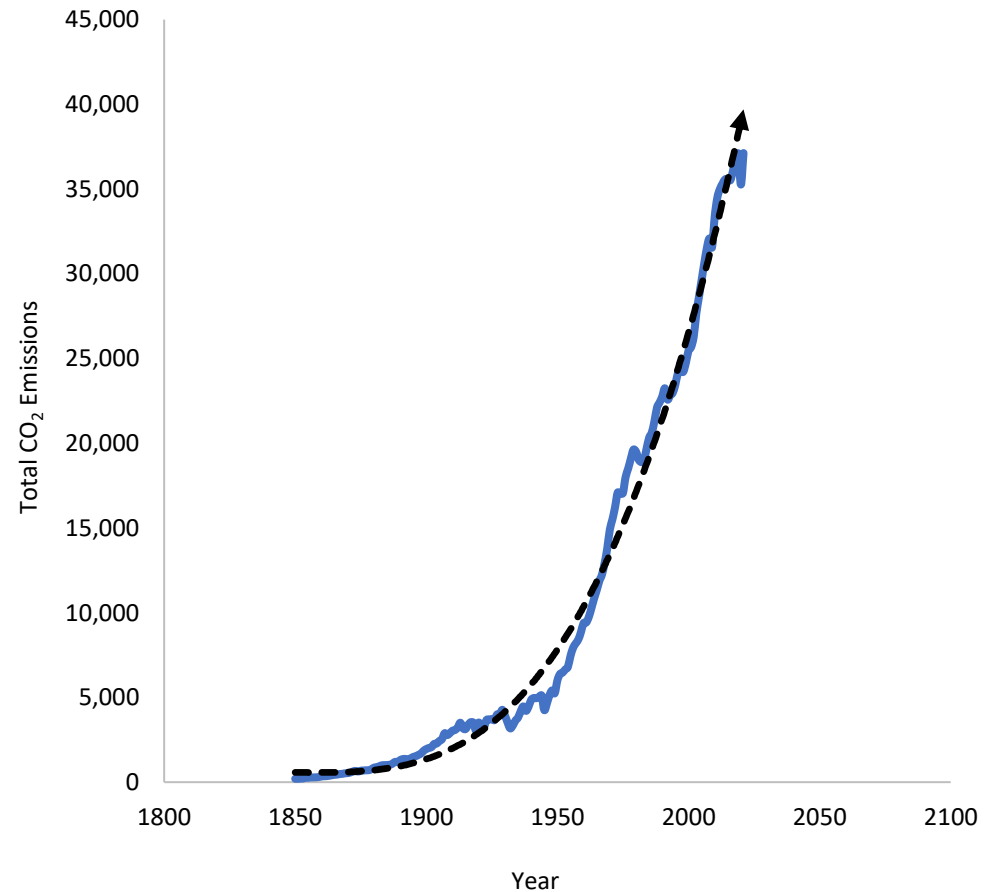
Towards the Bigger Picture (3 of 5)

As a global problem, climate change risk is determined by total global emissions (making redundant the production/consumption distinction and the per capita metric). The global curve is still heading upwards

UK/Per Capita/Production-based/Emissions



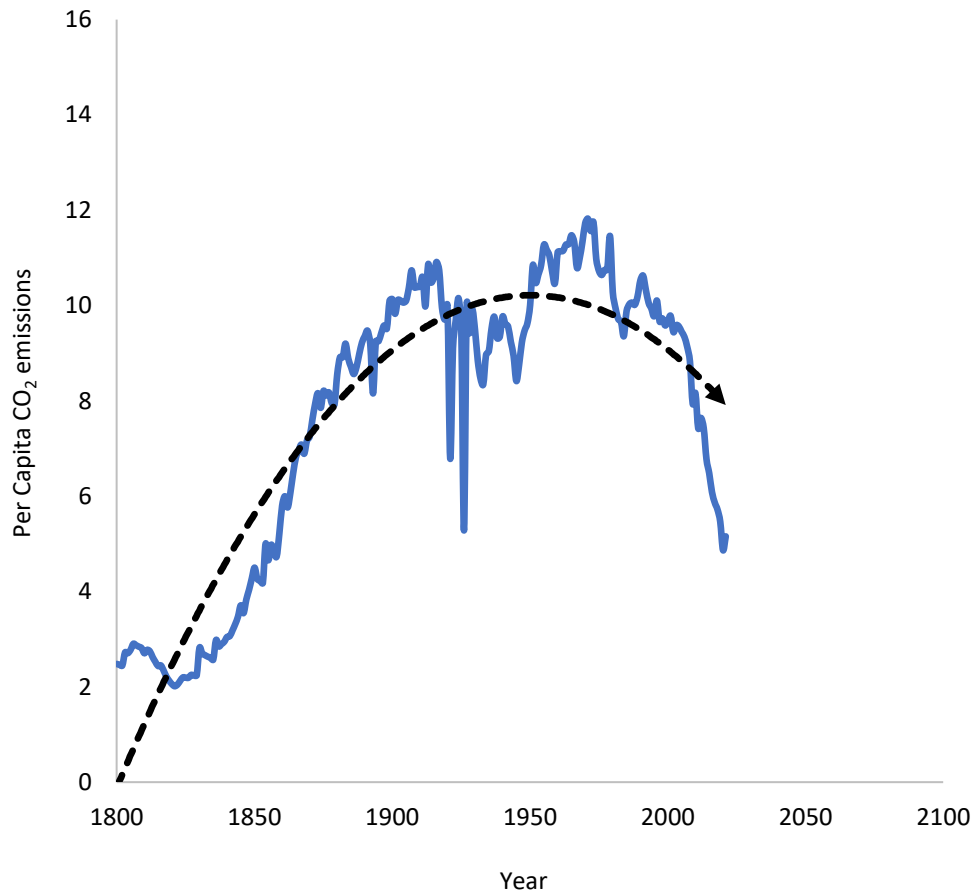
Global/Total/Emissions



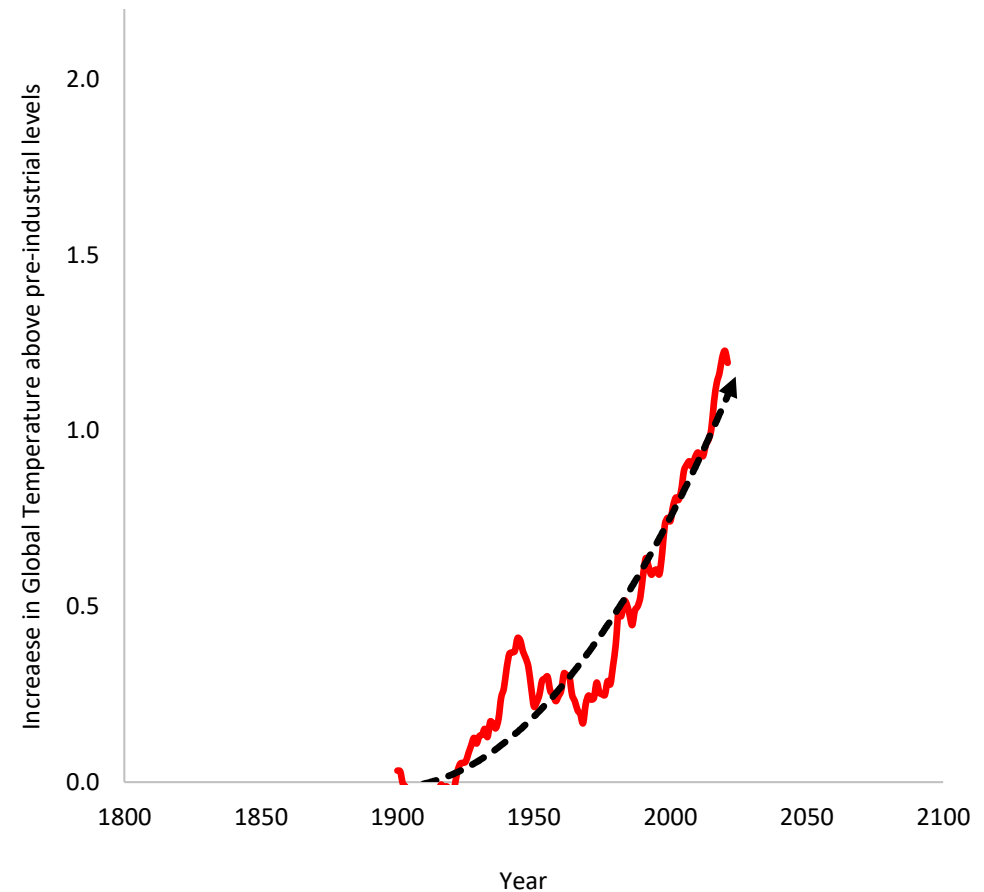
Towards the Bigger Picture (4 of 5)

Environmental *damage* – the original concern of the EKC formulation – is more closely proxied by global *temperature* not emissions or concentrations which are drivers. Per the Paris Agreement, the goal is to avoid global temperature increases.

UK/Per Capita/Production-based/Emissions



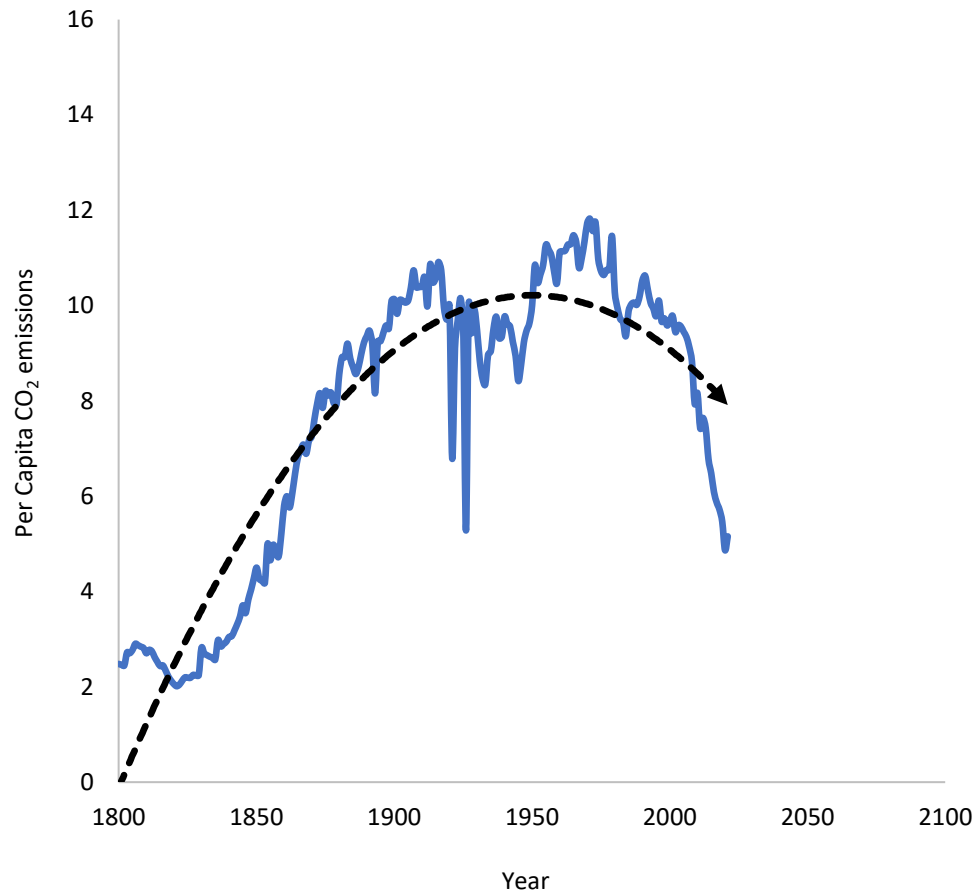
Global/Total/Temperature



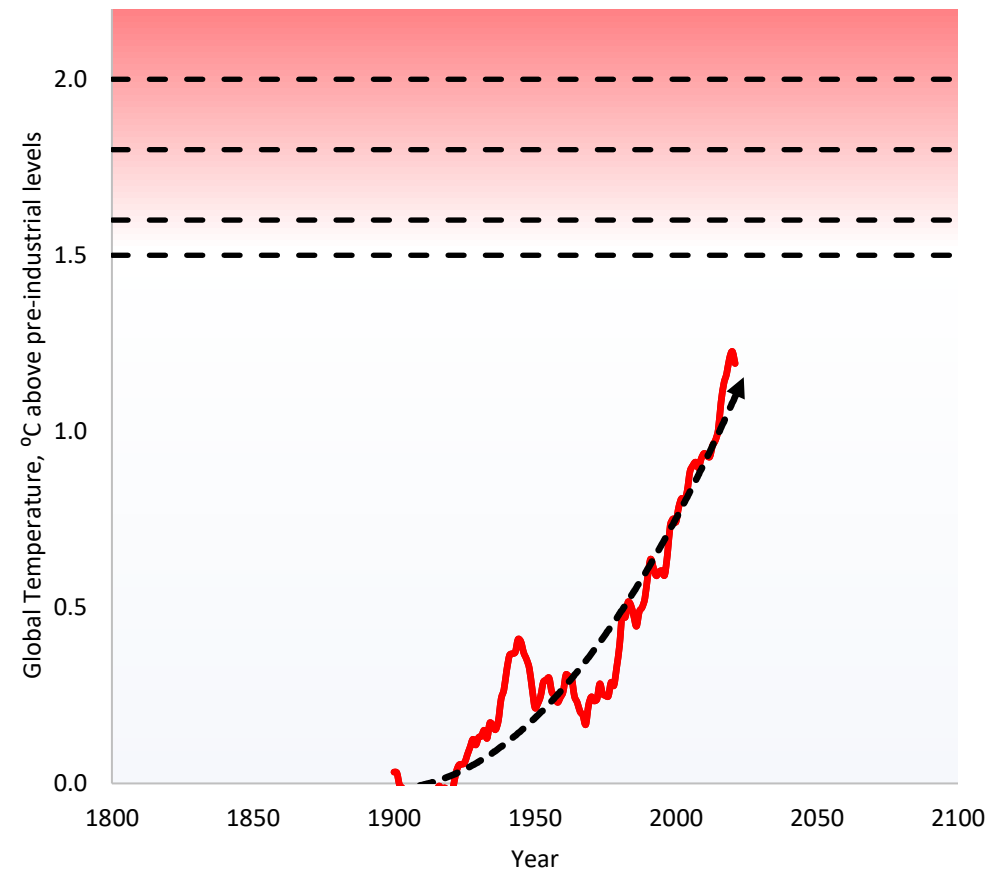
Towards the Bigger Picture (5 of 5)

The reason to avoid global temperature increases is because we are fast approaching climate 'tipping points', such as melting of ice sheets, which may be irreversible in nature and trigger runaway warming beyond our control. Hence, they ought to be in the frame.

UK/Per Capita/Production-based/Emissions

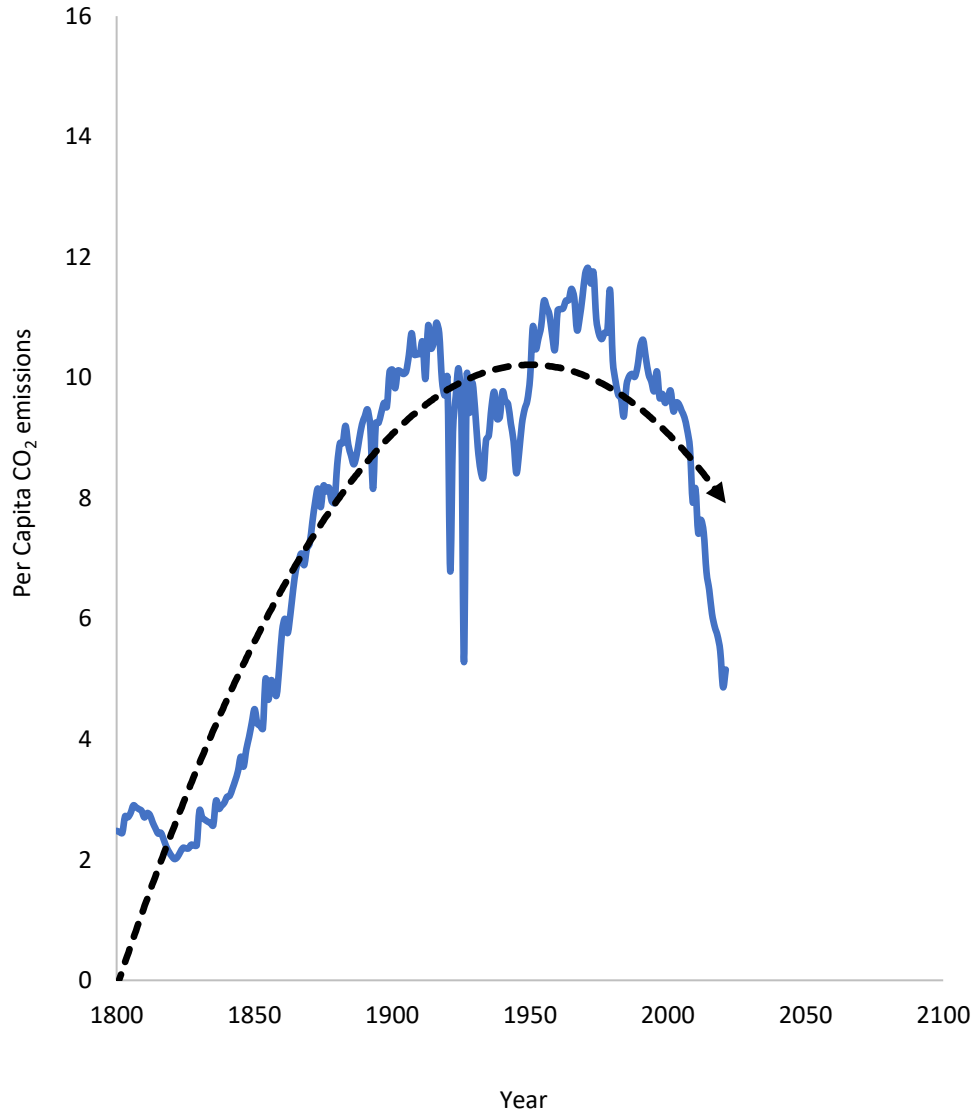


Global/Total/Temperature with Tipping Points



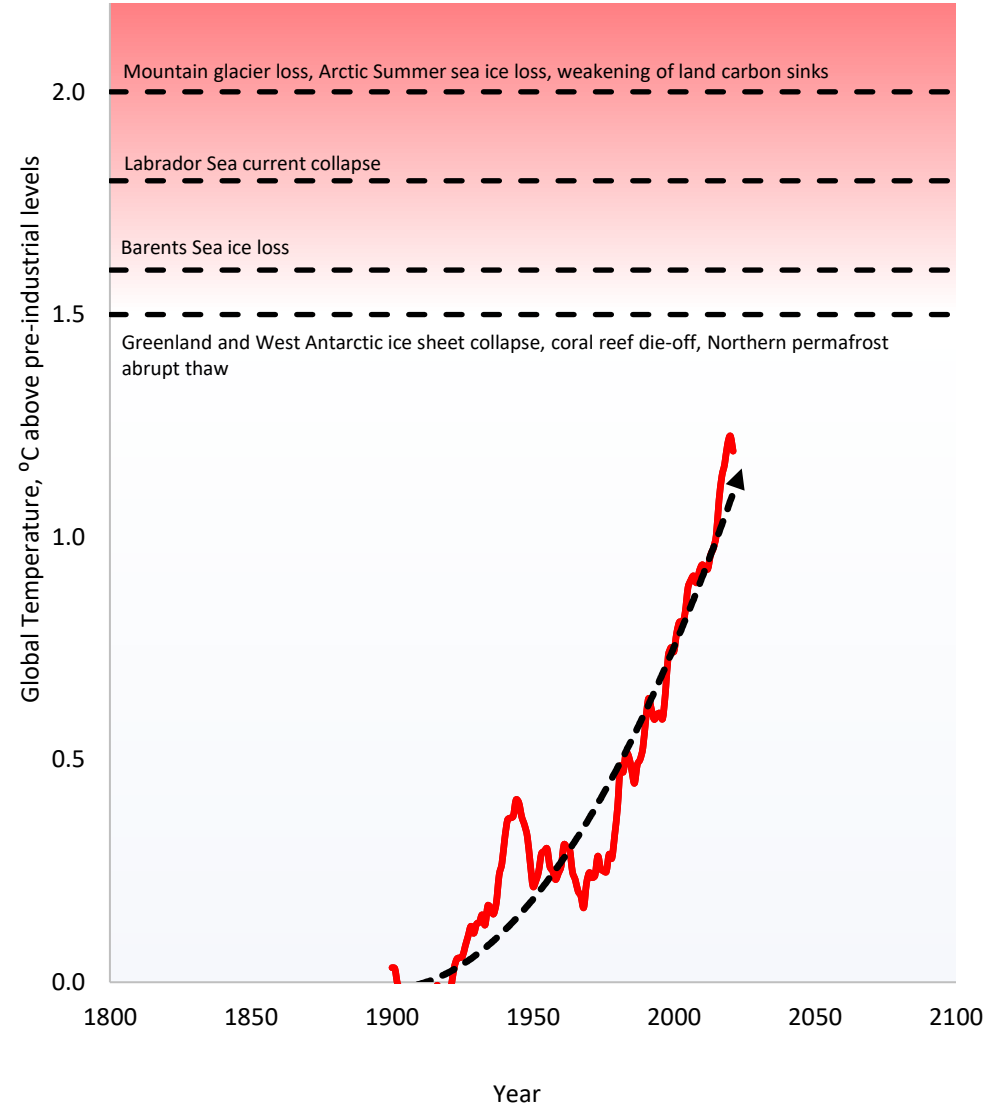
The Economists' Story...

UK/Per Capita/Production-based/Emissions



... The Ecologists' View

Global/Total/Temperature with Tipping Points



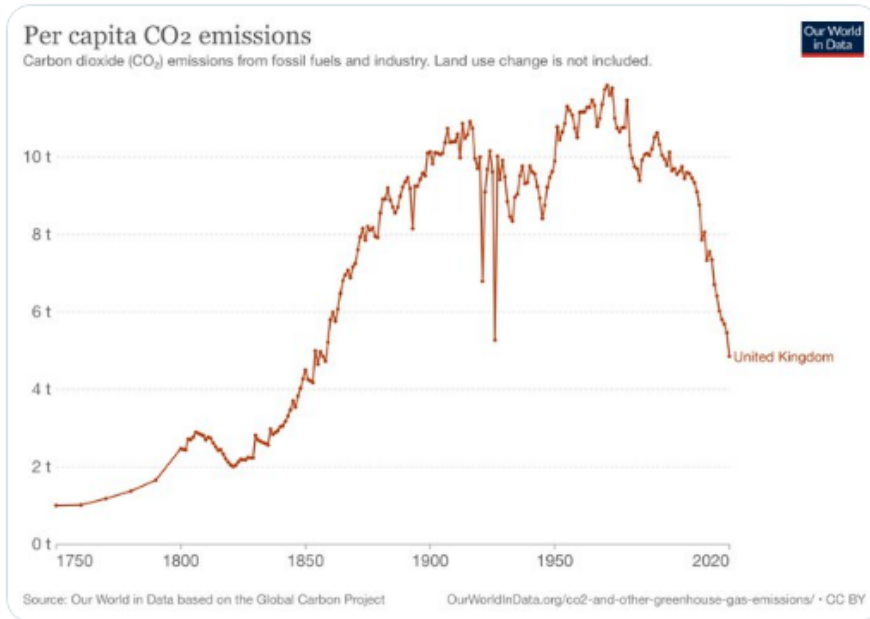
“Folks, here are two charts...”

So, what seems to be happening – far beyond Paul Krugman’s Twitter feed – is that the (understandable) hope that the left chart portends good news obscures the reality on the right, which raises difficult questions about whether economic growth is as benign as we would wish.



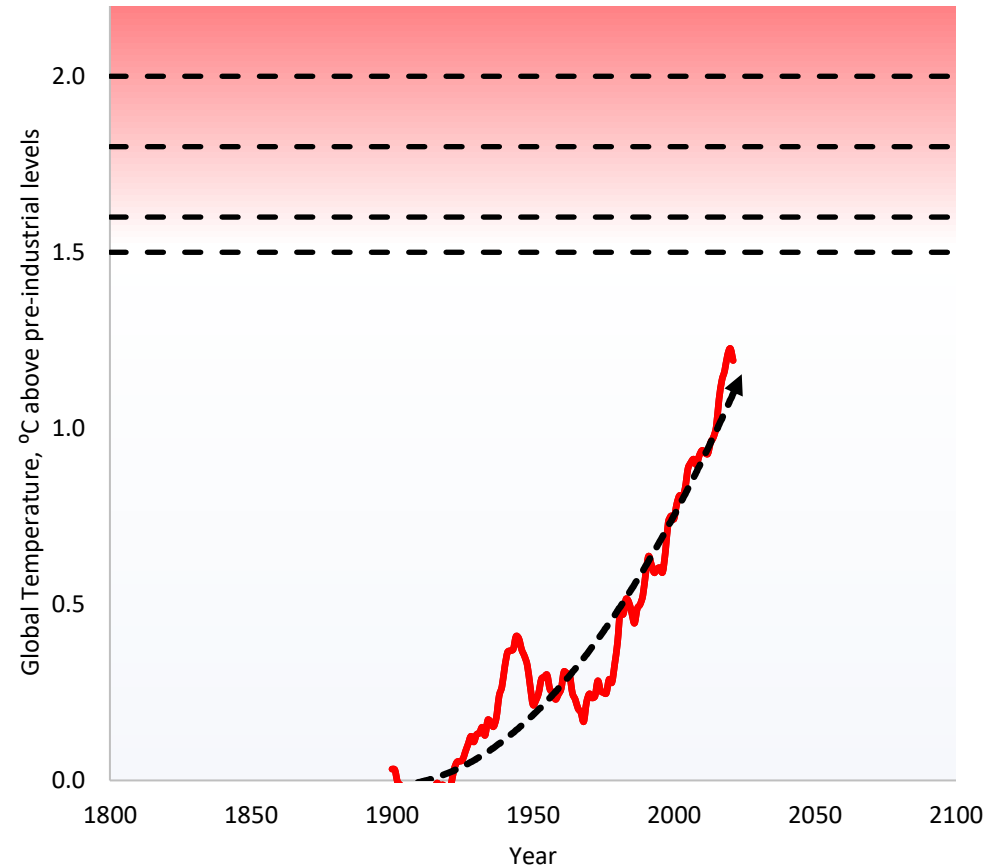
Paul Krugman @paulkrugman

On the margins of actual policy debate, there's a bit of harassment from "degrowthers" who insist that environmental protection requires an end to growth. Folks, here's a chart 1/

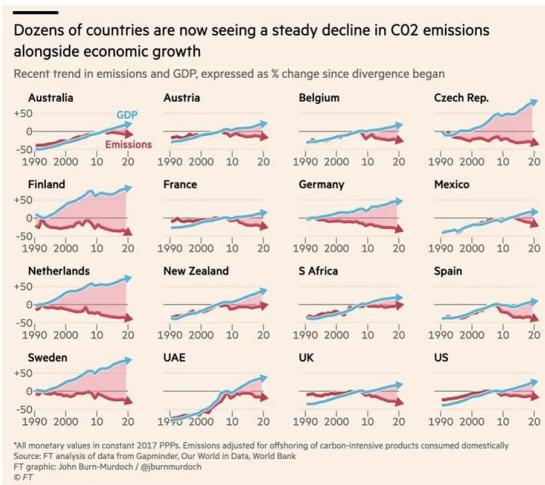


12:38 PM · Aug 4, 2022

Global/Total/Temperature with Tipping Points

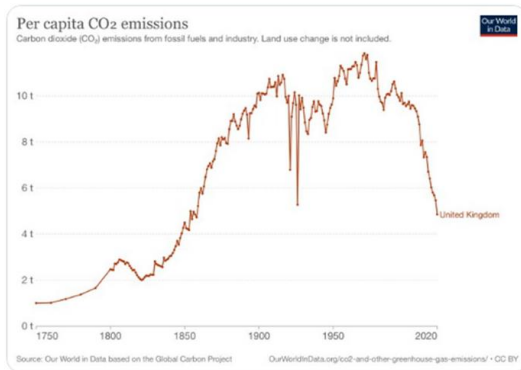


The decoupling narrative and the ‘fallacy of composition’



Paul Krugman
@paulkrugman

On the margins of actual policy debate, there's a bit of harassment from "degrowthers" who insist that environmental protection requires an end to growth. Folks, here's a chart 1/



12:38 PM · Aug 4, 2022

- From a systems perspective, the mistake made by over-enthusiastic ‘decoupling’ proponents is known as the ‘fallacy of composition’, i.e. what is true of the parts is not necessarily true of the whole.
- It is not that the turn in UK emissions (~1% of total emissions) is directionally unhelpful, but rather that it may not be indicative of what the ‘whole’ is capable of in the time required.
- The mental trap is that *sometimes* behaviour of the parts *can be* a good lead indicator of the eventual behaviour of the whole, but this cannot always be assumed.
- Moreover, even if behaviour of the parts is indicative of eventual behaviour of the whole, in a ‘race against time’/‘can’t afford to breach limits’ situation, there is no guarantee the whole can behave like the encouraging parts within the necessary timeframe.
- Recall that many of the EKC and ‘decoupling’ studies referred to earlier reached the conclusion that while partial decoupling – of resources or emissions – was sometimes evident, there was no evidence to support the idea that decoupling could occur at the scale and speed required for the whole system.

'Decoupling' narrative

Looking more carefully, the evidence being marshalled to support decoupling as an autonomous and sufficient solution draws on (atypical) country examples representing 25-30% of global emissions and 12-16% of global population, i.e. 'parts' a long way short of the 'whole'.

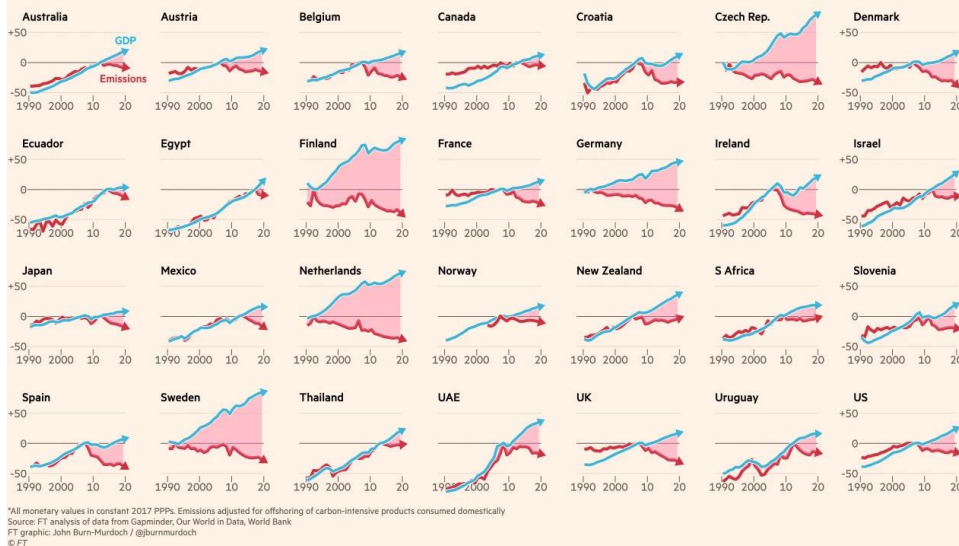
Economics may take us to net zero all on its own

The plummeting cost of low-carbon energy has already allowed many countries to decouple economic growth from emissions

JOHN BURN-MURDOCH + Add to myFT

Dozens of countries are now seeing a steady decline in CO2 emissions alongside economic growth

Recent trend in emissions and GDP, expressed as % change since divergence began

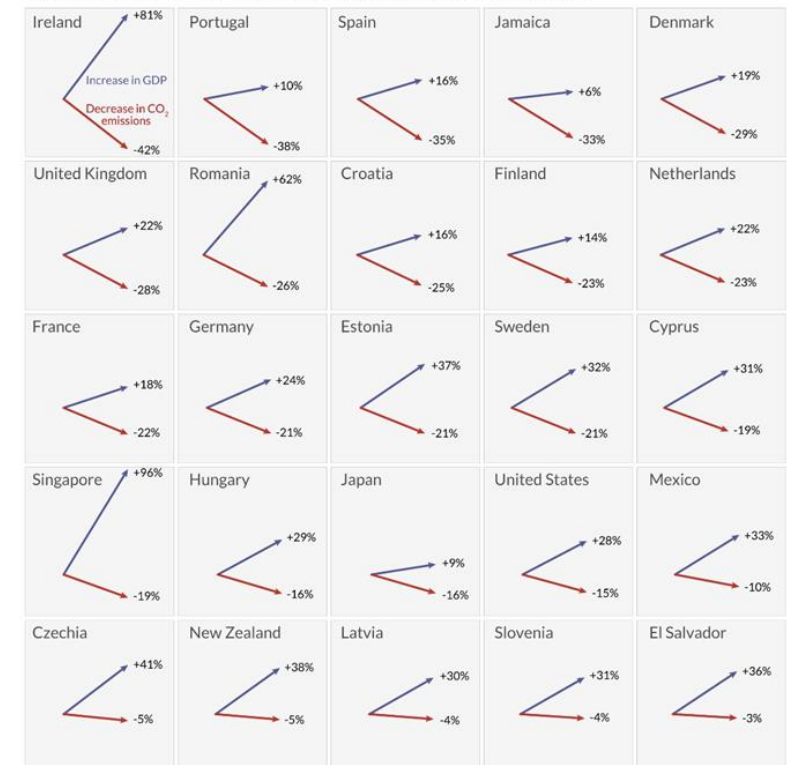


Source: Financial Times;
28 countries representing 29% of global CO₂ emissions and 16% of global population.

Decoupling: Countries that achieved economic growth while reducing CO₂ emissions, 2005-19

Our World in Data

Emissions are adjusted for trade. This means that CO₂ emissions caused in the production of imported goods are added to its domestic emissions – and for goods that are exported the emissions are subtracted.



Data: Global Carbon Project & World Bank. There are more than these 25 countries that achieved the same. OurWorldinData.org – Research and data to make progress against the world's largest problems. Licensed under CC-BY by the author Max Roser

Source: Our World in Data;
25 countries representing 24% of global CO₂ emissions and 12% of global population.

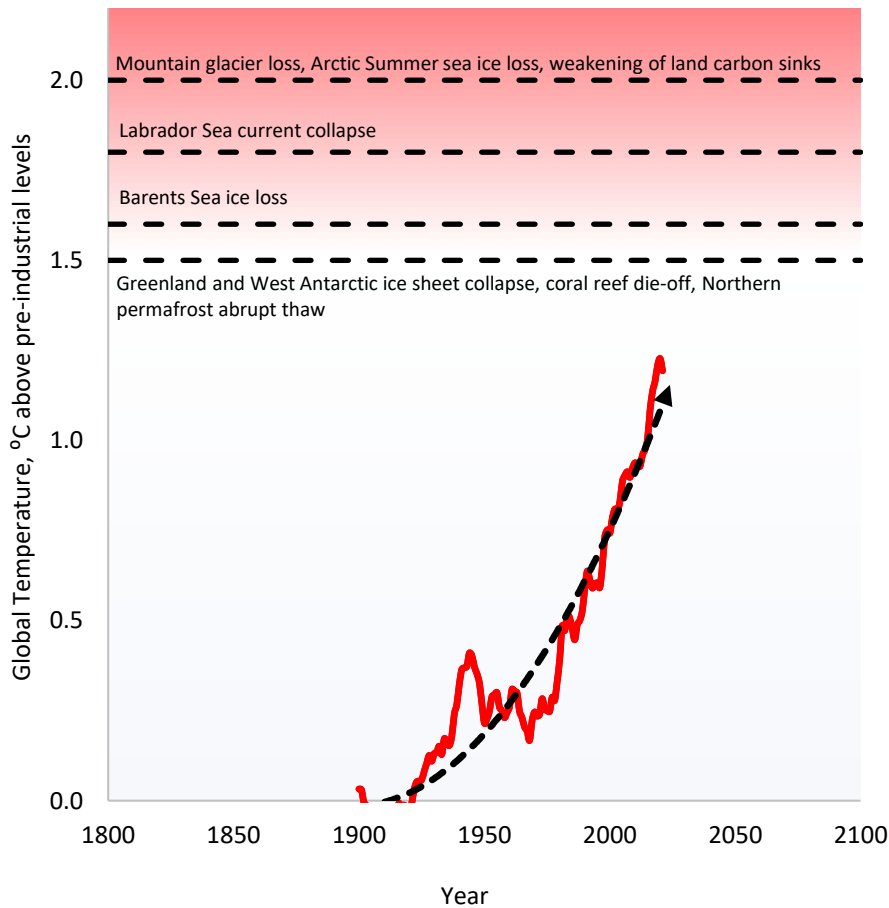
8. Can we learn and turn fast enough?

- We must start with the physics and work back to the economics.
- The economics will have to align with what the physics dictates, not vice-versa.

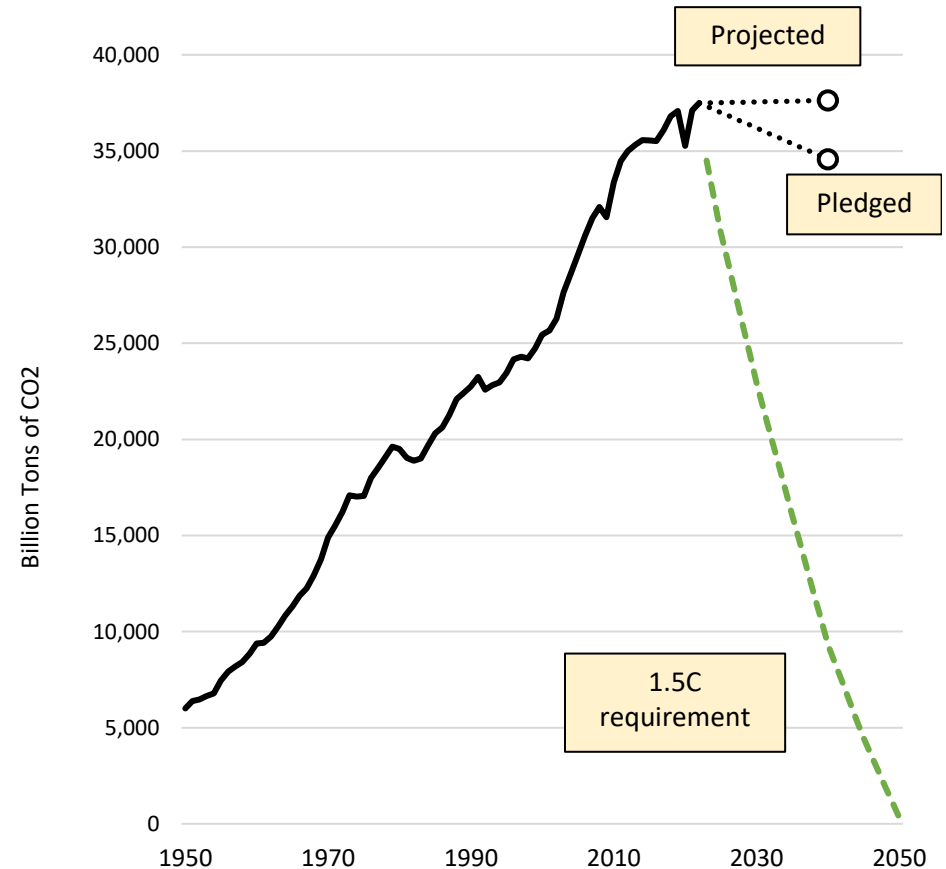
The Climate Change Challenge is a *Physical* Turning Problem

Using an X-Y space with thresholds clarifies that climate change is a 'turning problem' against limits. The deep inertia of ongoing economic growth – due to human habits, contractual obligations, institutionalized incentives, existing capital stock etc. – means we are in a 'race against time'. To prevent temperature breaching 1.5°C or certainly 2°C (left), *global* emissions (right) need to immediately start heading to zero.

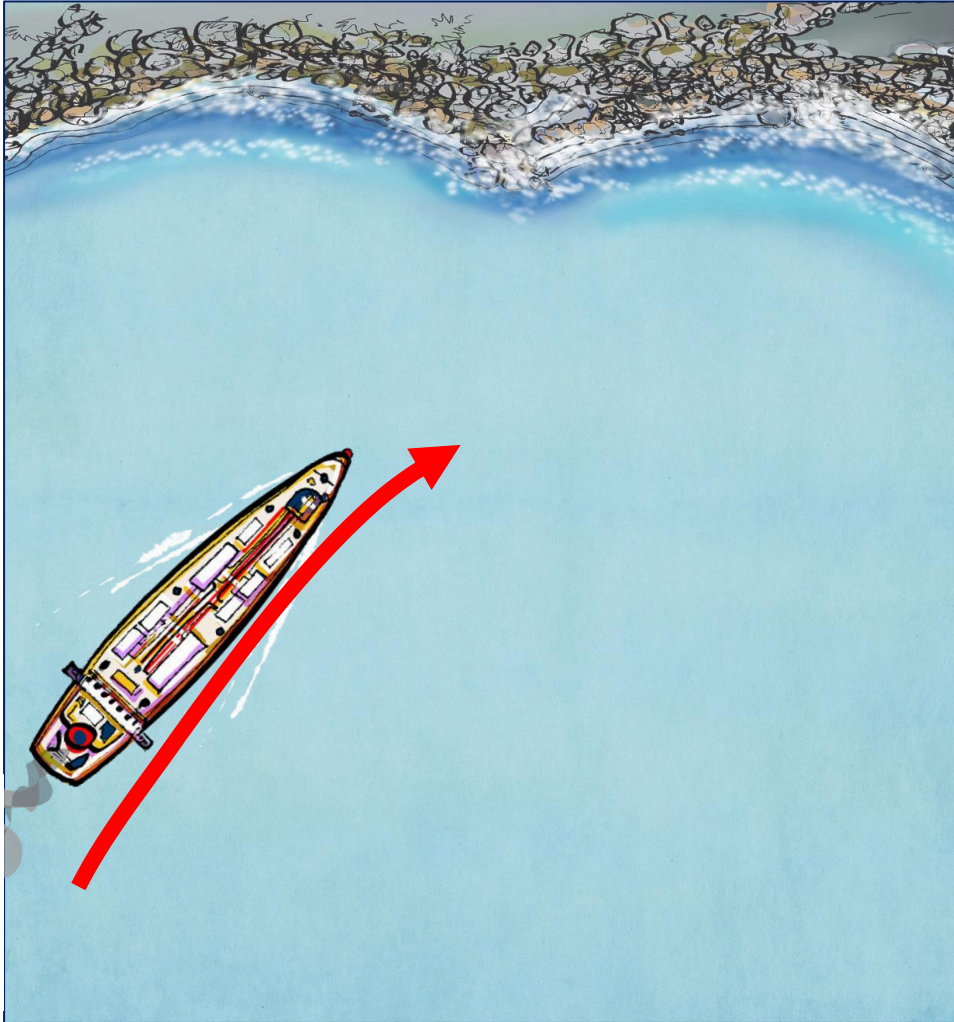
Global Temperature with Tipping Points



Global Carbon Emissions



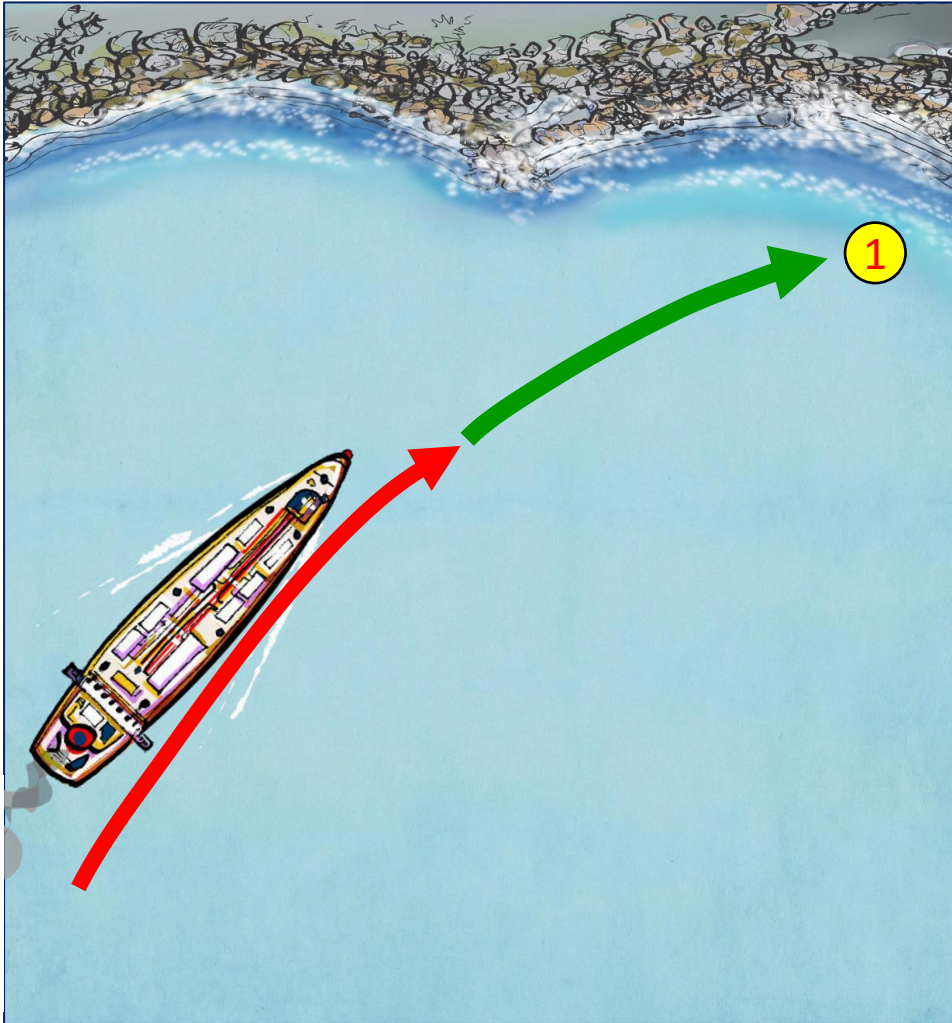
A turning problem



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- Given tipping points, climate change - and other global ecological challenges - have the basic form of 'turning problems', under constraints of time and ecological leeway.

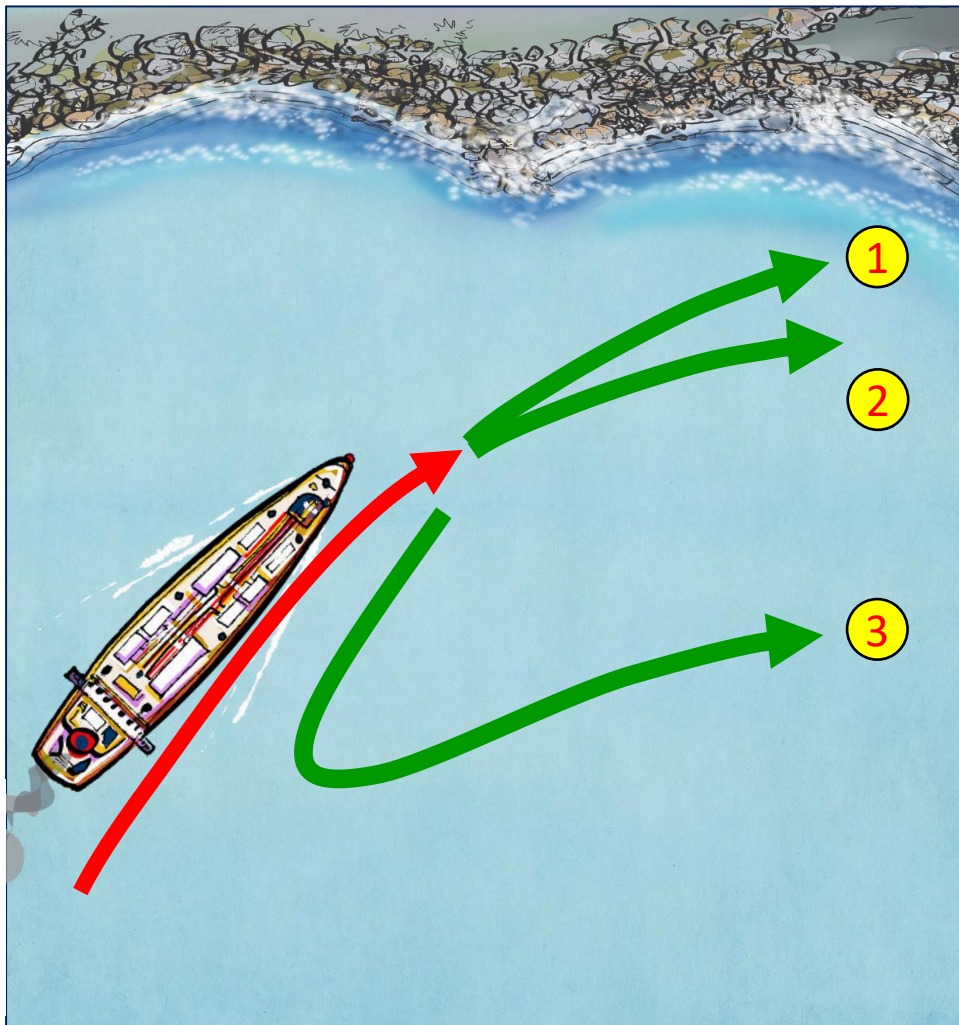
The market's turning mechanism is not proving strong enough



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- A growth-led market economy *does* have a turning mechanism. It's just not proving powerful enough to steer clear of tipping points.
- The turning mechanism is **voluntary technological substitution**, as evidenced by countless profit-spurred innovations voluntarily adopted by consumers (cars vs. horse carts, computers vs. typewriters etc.)
- However, the historical fact of much beneficial technological substitution – which fosters widespread faith in 'market dynamism' – does not mean that growth-led markets can always deliver sufficient voluntary substitutions fast enough.
- Also, there are 'slippage' problems.
 - A 'green economy' will have a considerable 'creation footprint', i.e. will use up a significant amount of the remaining turning space. Just building a low carbon energy production system *and nothing else* uses up 0.1°C of further warming (Slamersak, et al, 2022).
 - Further slippage as a 'win-win' narrative licences general economic growth, much of which is not at all contributing to ecologically-valuable innovation.

Three turning mechanisms to avoid tipping points



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1. Market-led growth ('win-win')

- Turning mechanism: voluntary technological substitution under current prices and policies

2. Government-directed growth ('spend to win')

- Turning mechanism: technological substitution accelerated by 'carrots' of subsidies, tax credits, direct investment etc.
- Challenge: who pays for the additional cost?





3. Government-directed degrowth ('buy time and space to win')

- Turning mechanism: technological substitution and behavioural change accelerated with 'sticks' of higher carbon prices, environmental regulations, prohibitions.
- Challenge: who bears the burden of foregone growth (even if BAU growth seems increasingly unobtainable) and how can they be compensated?

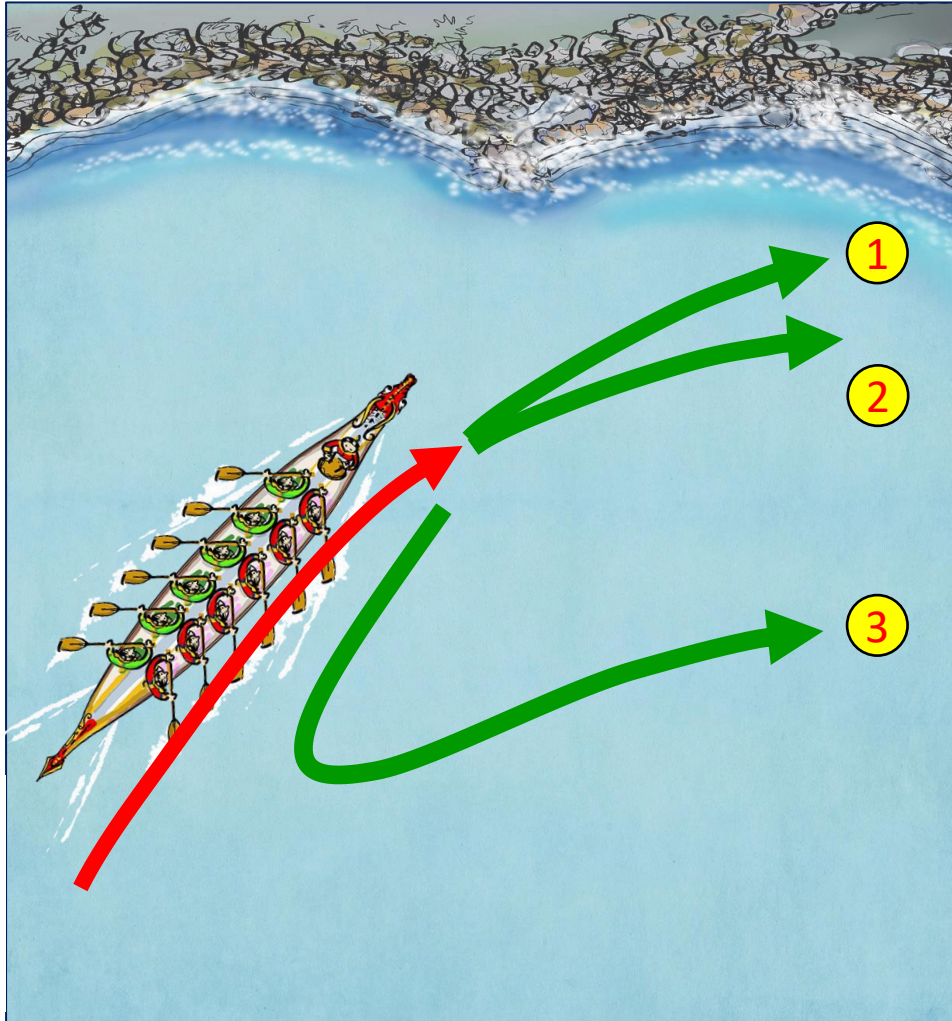
(Note that both (1) and (2) suffer from 'slippage' dynamics in that the building of a green economy will have a 'creation footprint' that uses up some of the remaining ecological headroom and the general licensing of growth waves through much economic activity not involved in developing a sustainable economy.)

Market actors cannot do constraint strategies

The critical asymmetry between public and private leadership on sustainability challenges is that while both can contribute to growth-reinforcing strategies, only governments have the authority and power to implement binding constraint strategies. The need for government leadership today is because the severity of situation increasingly demands 'stop doing' strategies.

	Growth strategies	Constraint strategies
Private sector leadership		
Government leadership		

'Green growth' v BAU growth: a dragon boat analogy



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Isn't growth a mix of good and bad? Yes, so the question becomes the relative mix and strength of the two:

Green growth helps?

'Green' paddlers on the left of the boat can try paddle faster to overpower the 'business as usual' paddlers on the right to induce a turn.

Question: can the 'green' paddlers paddle fast enough to overpower those on the right? (= is 'green growth' a powerful enough force to overcome 'business as usual'?; how powerful is the dynamic of voluntary technological substitution really?)

Stop doing?

To make a sharper turn, paddlers on the right can either stop paddling or paddle in reverse.

The latter is the equivalent of introducing 'constraint' or 'stop doing' policies (e.g. carbon taxes, regulations etc.) to deliberately prevent certain things from happening.

Net effect on overall growth?

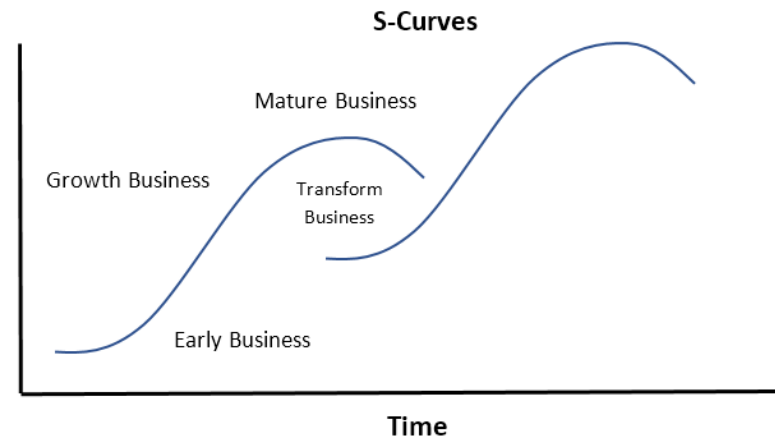
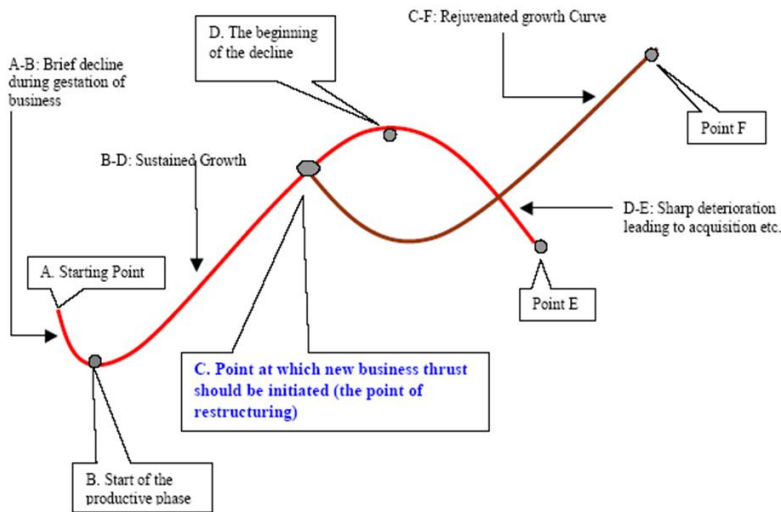
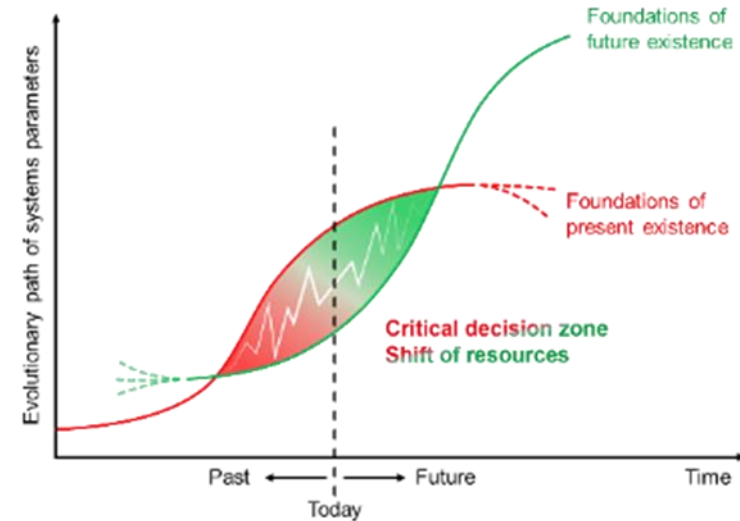
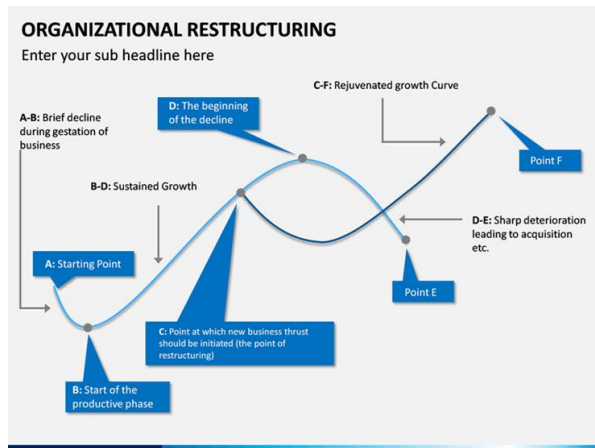
Depending on how sharp a turn is needed, the boat as a whole (its centre of gravity) may either keep moving forwards (= 'economic growth') or move backwards to create space and time to make the turn (= 'degrowth')

At the moment, we are assuming 'green growth' is powerful enough to force a turn without the help of 'stop doing' policies that might accelerate the turn, albeit at the cost of 'overall growth'.

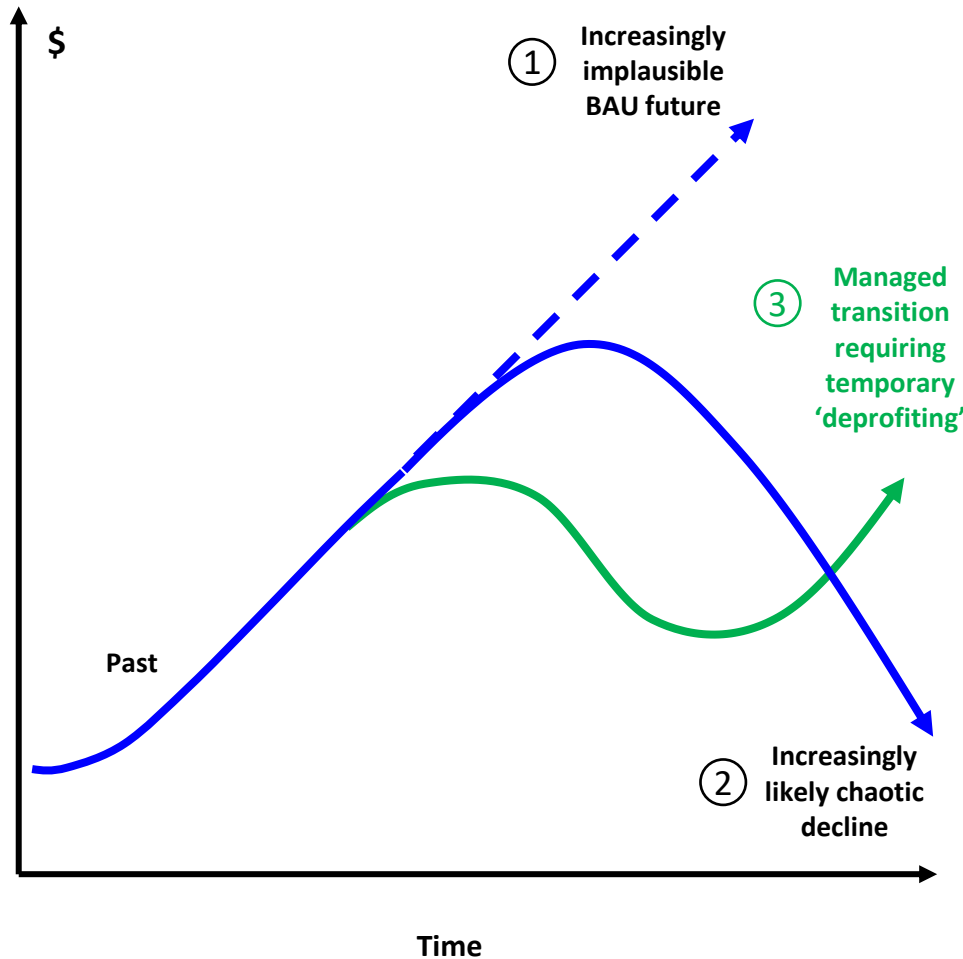
9. More helpful curves? The 'S' curves of restructurings

The Shape of Corporate Restructurings, or 'S' curves

The 'S' curves used to frame corporate restructuring choices may serve as a more realistic guide for understanding and responding to sustainability challenges.



The Shape of Corporate Restructurings, or 'S' curves



- *“The problem with the present is that the future is not what it used to be.” (Paul Valery)*
- Humans tend to extrapolate beneficial past trajectories into the future. For corporations, this takes the form of making roughly linear forward projections of past performance.
- But if the external world changes sufficiently (new competition, change in consumer tastes or input prices, etc.), the expected future (1) is increasingly implausible. ‘The future is not what it used to be.’
- Instead, if the company persists with its existing strategy, it increasingly faces the prospect of chaotic decline (2) – *hard as that may be for executives to imagine or accept.*
- The solution is a pre-emptive acceptance of, and adjustment to, the new reality that permits a ‘managed transition’ that typically involves a period of loss-making or ‘deprofiting’, but which is the only route to long-term survival.
- **There are two layers of inconvenient truth:** executives (i) struggle to accept the world has changed so much their business cannot succeed as it has and (ii) if they can accept (i), then struggle to believe that adapting to the new reality cannot be achieved without interrupting growth. (The Wall Street adage ‘profit warnings come in threes’, i.e. a company makes warnings in 3 successive quarters, is a manifestation of this denial.)
- This pattern – and its psychological demands – seems to describe the challenge of accepting both that the real world has changed (climate change etc.) and that adaptation is unlikely to be consistent with uninterrupted economic growth.

10. The concealed meta-strategies of ESG and a carbon tax

- ESG is a 'growth-reliant' strategy and carbon taxes a 'growth-resisting' strategy, but neither strategy is generally presented in those terms.

Sustainability strategies can be divided into two main camps

If 'economic growth' is the crux of the matter, current sustainability strategies can be divided into whether they are 'current-growth-conforming' or 'current-growth-resisting'. Probably the two respective flagship strategies are 'ESG investing' and a carbon tax.

ESG investing

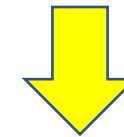
(and
CSR, SRI, impact investing,
green growth, 'win-win' etc.)



Voluntary
Market-Led
Growth-supporting

Carbon tax

(and
other environmental regulations,
prices, caps and prohibitions, etc.)



Mandatory
Policy-led
Growth-constraining

Strategies rely on meta-strategies

The meta-strategies of ESG and Carbon Tax are about growth.

ESG investing

Message or Strategy

Investing in sustainable A rather than unsustainable B is good for profits and sends a market signal that will lead to more of A and less of B.

Meta-message or meta-strategy

Voluntary changes within established market-led economic growth norms are the solution.



“Growth is the solution”

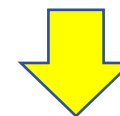
Carbon tax

Message or Strategy

Introducing a price on carbon emissions will lead business and consumers to take steps to reduce newly-costly emissions.

Meta-message or meta-strategy

Raising the price of such an economically critical input as fossil fuel will curb growth until we have found some way to grow safely around a newly identified problem.



“Growth is the problem”



Carbon tax advocates have not dared tell it straight...

But public debate seems not to tolerate candid discussion about growth. ESG investors invariably describe their strategy in terms of skilful and selective decisions without mentioning ESG's fundamental dependency on a faith in growth. It matters much more that carbon tax proponents dare not challenge growth...

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Economists' Statement on Carbon Dividends

Bipartisan agreement on how to combat climate change.

Jan. 16, 2019 6:55 pm ET

"..Substituting a price signal for cumbersome regulations will promote economic growth..."

- The Economists' Statement on Carbon Dividends, signed by over 3,500 economists, is well-intended but is a showcase of how economists still demur from challenging growth.
- It states that for a given degree of regulatory constraint, price signals (e.g., taxes, permits etc.) should arrive at a more cost-effective solution than blunt command-and-control measures.
- But the current situation is not characterised by the possibility of substituting more efficient price signals for regulations that are already doing the job, but rather that we are starting from a position of hardly any regulation at all!
- The profound conceptual error in the Economists' Statement is that 'laws' are being confused with 'initial conditions'.
- **A carbon tax achieves its goals by *slowing* economic growth until we have found a way to grow around newly-identified major externalities. It is the same wisdom as using brakes before you go over a cliff.**
- In shying away from the truth, advocacy is invariably ineffective. If carbon tax advocates don't seek to occupy the high ground of the truth of the matter, carbon tax opponents will, and will wield the difficult truth effectively because public and politicians have not been pre-emptively inoculated to it by prior candid discussion.

The meta-problem: too few opinion leaders are debating growth out loud

xyz

ESG investing

Carbon tax

... or Strategy

I see.... So, the meta-problem, if you will, is that we are not having a candid debate about whether growth is the solution or the problem.

And, because our norms and institutions are strongly pre-committed to growth (for pre-Anthropocenic reasons), that is the meta-strategy we continue to execute under successive new labels (CSR, SRI, ESG, impact investing, green growth... etc)


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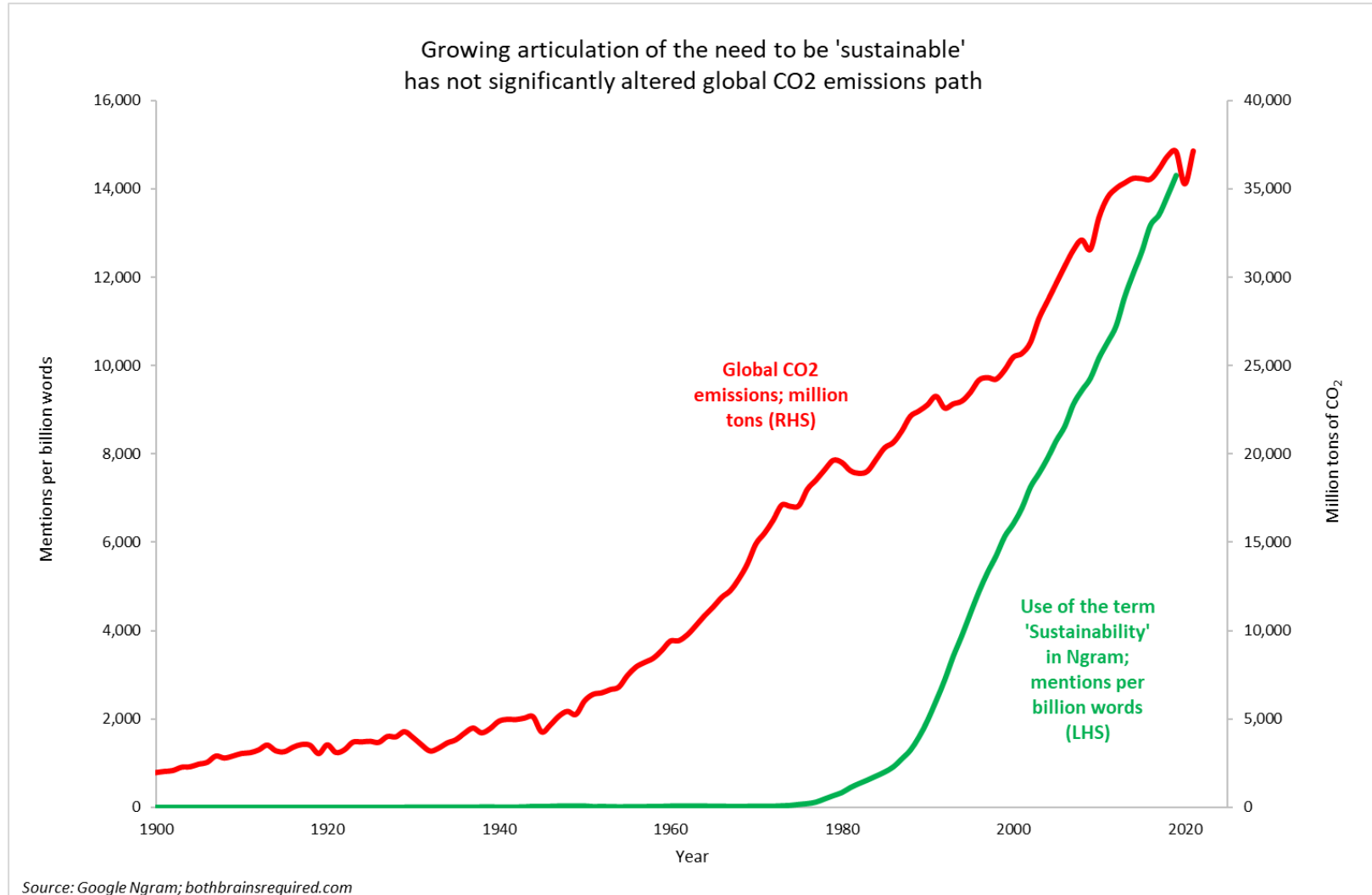
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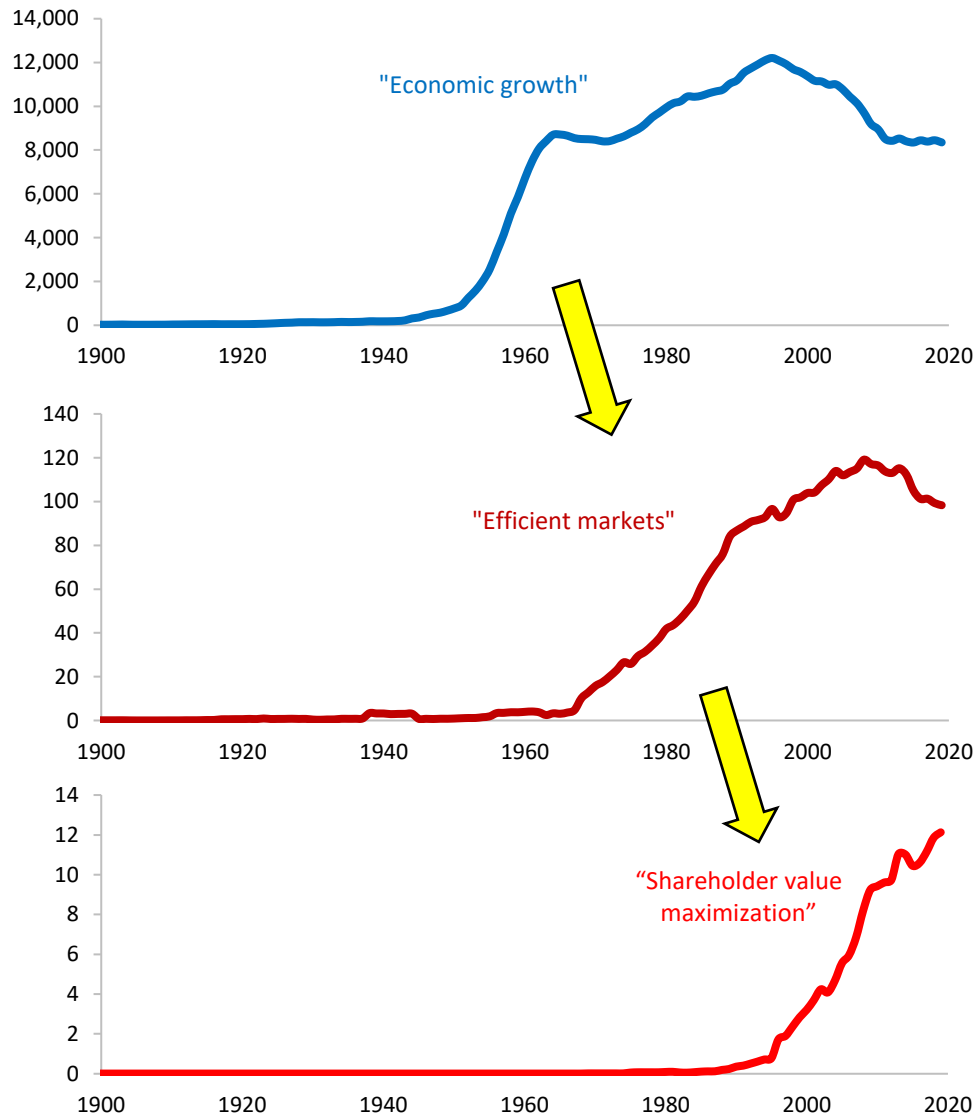


11. We have chained ourselves to 'growth' in a way that only moral leadership can overcome

Whatever “sustainability” may be achieving, it has not turned global emissions



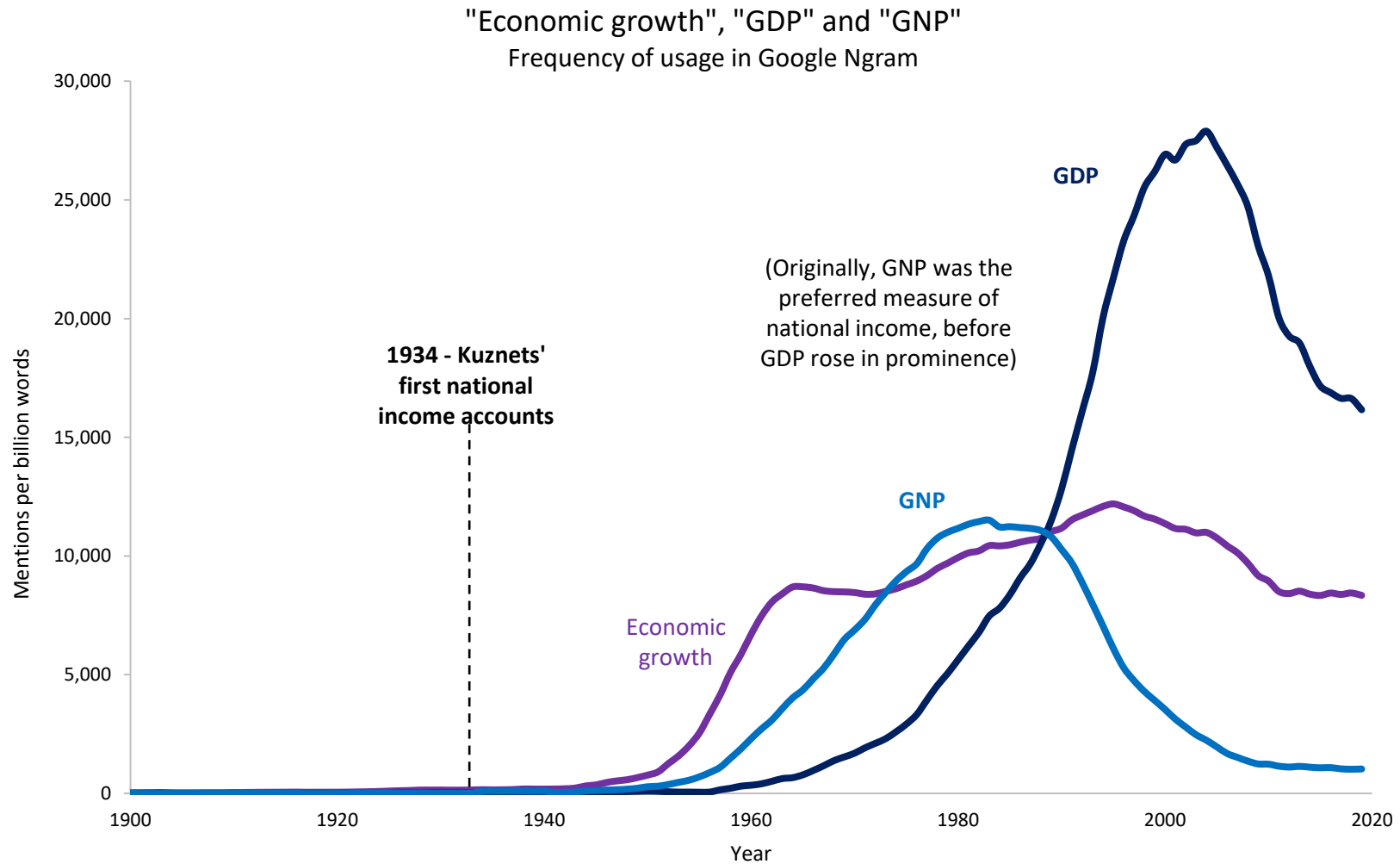
We chained ourselves to growth



- 'Efficient market' theories of mid-20th Century combined with neoliberal political ideas to catalyse today's market *primacy* of socio-economic coordination.
- We have organized society *as if* markets were complete and efficient – and hence *as if* market growth was unambiguously beneficial – only to find they are not at all complete and that externalities are large.
- But we have trapped ourselves by shaping modern institutions and incentives in line with 'economic logic':
- **Politicians** are obliged to promise economic growth or face electoral defeat by those who will.
- **Corporate executives** profess they want their companies to be sustainable but find themselves incentivized by share-based compensation and obliged by fiduciary duty to maximize profits – or be replaced by someone who will.
- **Investment managers** want their funds to be green and sustainable, but if they do not outperform, they will not earn fees and clients will take their funds elsewhere.
- **Savers and pensioners** have staked their future on the monetary growth of their funds, whose appreciation in value relies on external costs continuing not to be monetized, etc..
- **Modern social coordination is profoundly rooted in a shared commitment to steady monetary growth.**

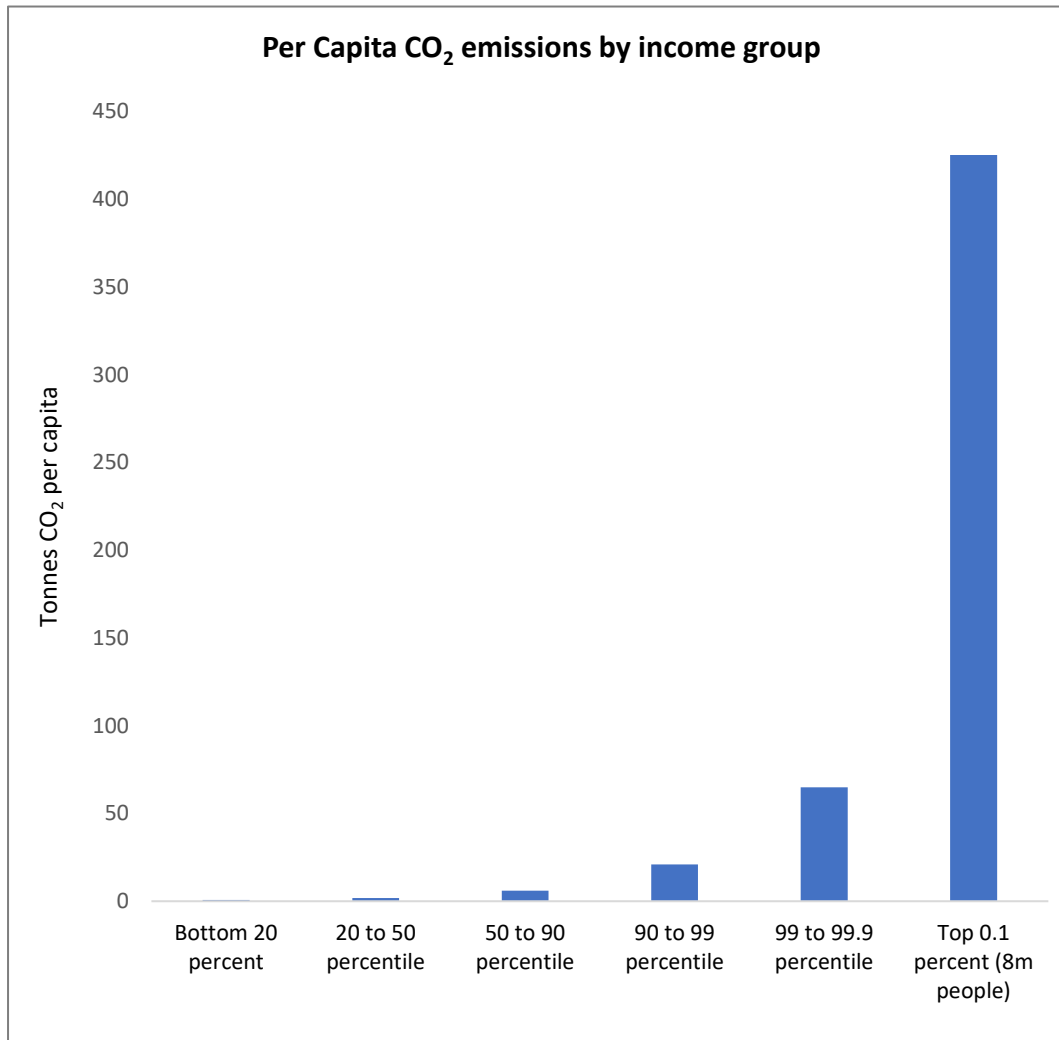
Could we turn 'economic growth' into just a phase?

It is certainly within human power to consign narrow 'economic growth' and associated metrics to being simply a short chapter of human history




Source: Google Ngram; bothbrainsrequired.com

The huge global imbalance



- The opportunity to slow or reverse growth is not evenly distributed.
- Any talk of constraining growth is understandably most threatening for those populations, primarily in the Global South, who have not yet had the opportunity to enjoy the benefits of economic growth.
- Even as developing countries might justly criticize developed countries for the environmental damage the latter's growth has set in motion, they might rightly be wary that a post-growth or degrowth mindset that takes hold in developed countries as a response would be unfairly and prematurely imposed on them in some fashion.
- 'Economic growth' has been the long-time default meta-strategy to address inequality both within and between countries – even if many of the claims for 'trickle down' and 'development' dynamics have been significantly overstated.
- This is why the sustainability challenge is doubly 'wicked' – a simultaneous need to respect biophysical dynamics and limitations while also continuing to strive for greater equality of global living standards and opportunities.
- The real difficulty is that the physical, chemical and biological processes driving global environmental challenges are entirely impervious to human desires and will not yield to our instinct to procrastinate.



“The ultimate, hidden truth of the world is that it is something that we make, and could just as easily make differently.”

David Graeber

“Change is always in the last resort a change in habits of thought.”

Thorstein Veblen

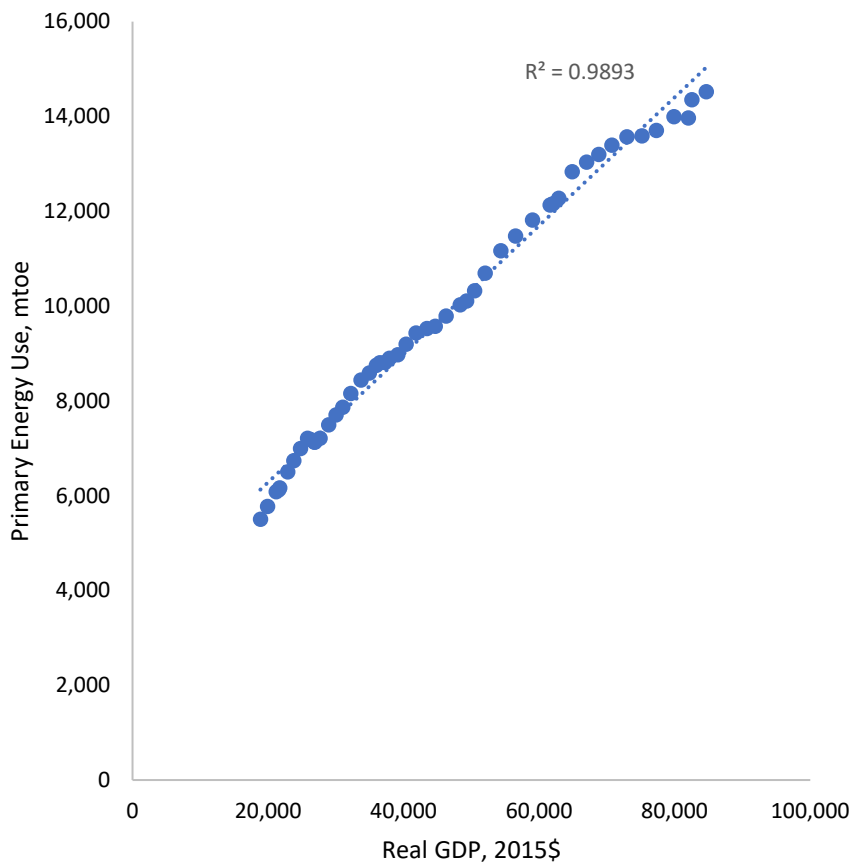
Appendix 1: what are we 'growing' anyway, when we 'grow' economically?

- "...the 'goal' of a whole system is "not so much deducible from what anyone **says** as what the system in fact **does**." (Donella Meadows)

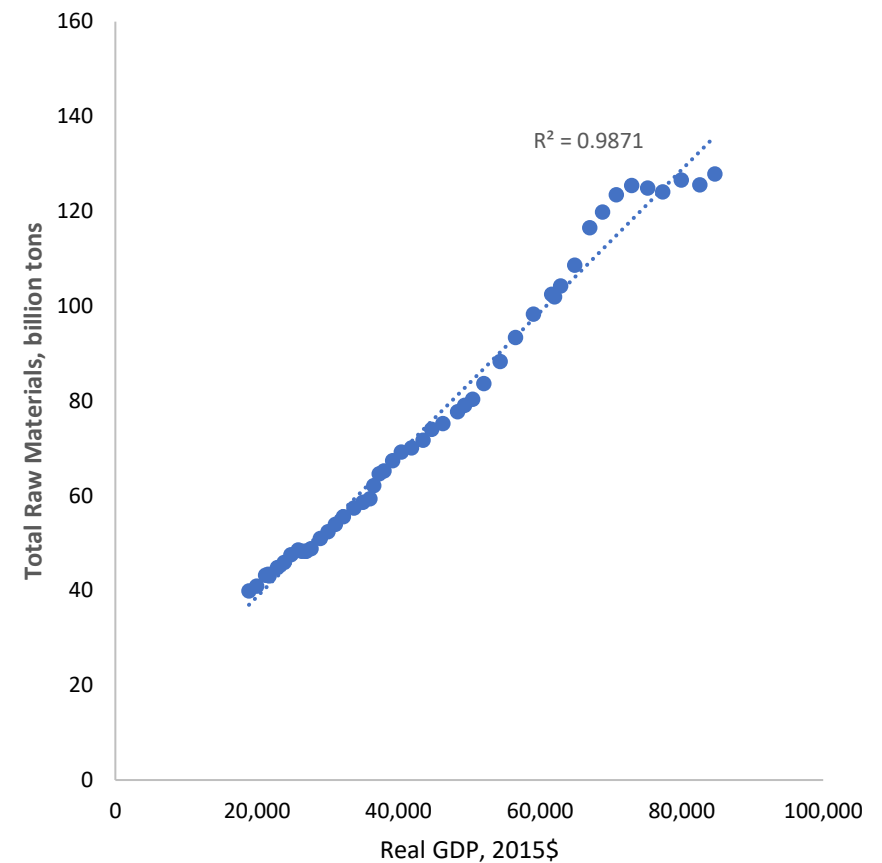
Intriguing correlations

It is intriguing that GDP growth has shown such tight correlations with energy consumption and material extraction respectively. It is not obvious why this should have been the case given that GDP is the summation of total economic activity. We seem to have self-organized around a measure that happens to closely track the harnessing of energy and materials.

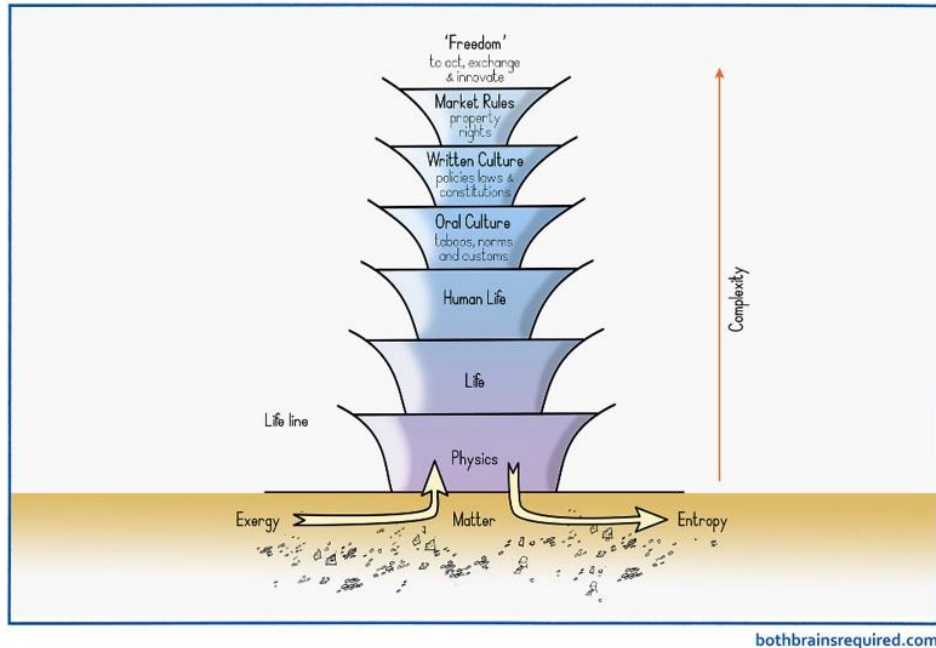
GDP and Primary Energy Consumption (1971 to 2020)



GDP and Total Raw Material Extraction (1971 to 2020)



Intriguing correlations



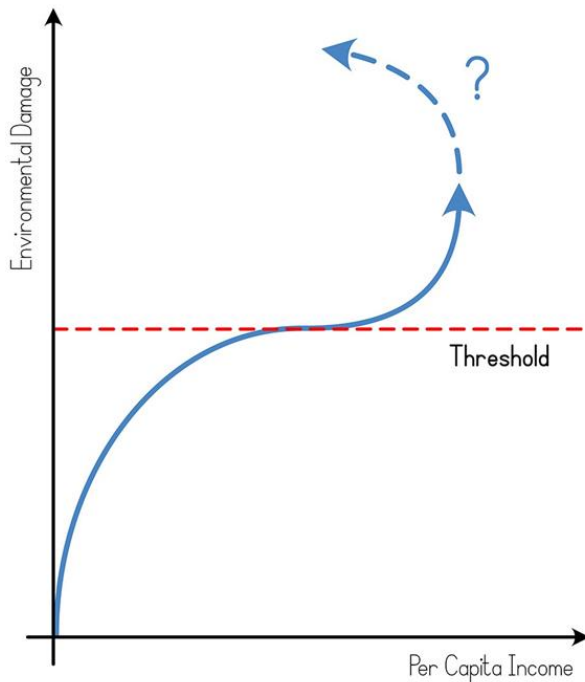
- Scientists and systems thinkers have long pondered whether there is a 'direction' in which complexity and life is being pulled.
- E.g., Boltzman (1905) said that the struggle for existence is the struggle for usable energy (or 'exergy')
- E.g., Lotka (1925, 1956) formulated a 'maximum power principle' positing that the systems that prevail at any point in time are those that maximize the flow of useful energy.
- The advantage enjoyed by systems that maximize flow of energy is that they increase their chances to withstand the inevitable surprises of real-world perturbations.
- Exergy can be advantageous both in its immediate consumption and also to pre-emptively build structures – to 'create order' – that insulate systems against surprise; hence, the link to material extraction, which catches the energy-enabled transformation of the physical world to make the world more amenable and less risky for those doing the extraction.
- It is curious then that GDP, which was not formulated with such ideas in mind, should have tracked so closely the increase in energy and material usage – even with the much-vaunted development of a 'lighter' service economy in recent decades.
- Alas, the seemingly powerful instinct to self-organize around the harnessing of ever more energy and materials – even unconsciously – offers no guarantee against those sources diminishing in supply and/or the use of energy and materials triggering adverse feedback effects for the system's survival that are only recognized too late.

Appendix 2: how the EKC exemplifies the deeper unsustainability of 'economic thinking', which has nonetheless profoundly shaped modern social behaviour

- The EKC is just one – albeit highly consequential – manifestation of the non-systemic and decontextualized nature of economic thinking that, given its profound influence, is in many respects the deeper cause of our sustainability challenge.
- We are no longer consciously tempering economic thinking with non-economic thinking.

A backward-bending EKC is a signal of the framework breaking down

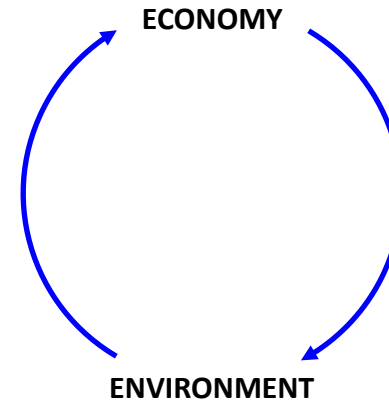
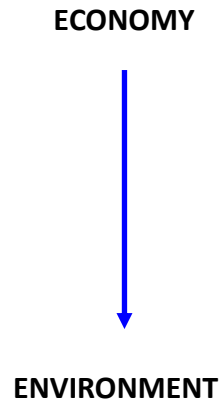
A Backward-Bending EKC ?



- While it is possible physically to draw a backward-bending curve, it stretches the conventions of X-Y plots in such a way that it suggests the sort of thinking that underpins such analysis is being transcended.
- Useful as X-Y plots can be, they have limitations that we seem to be running up against.
- In particular, the assumption of one-way causation – the idea that one variable (Y) is exclusively dependent on another (X) – is breaking down.
- This is happening because the threshold line contextualizes (de-abstracts) economic growth back into biophysical reality and opens the door to seeing the two-way causation between economy and environment.

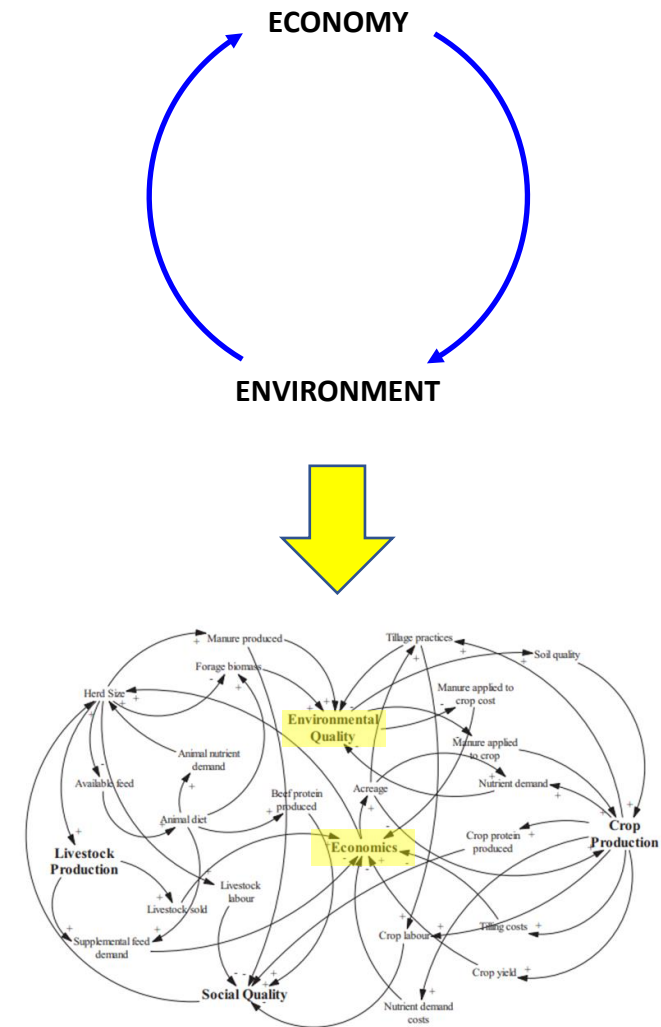
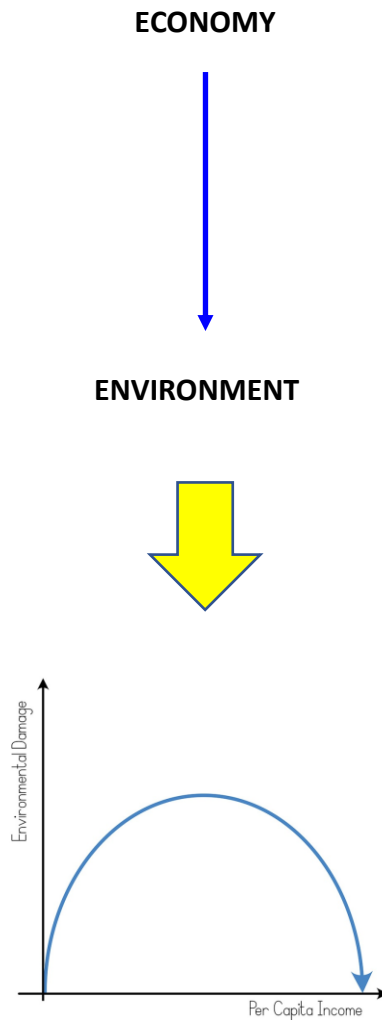
The EKC is too abstract

In simplest terms, the EKC's abstraction can be viewed as believing that economy unilaterally determines environment (left), rather than there being an interdependency between the two.



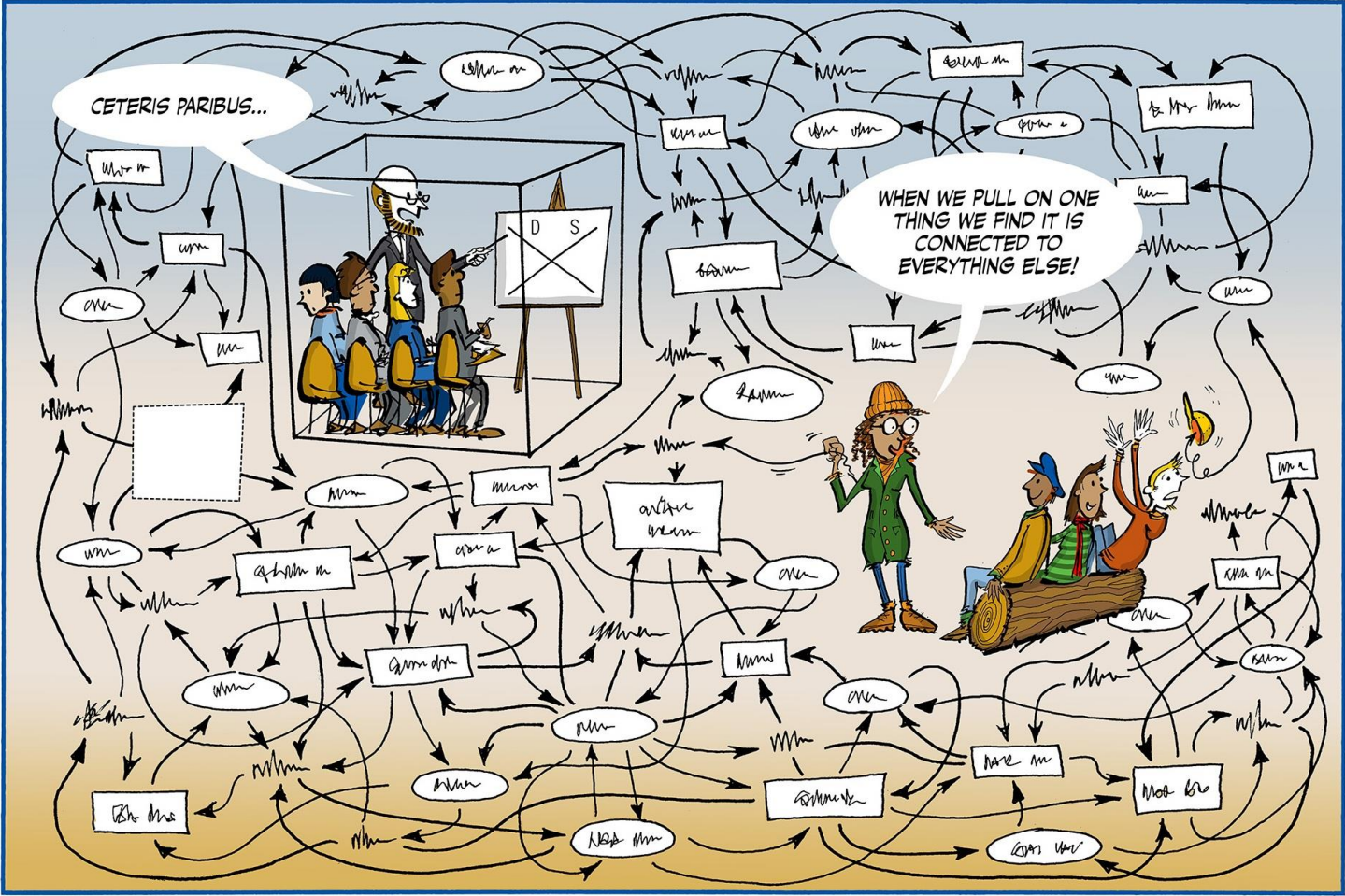
The EKC is too abstract

Contemplating the interdependency of economy and environment is a first step towards recognizing the economy and environment as connected parts of a complex system, for which causal loop diagrams (CLDs; bottom right) are a much more representative tool than X-Y diagrams.



Economics' 'ceteris paribus' problem

The worm at the heart of economics thinking is its dependence on 'ceteris paribus' ('assume all else equal') framing. To some extent, any analysis (= 'breaking apart') must abstract from the full complexity of the world, but the insights of analysis must continually be tested in the context to which they are applied. Ecologists and systems thinkers head in the other direction to keep as much of that complexity in mind as they can.

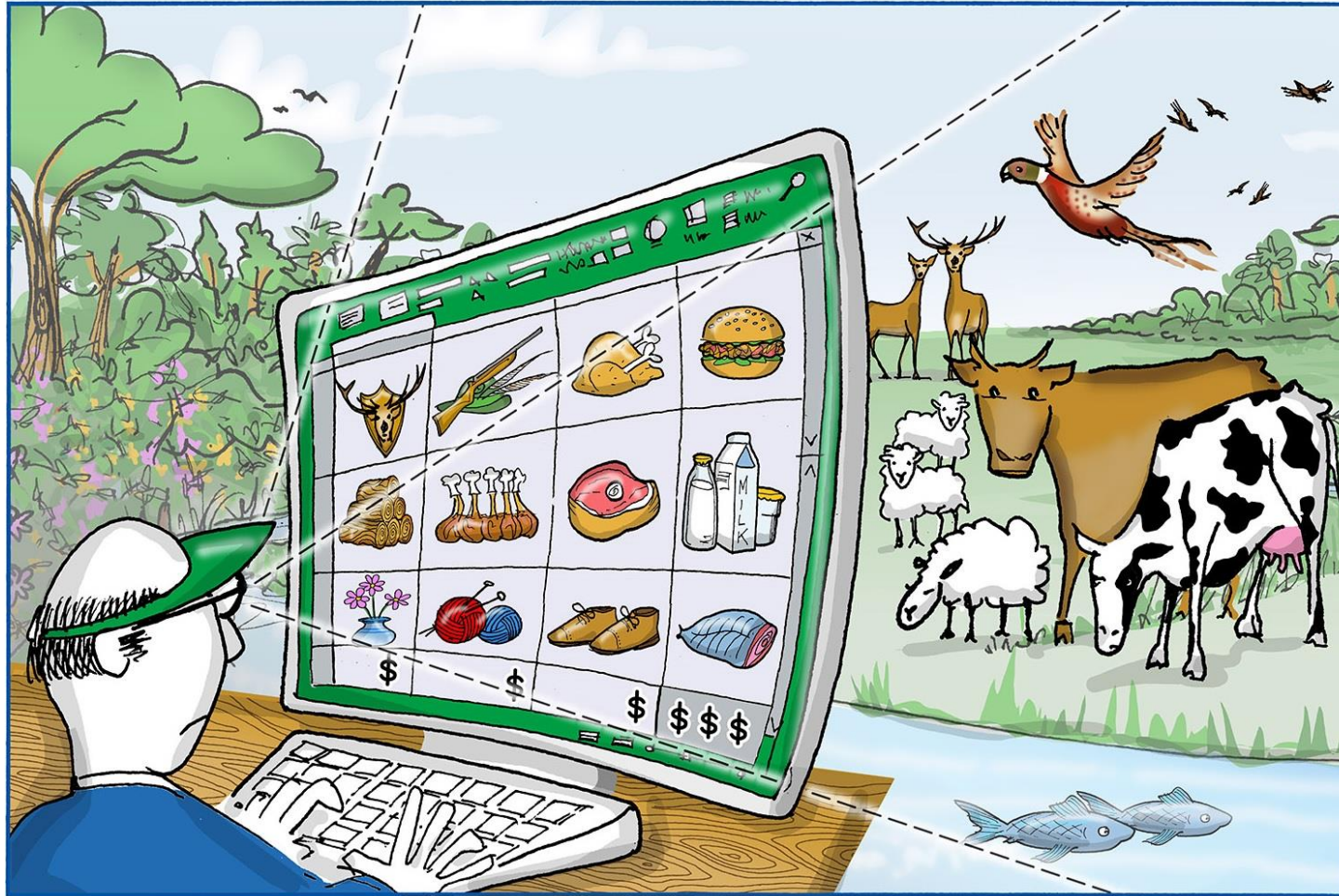


After Virpi

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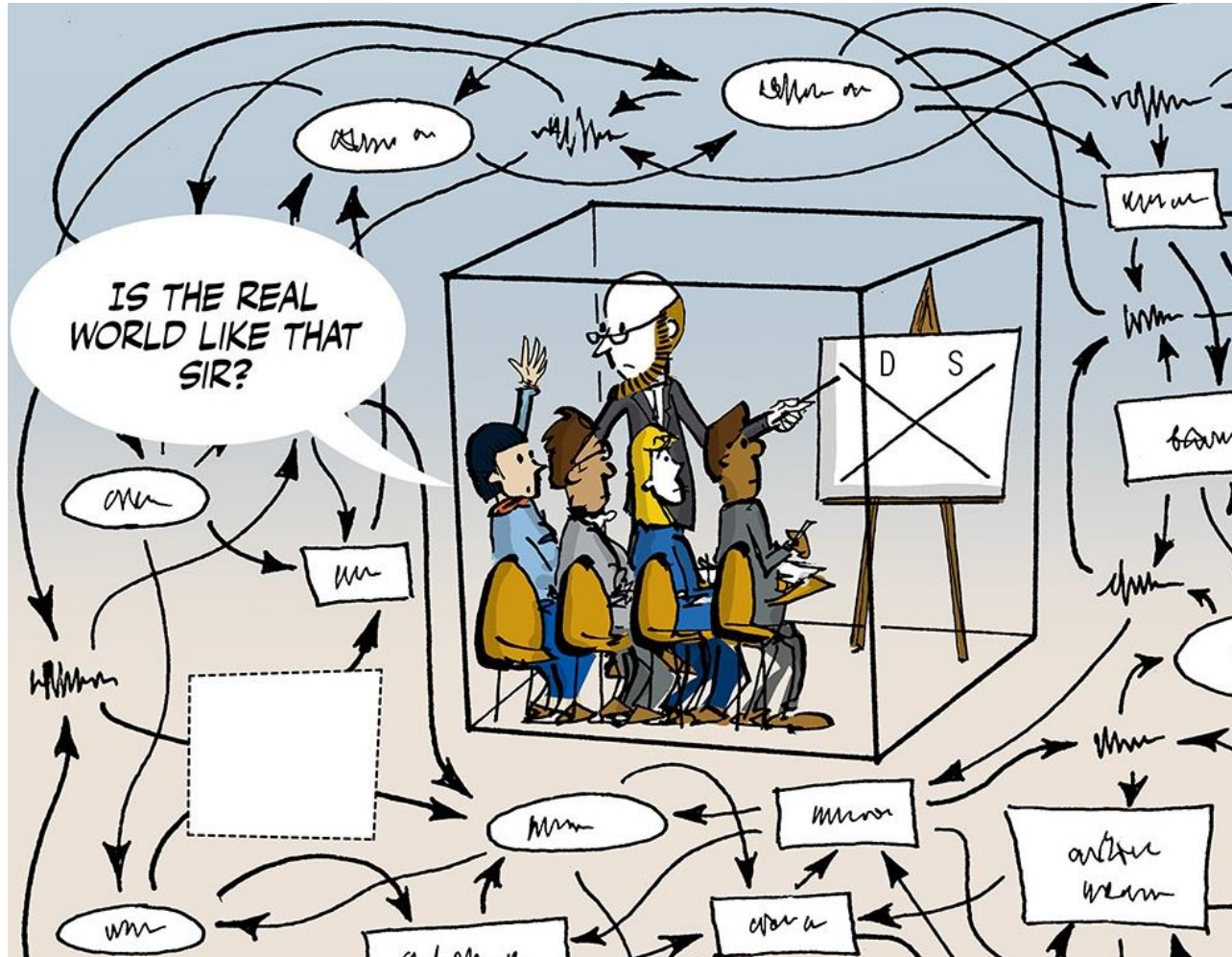
Real world 'ceteris paribus' problem

Because of the influence of economic theory in catalysing today's market primacy ('neoliberalism'), we effectively have a 'ceteris paribus' economy, in which resources, energy and human time are directed by market signals that only partly reflect underlying reality. 'Ceteris paribus' thinking has spawned 'ceteris paribus' behaviour. "If we assume all else is equal, we are 'growing'"; "if we assume all else is equal, we are making a 'profit'", etc.



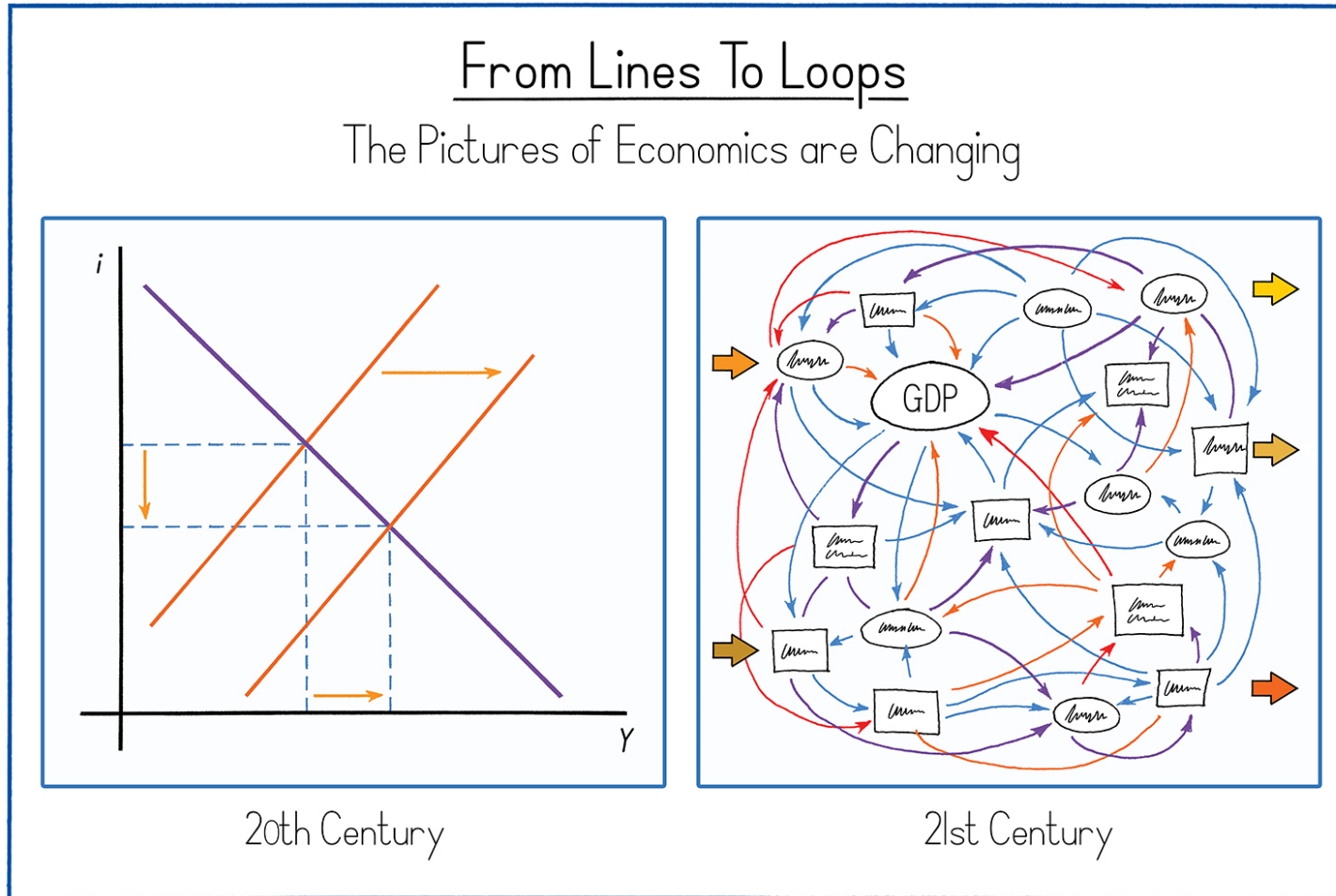
Economics' 'ceteris paribus' problem

A major challenge for economics today is that students are no longer buying its over-abstractions, because they have grown up in a world where the market primacy rationalized by economics is demonstrably not solving major social and ecological problems.



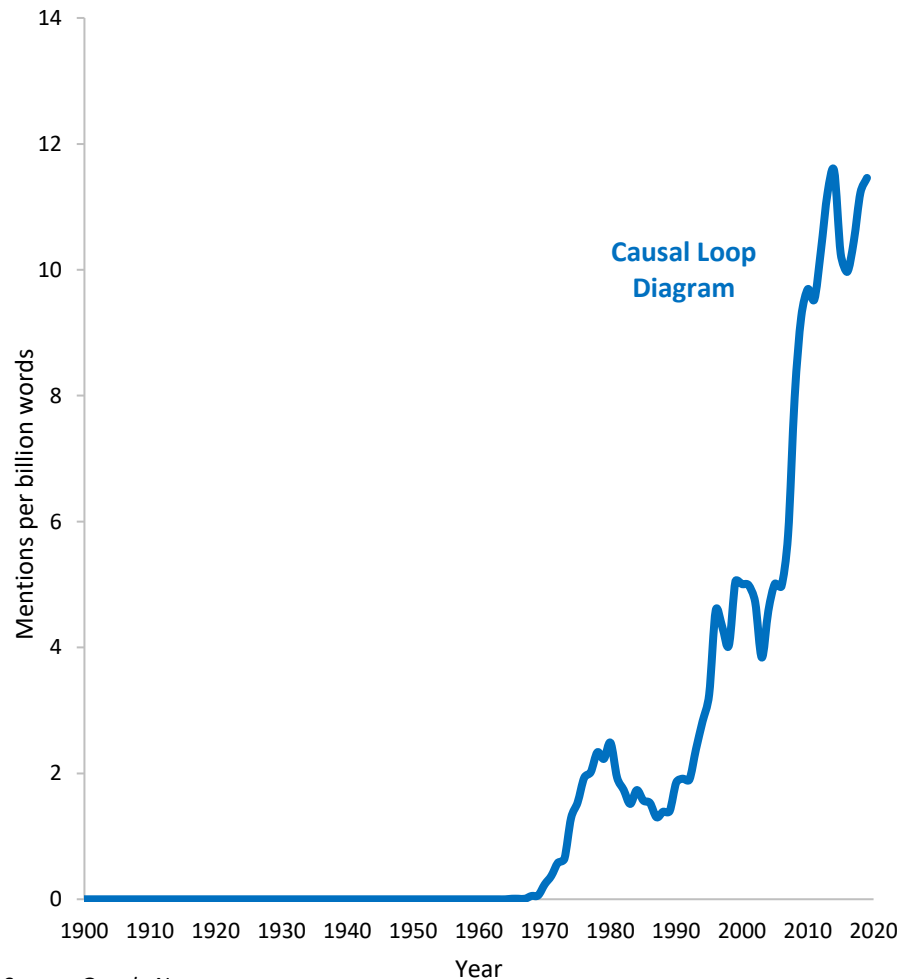
Economics' 'ceteris paribus' problem

Fortunately, there are encouraging signs that economics is changing for various reasons – e.g., the inevitability of systems thinking's ascent, the ability to simulate complexity with modern computing, the failure of overly abstract earlier theories. This is a welcome – and promising – development.



Causal Loop Diagrams are one marker of ascendancy of systems thinking

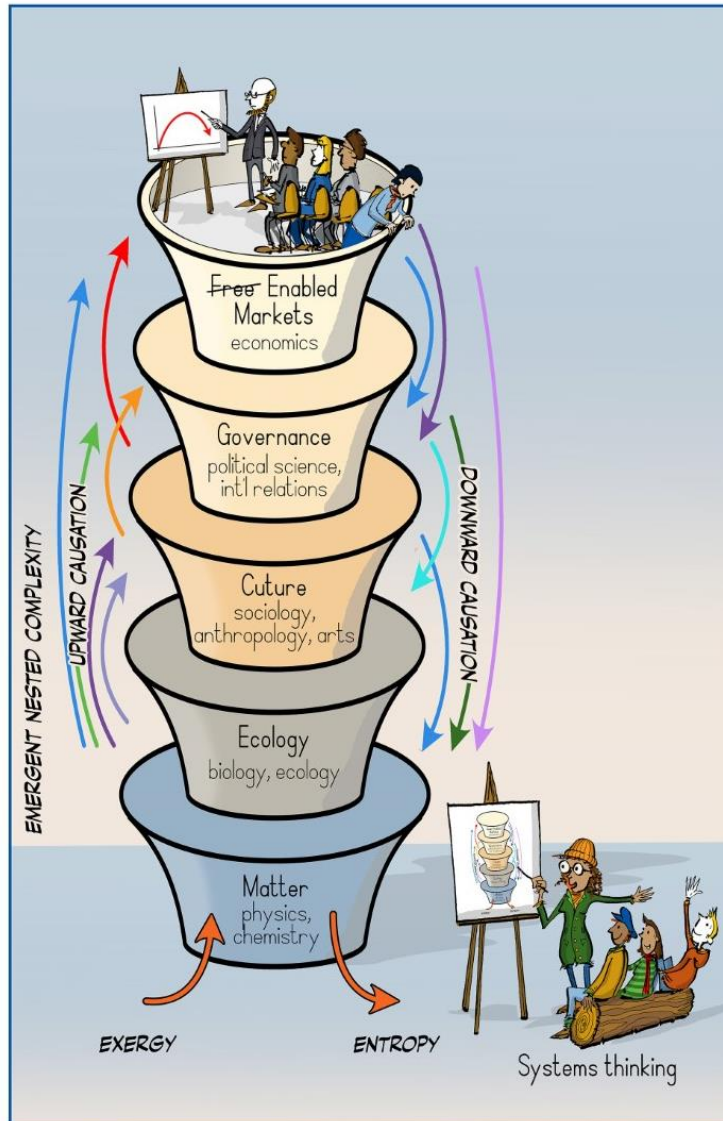
"Causal Loop Diagram"
Frequency of usage in Google Ngram



Source: Google Ngram

- Causal Loop Diagrams (CLDs) have their own limitations – as all diagrams do – but they constitute a diagrammatic antidote to the excessive reduction that is often intrinsic to the staple diagrams of economics, established in an era before systems thinking really took hold.
- CLDs force conscious (re)contemplation of the complexity from which familiar analyses abstract from.
- It is not that CLDs offer a panacea, but that they head in a different, but complementary, direction to analysis
- Their uptake is just one marker of the much broader intellectual development – a ‘Systemic Spring’ – that is the retreat from excessive reductionism and embrace of systemism via system dynamics, complexity, reflexivity, feedback loops, etc.
- The light this will shine on economic thinking – and hence on business and financial practice – is how *decontextualized* economic theories, incentives and behaviours have become from real-world implications.
- This development needs to be accelerated.

2D causal loops lead to 3D emergent, nested, complex systems

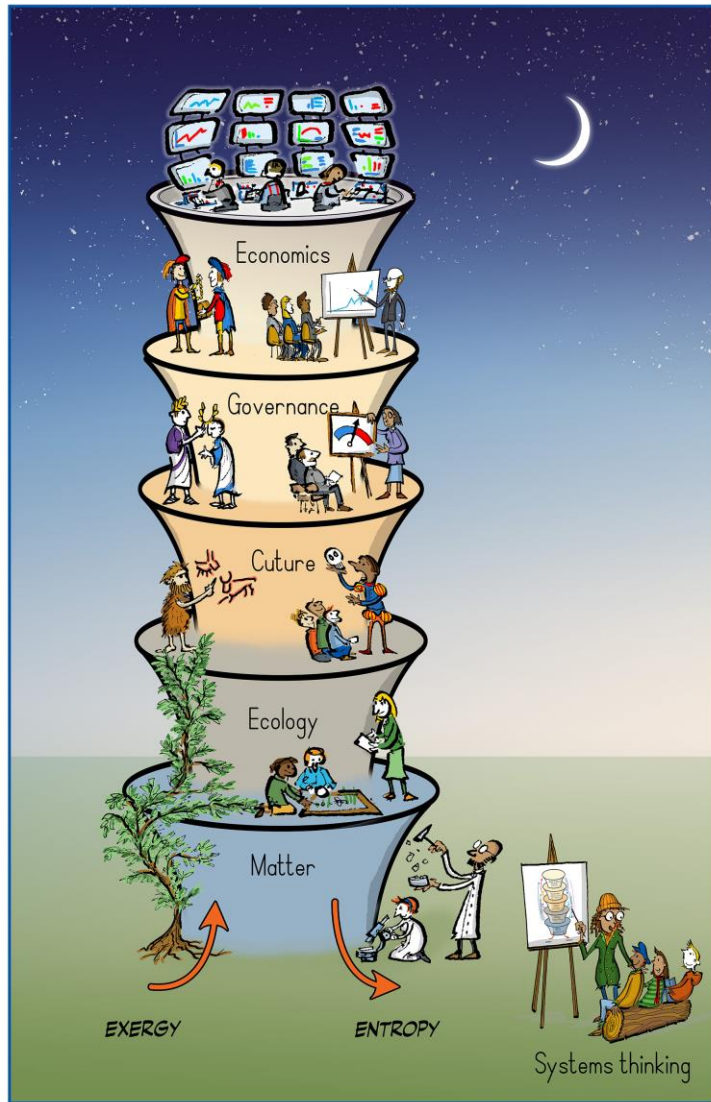


After Greg Henriques & Willem Hol

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- Those who contemplate causal dynamics of complex systems for any length of time soon come to see complex systems as layered, hierarchical structures.
- 2D causal loop drawings give way to 3D emergent, nested, depictions of living systems.
- This is because some causal loops are slower-moving, while others are fast-moving, and slower-moving causal loops enclose or constrain fast-moving causal loops. They 'scaffold' and so direct the way in which fast-moving causal loops generate further upward complexity.
- Human behaviour slowly develops a culture which enables a legal system which enables formal property rights which enables fast-moving market exchanges, whose patterns and innovations simultaneously flow back to shape the legal system, culture, ecology etc.
- There is continual upwards and downwards causation between layers, all the way back down to 'ecology' and 'matter'
- The modern formal economy is a decision-making arena enabled by prior, foundational levels of society and ecology **and remaining dependent upon them.**

Academic disciplines naturally emerged on the levels

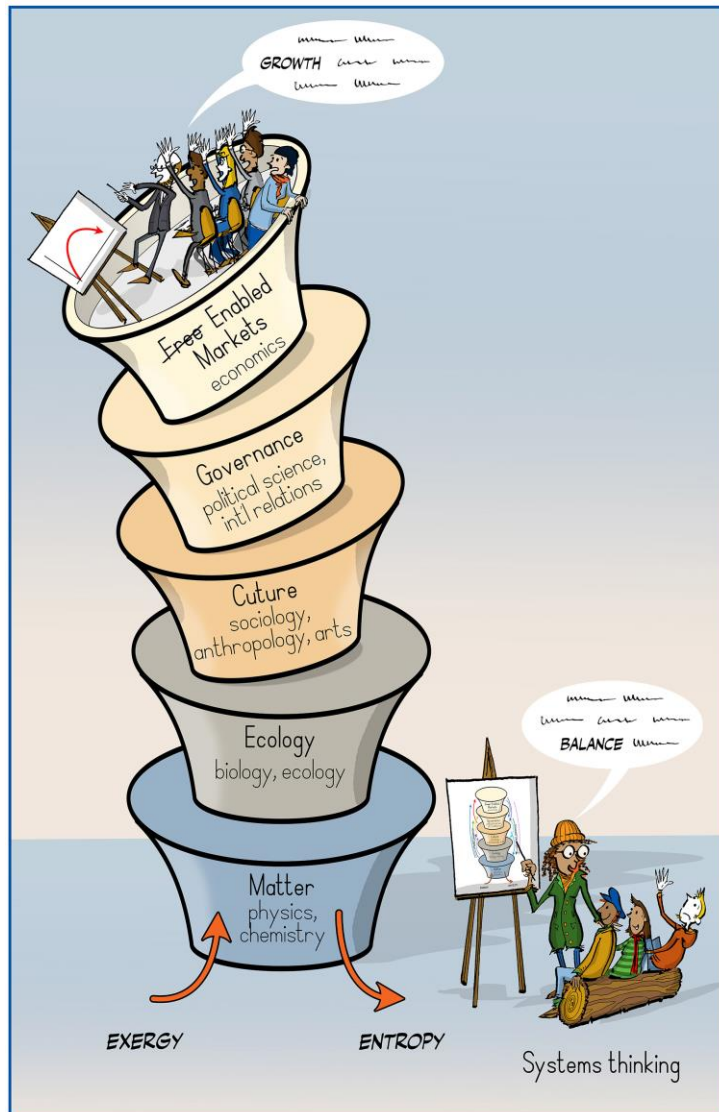


After Greg Henriques & William Hall

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- Because the development of most academic disciplines preceded our understanding of the emergent, layered structure of human society, disciplines naturally developed at different 'levels' with increasingly 'focused' exploration of the dynamics at that level (i.e. specialization).
- Economics has been the discipline that has focused on the 'high-level' of market exchange, but at a cost of under-appreciating the embeddedness of markets in lower levels.
- A systems perspective – resurgent in Western thinking since the mid-20th Century and central to many non-Western traditions – offers a better appreciation of the 'whole' – how it is structured, how it emerged over time and how we came to analyse it in the segmented way we have.
- Importantly, a systems perspective is not the exclusive preserve of 'big brain' polymaths, but a choice of perspective available to all. Alas, in a world that has incentivized specialization, the generalist/systemic view is currently in precious short supply.

Sustainability is about not toppling over



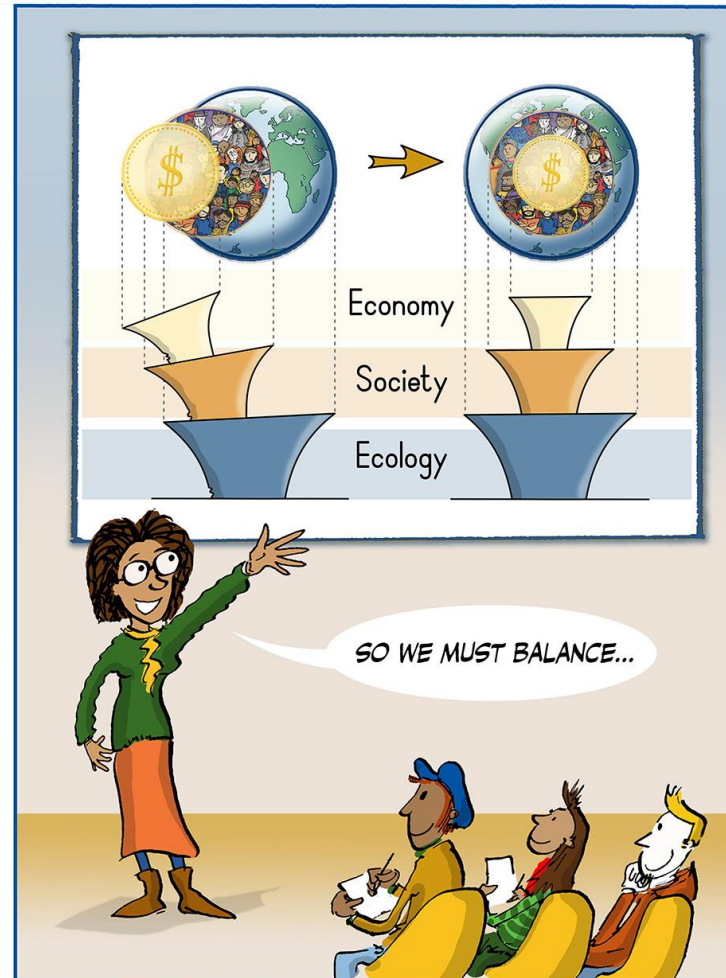
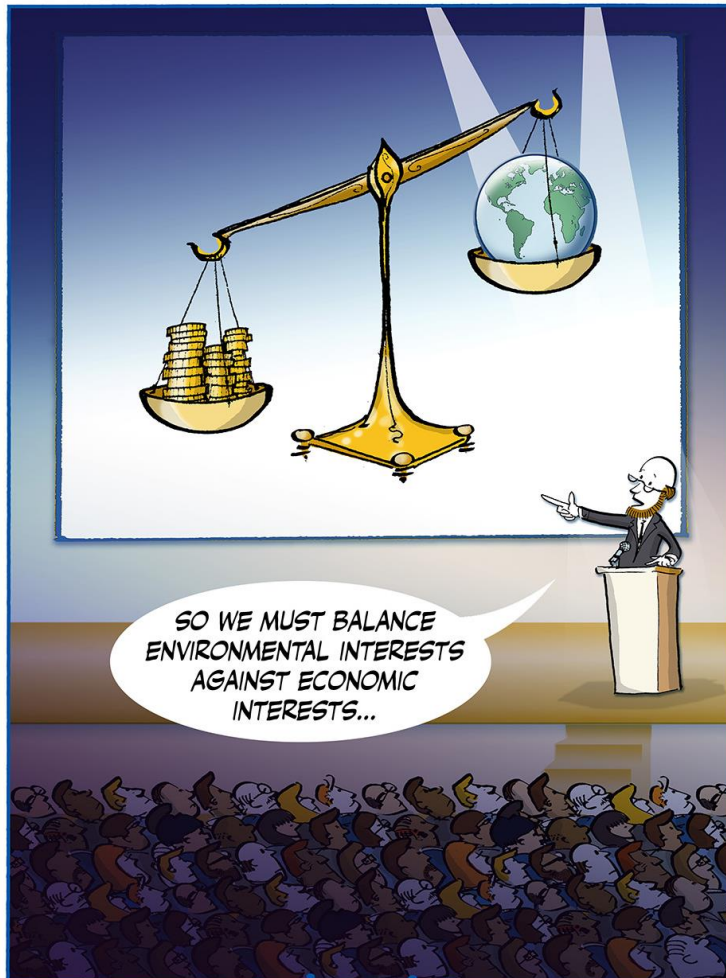
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- While all living systems are ‘pulled up’ to ‘complexify’ in some way – what humans are now doing on steroids! – the *sine qua non* goal of a complex system is not to topple over.
- Yet an economy may grow so top-heavy (too extractive, say) or lop-sided (too unequal, say), that it starts to undermine its social and ecological foundations.
- This might happen if growth-led markets granted primacy of influence were blind to certain needs of lower levels, because they had not been given ‘value’ in ways markets can grasp (prices, regulations etc).
- Economists anchor around ideas of **growth**.
 - Implicitly, 20th Century ideas of ‘complete markets’ encouraged complacency about the possibility of ‘externalities’ and concerns that the economy might undermine its foundations.
 - The Kuznets Curves (social and environmental) are the belief that even if social and environmental damages arise from the pursuit of growth, the wealth generated by that growth can repair, remediate or compensate damages before irreversible harm is done.
- In contrast, systems thinkers anchor around the idea of **balance** or **homeostasis**.
 - For many living systems, growth is a limited, early phase of development for which the longer, ongoing goal is the ability to maintain balance or homeostasis.
 - Emergent complex systems that fail to achieve homeostasis - both internally and with regard to external conditions - collapse.

There are two conceptions of balance

Failure to appreciate the embeddedness of the economy within the environment leads to unsustainable conceptions of 'balance'. Appeals from today's political and corporate stages to 'balance' economic and environmental interest (tacitly) rest on the view that economy and environment are separate entities, rather than connected parts of an interdependent complex system.



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