



CENTRE FOR
SUSTAINABILITY AND ENERGY

Dynamic Macroeconomics for a Finite Planet

**A new paradigm for macroeconomic policy analysis,
illustrated by the Earth4All system dynamics model**

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Dynamic Macroeconomics for a Finite Planet – Main message

I give this presentation because I wish to help dethrone neoclassical theory (NCT) as the dominant paradigm for macroeconomic policy analysis.

And to replace neoclassical thinking with a new paradigm – system dynamics (SD) – which I believe is better suited to achieve what I see as the ultimate goal: namely high wellbeing for the global majority on a thriving planet.

1. Looking fifty years ahead, I see accelerating change and rising frictions – between man and nature, among nations, and within nations – in a world that is getting ever fuller.

Change and frictions in an ever fuller world



2. Recently my colleagues and I wrote the *Earth for All* book. The book describes what will happen over the next fifty years if we continue conventional decision-making practices – including the continued focus on growth in GDP.

50 years after *The Limits to Growth: Earth for All*

Essential reading on our long journey toward an "Earth for All" society.
— THOMAS PIKETTY, author, *Capital in the Twenty-First Century*

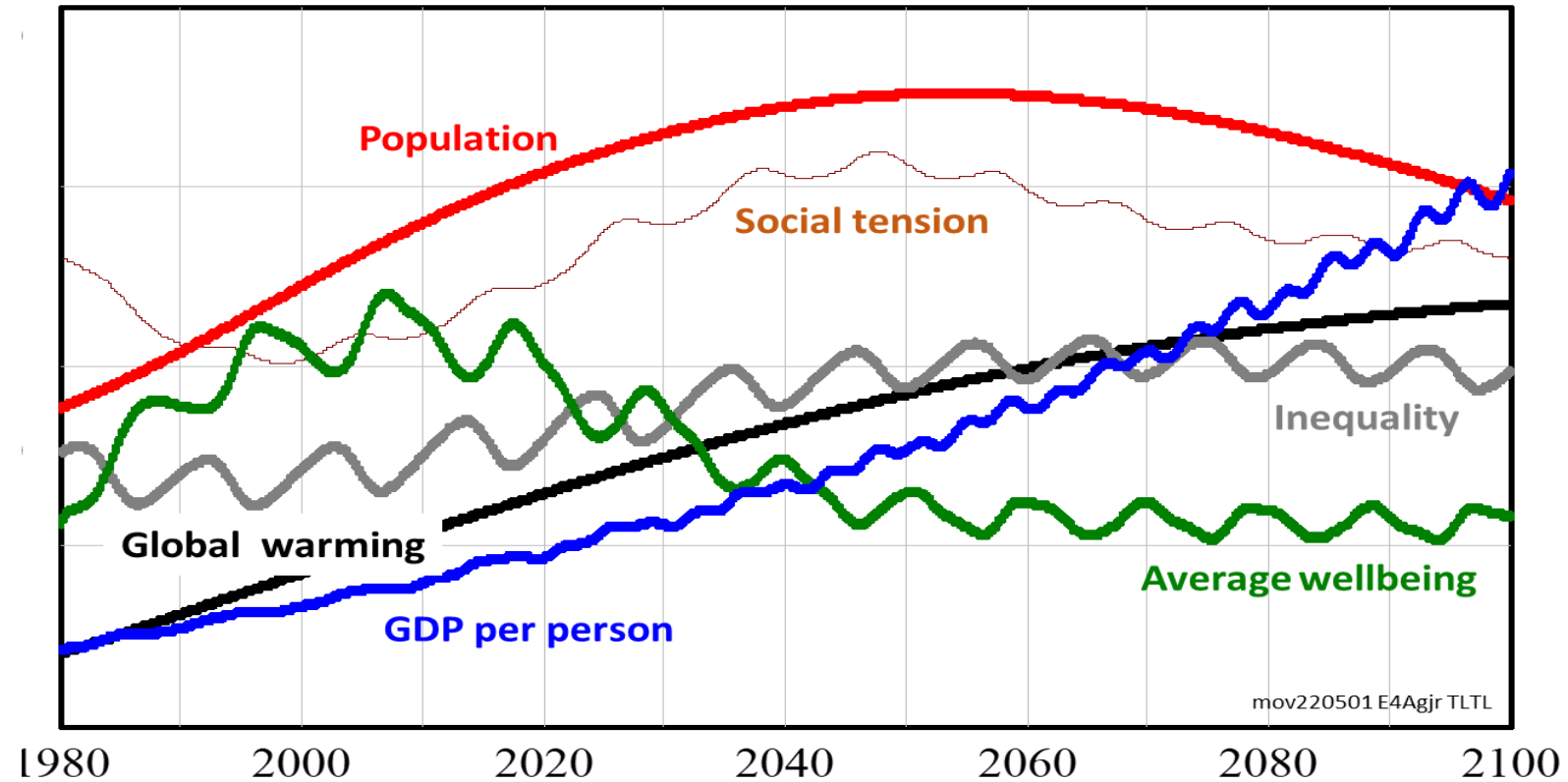


Earth for All

A SURVIVAL GUIDE for Humanity

Sandrine Dixon-Declève | Owen Gaffney
Jayati Ghosh | Jorgen Randers
Johan Rockström | Per Espen Stoknes
Forewords by Christiana Figueres and Elizabeth Wathuti

A REPORT TO THE CLUB OF ROME

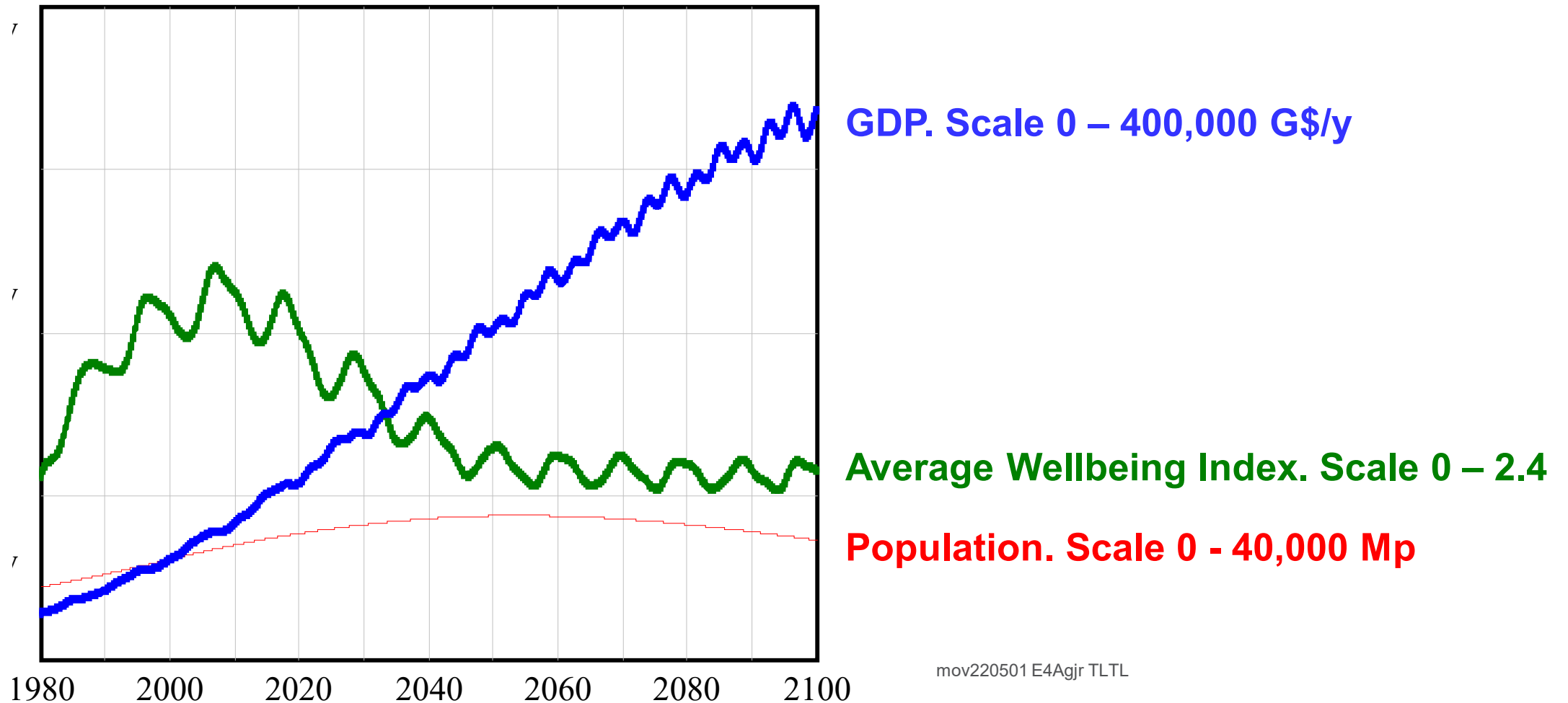


The «No Extraordinary Action» scenario (aka TLTL).
See www.earth4all.life

3. The main conclusion from *Earth for All* is that pursuit of conventional policy will lead to higher GDP, but lower wellbeing for the majority.

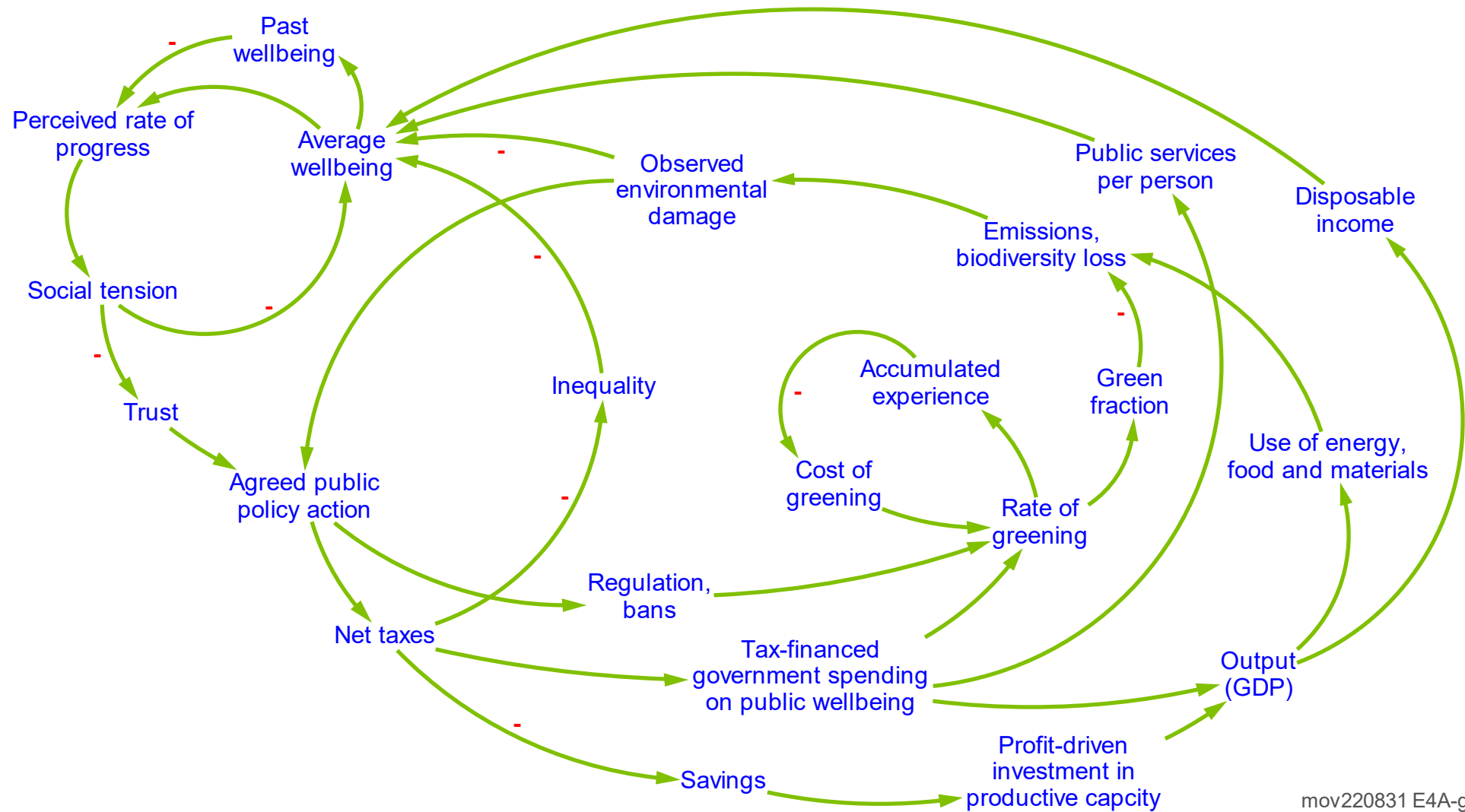
This decline – if allowed to continue for decades – may trigger local social collapse.

GDP growth leads to wellbeing decline - World 2020-60



4. In an increasingly crowded and turbulent, where everything affects everything else, one needs a new way to explore the consequences of policy action.

High-level summary of the Earth4All model



mov220831 E4A-global jr

5. It is no longer enough to study the effect of proposed policy on GDP.

One must study the effect on all variables that influence human wellbeing in a major way.

The E4A *Average Wellbeing Index* depends on

1. Worker disposable income per person – after tax and transfers
(in 2017 PPP \$ per person per year)

2. Public spending per person
(in 2017 PPP \$ per person per year)

3. Inequality

(Owner disposable income divided by worker disposable income)

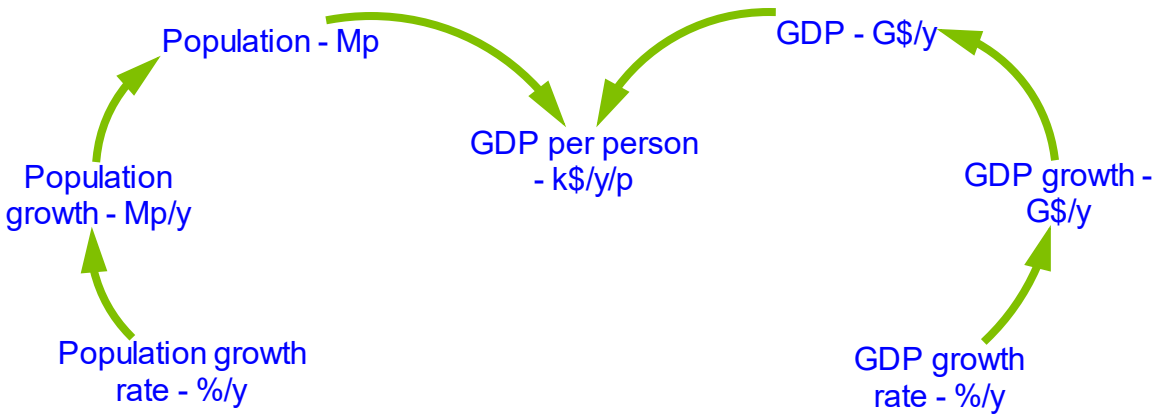
4. Environmental damage
(Global warming in degrees Centigrade since 1850)

5. Social tension
(The rate of decline in wellbeing during last 5 years)

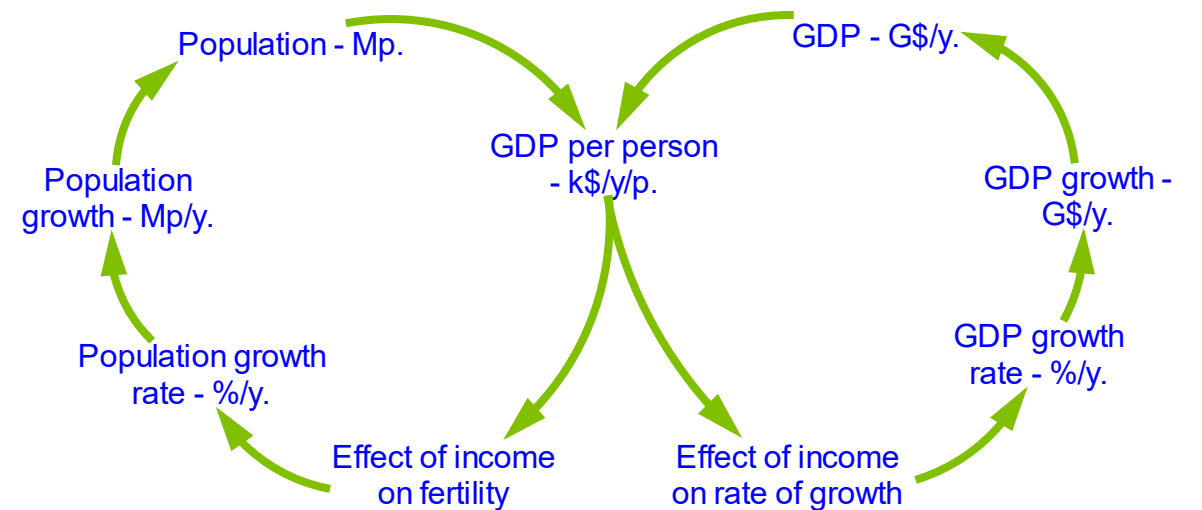
6. It is no longer enough to use linear thinking and estimate the effect on a final equilibrium. One must accept the reality of circular causality and the need for new mathematics (differential equations instead of linear algebra).

Feedback perspective on GDP per person

LINEAR SHORT
TERM
PERSPECTIVE:



CIRCULAR LONG
TERM
PERSEPECTIVE:



Fertility declines when
nation gets richer

GDP grows slower
when nation gets richer

7. It is no longer enough to study the effects of policy change in the short term (<2 years).

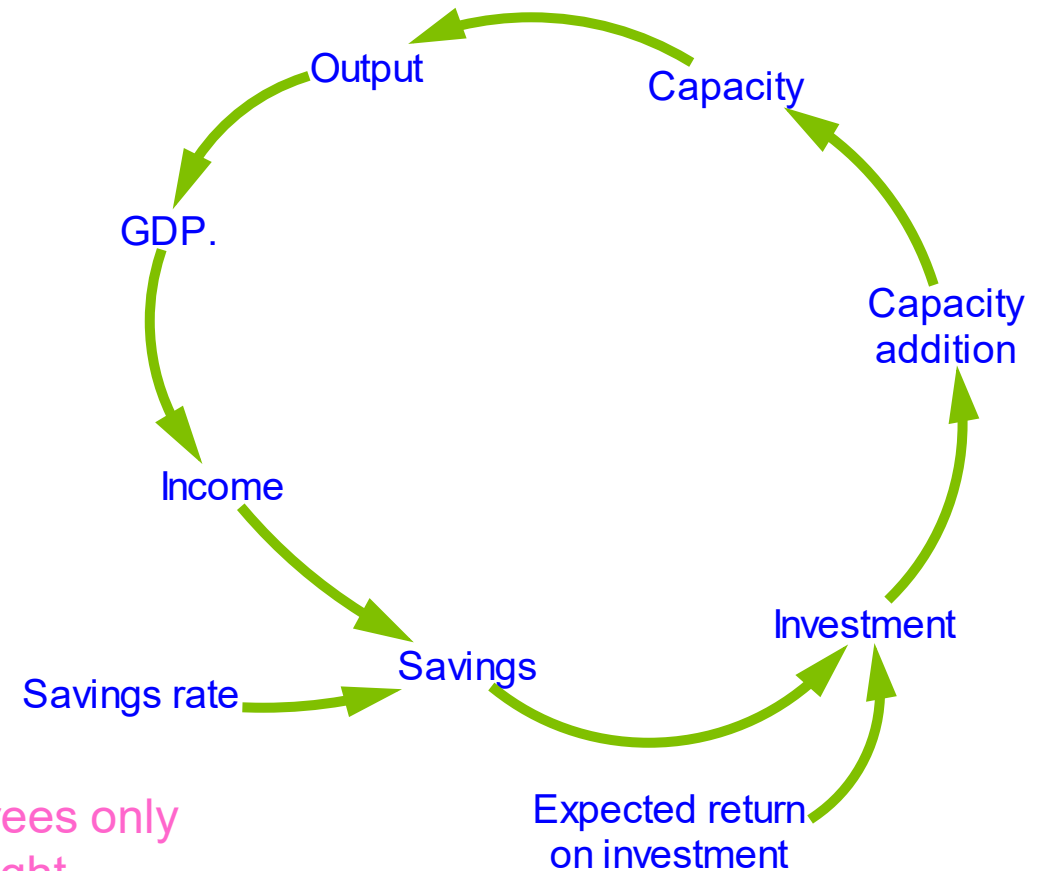
One must lengthen the time horizon to cover the feedback effects triggered by the first move.

Linear versus circular causality

LINEAR SHORT-TERM PERSPECTIVE:



CIRCULAR LONG-TERM PERSPECTIVE:

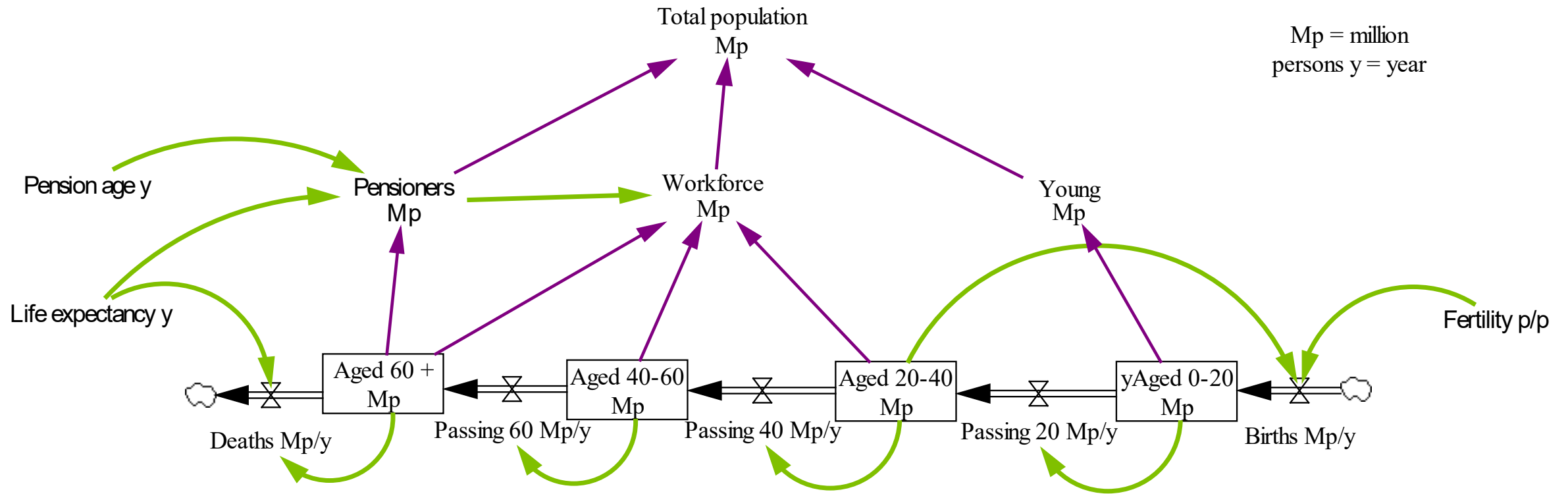


Keynesians and the neoclassicals disagree only on what starts growth in the loop to the right – more demand or higher return on investment.

8. It is no longer enough to study (economic) flows.

One must track the changes in the relevant stocks, since normally it is the accumulated stocks that determines what happens next, not the current flows.

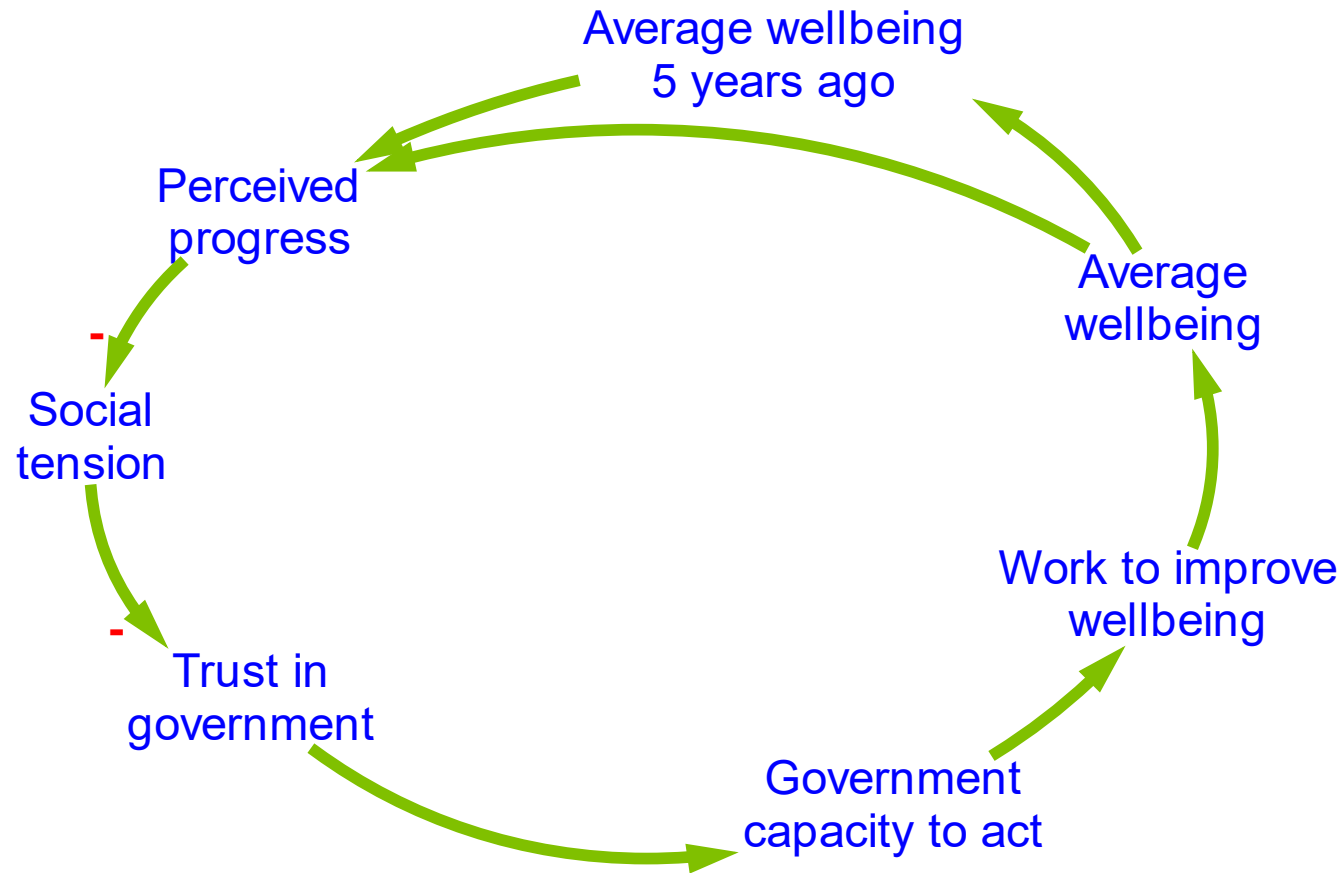
Stocks and flows in population growth



9. It is no longer enough to rely on economic data (time series in dollar terms).

It is always helpful – and sometimes necessary – to supplement with non-economic data (physical flows), and even very-hard-to-quantify (soft science) data.

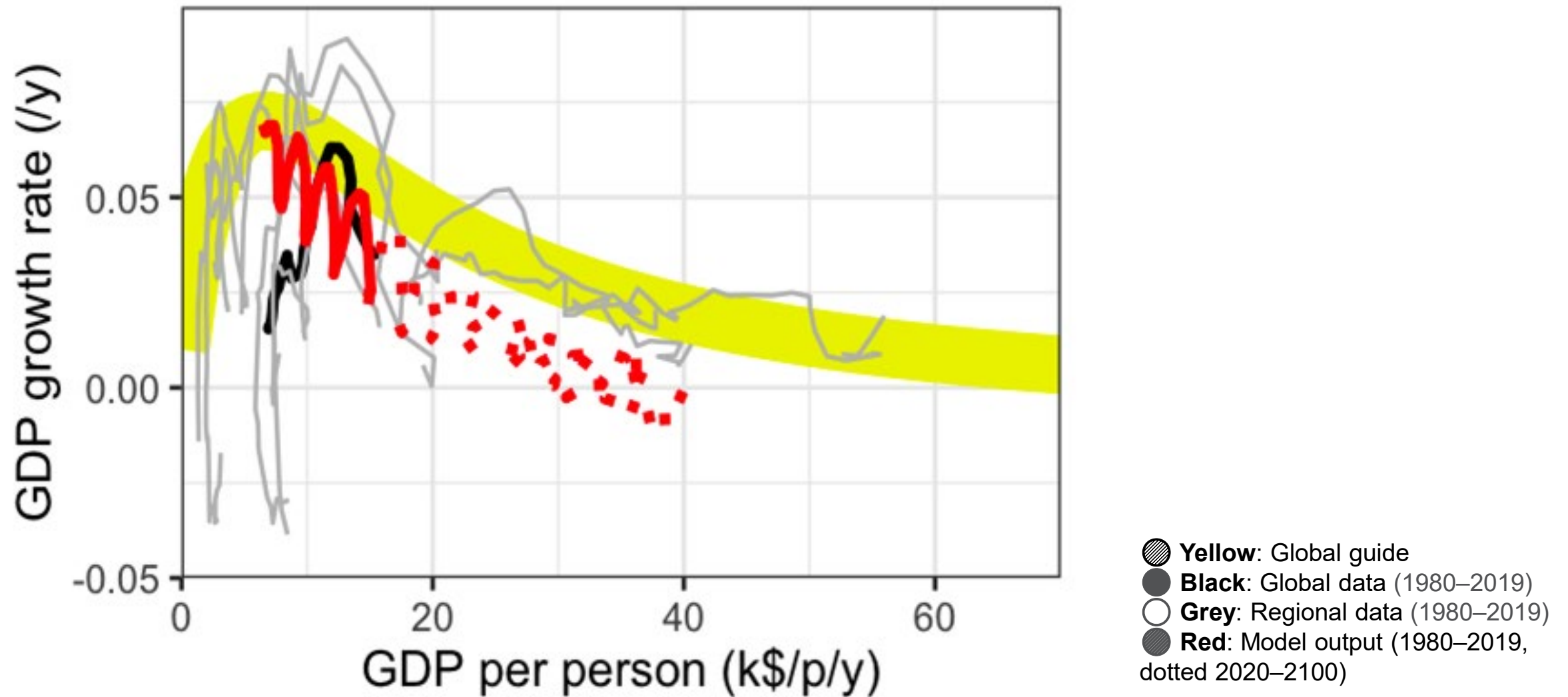
The vicious cycle of rising tension (causing social collapse)



10. It is no longer enough to study/build theory on historical correlation.

The focus must be on the underlying causality – cause and effect relationships.

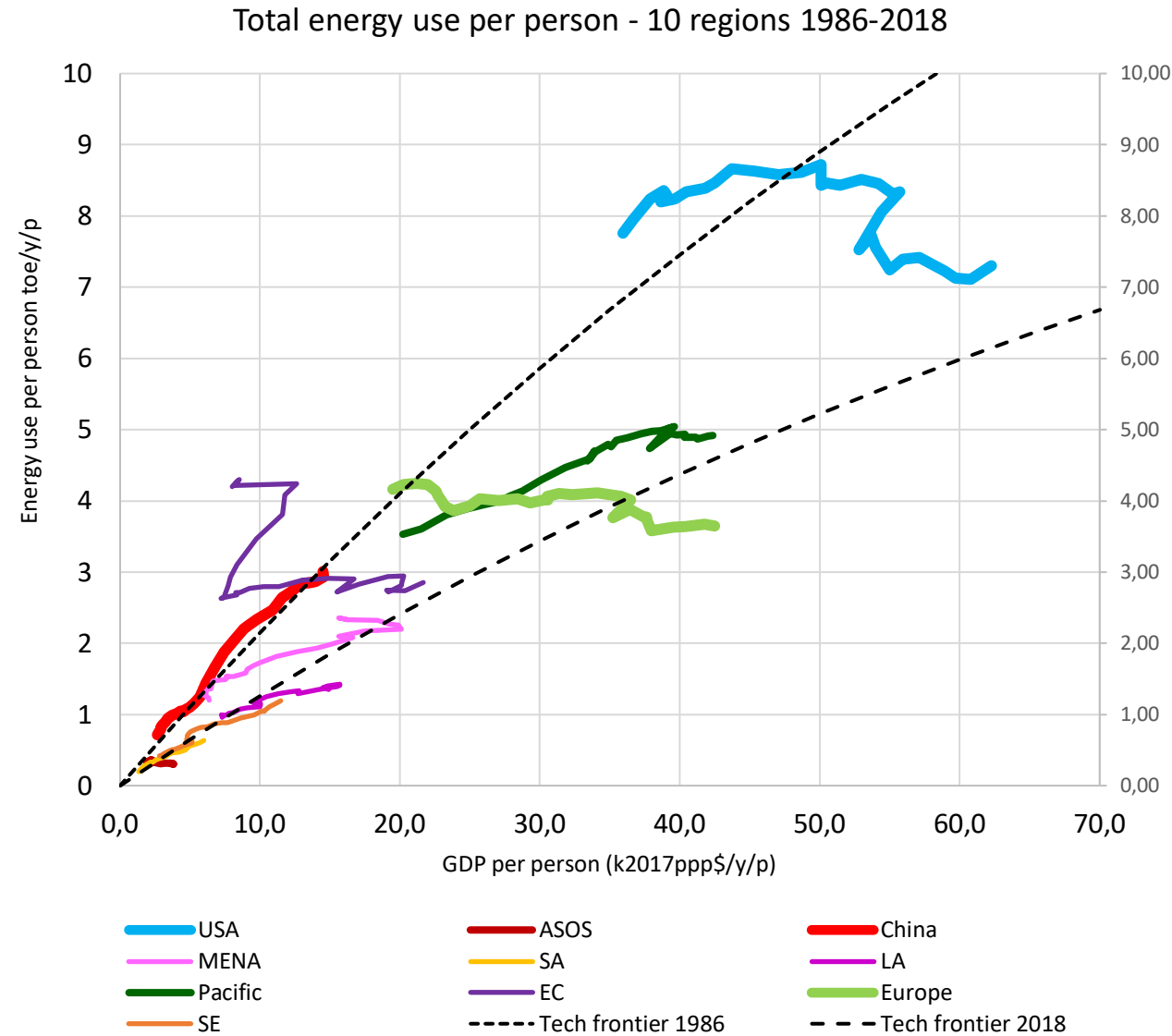
GDP growth slows when a country gets richer – regional data



11. It is no longer sufficient to assume a linear response to an input.

The real world includes non-linearities – which tend to dominate system behavior when the system is pushed against limits.

Total energy use per person rises with income, but stagnates



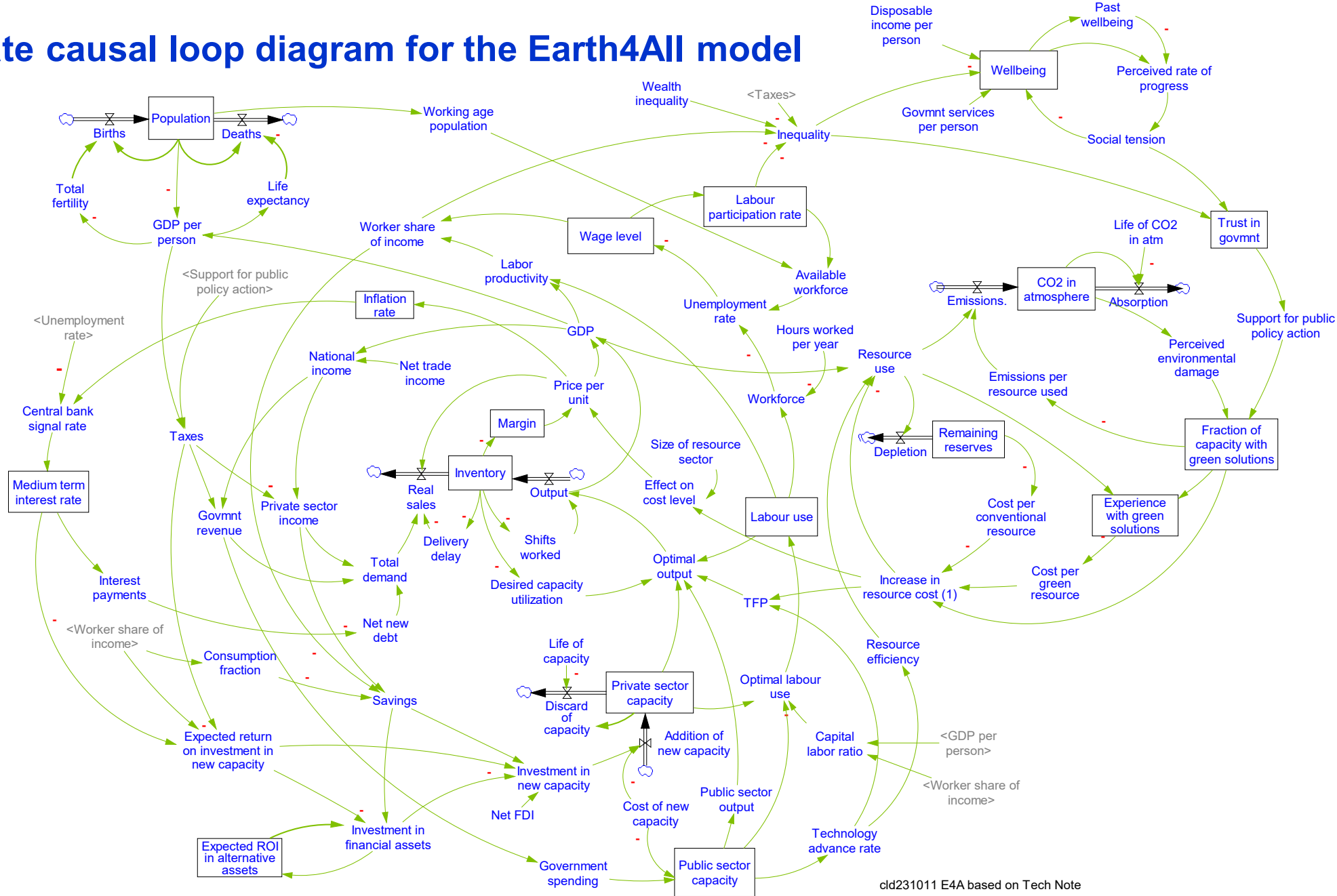
12. There already exists a practical and mature method for the study of complex systems – system dynamics.

System dynamics (SD) could become the mainstream guide to better policy but is fiercely resisted by neoclassical theory (NCT).

13. The strength of system dynamics paradigm is illustrated by the *Earth4All* model of human wellbeing on a finite planet towards 2100.

The model helps clarify the consequences of radical policy to stop the decline in human wellbeing.

Aggregate causal loop diagram for the Earth4All model



5 Turnarounds to increase wellbeing

“THE SUSTAINABILITY TRANSFORMATION”

1. Eliminate global poverty

Use new growth models: more plan less market

2. Reduce inequality

Tax the rich to pay for higher wellbeing for the working majority

3. Empower women

Free education, health, contraception and opportunity to all

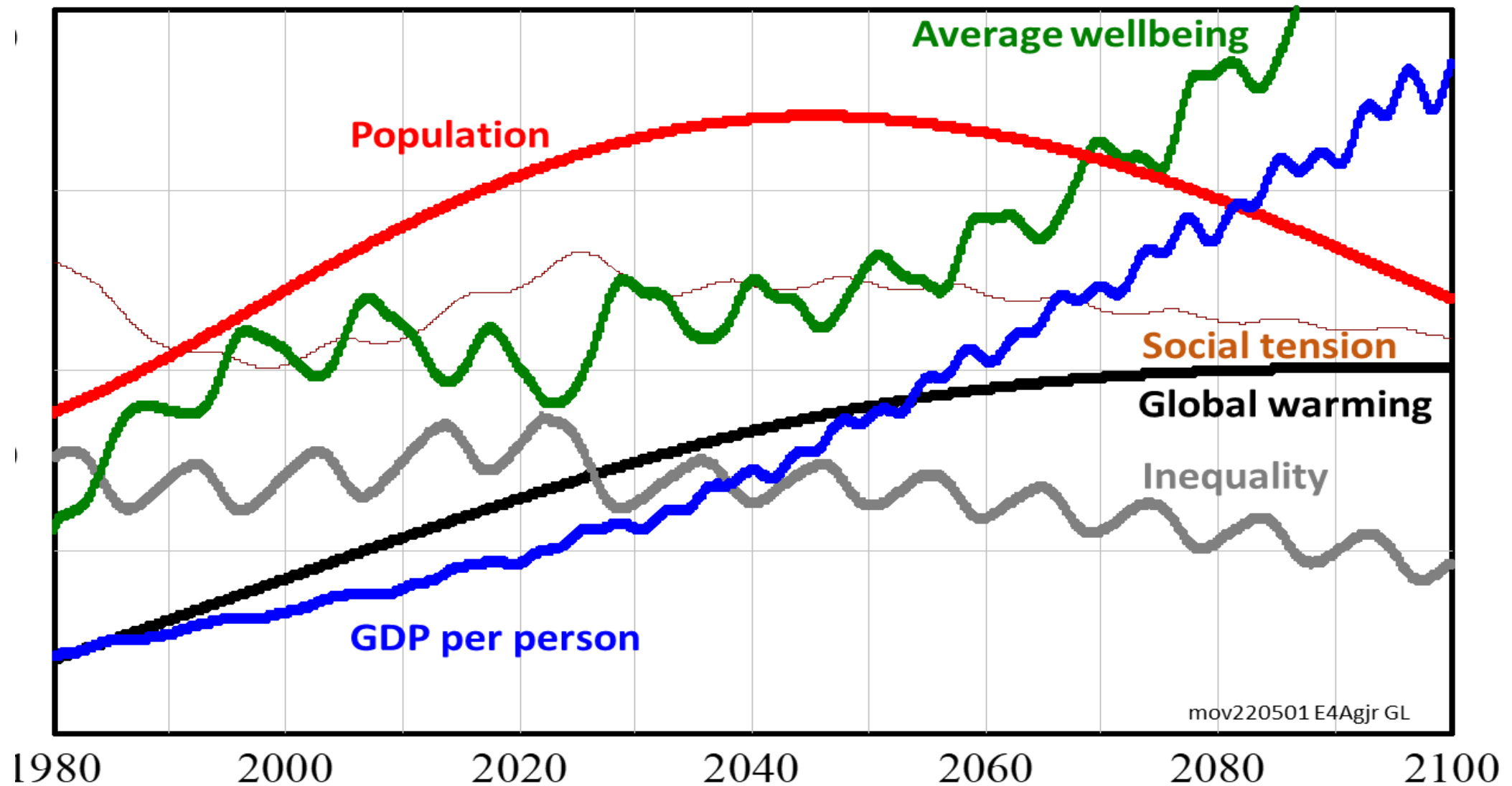
4. Halt biodiversity decline

Shift to carbon-positive agriculture to protect remaining forests

5. Stop climate change

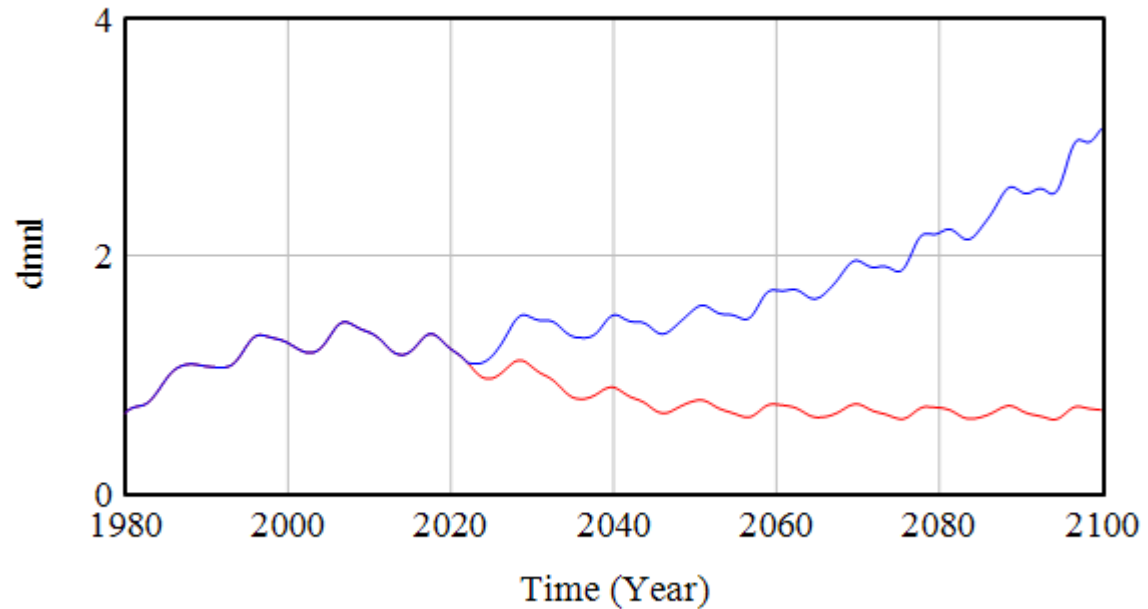
Replace fossil energy with sun, wind, efficiency, and CCS

Main trends in global development – «Giant Leap»



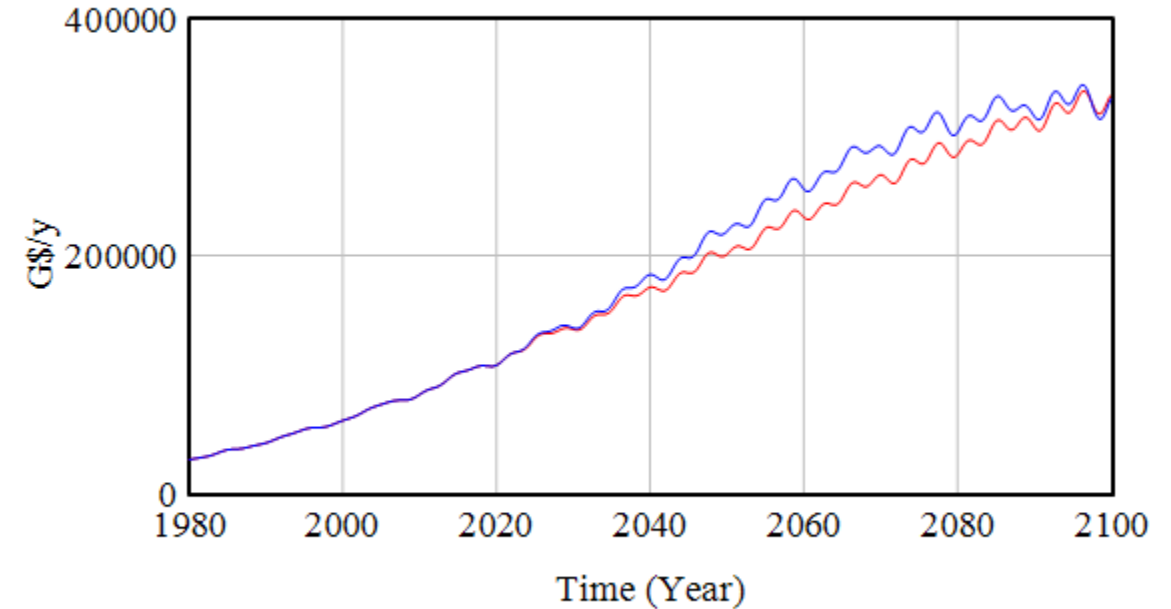
Comparing “Giant Leap” and “No Extraordinary Action”

"AVERAGE WELLBEING INDEX (1)"



— E4A-220501 GL — E4A-220501 NEA

"GDP G\$/y"



— E4A-220501 GL — E4A-22050 NEA

14. Neoclassical theory is not suited to describe the real world in a manner which is useful for long-term policy making.

System dynamics simulation models can help.

15. The best way forwards is peaceful coexistence between SD and NCT

16. Promising sign 1: Increased willingness to deviate from NCT dogma

17. Promising sign 2: Theoretical innovation led by practical policy making.

18. We may live to see the introduction of system dynamics as a competing paradigm for global policy making.

We need a good tool for reliable policy analysis

