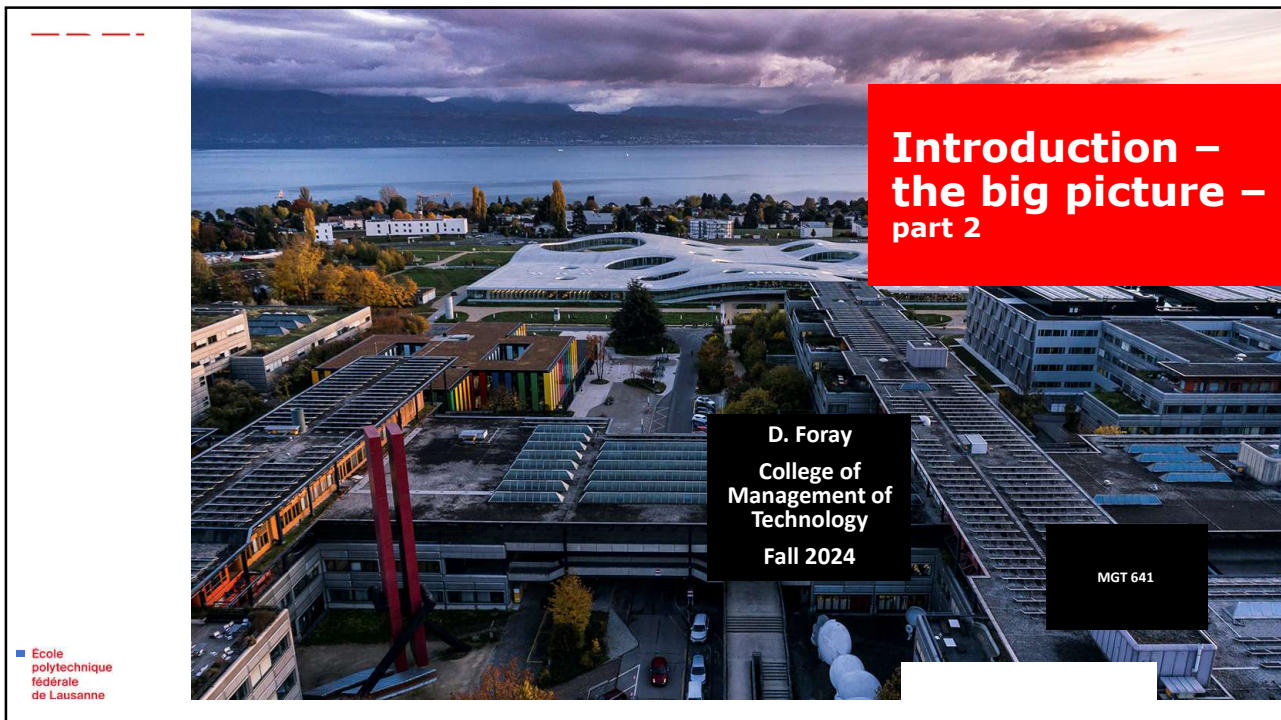


**EPFL**

- GDP growth – the usual barometer
- Productive base, GDP and sustainable development
- The global impact inequality (focus on natural capital)
- Making our greatest achievements sustainable : multiple areas of policy intervention

Global impact inequality

$$Ny/\alpha > G(S)$$

N = global pop., y = global GDP per capita;

α = the efficiency with which natural resources are converted into goods and services

Ny/α = the aggregate demand for Nature's services or a measure of humanity's ecological footprint

G = biosphere net regeneration rate

S = stock of natural capital

G is a function of S – when S is small, G can be made to increase by allowing S to increase

By some estimates the ratio of our demand for Nature's services to Nature's ability to meet this demand is 1.7 = we need 1.7 Earths to meet our demands

Meaning that we are enjoying the overshoot at the expense of the health of the biosphere; that is by depleting S (and so G)

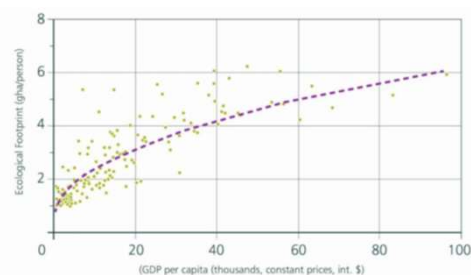
Closing the inequality - $Ny/\alpha > G(S)$

- Reducing Ny

- N – a long run trend – supported by social policies (family planning, reproductive health, education)
- y – problems within problems

- Increasing α

- Increasing $G(S)$



We need a growing y or GDP/capita for:

Eradicating poverty

Securing a reasonable rate of material progress for all

Democratizing our greatest achievements

Redistribute wealth from rich to poor and keep

GDP/capita constant (fiscal policy)

Mitigate the effects of a growing GDP/capita –how the extra money is spending? This is about α

Closing the inequality - $N_y/\alpha > G(S)$



- Reducing N_y
- Increasing α
 - Innovation is crucial
 - But α cannot be increased indefinitely
- Increasing $G(S)$
- Discrete innovations
 - better solar panels, more efficient wind turbines, more powerful batteries, hydrogen trucks
- System's transformation
 - establishing a circular economy in the food industry, developing a sustainable mobility system in Lausanne
- Drive:
 - Factor's substitution (e.g. scarce water x improved distribution infrastructure, desalination of sea water)
 - Efficiency (e.g. higher energy efficiency of buildings)
 - Recycling (e.g. waste, products, materials)
 - Management (e.g. forestry, land use, agriculture)

Closing the inequality - $N_y/\alpha > G(S)$



- Reducing N_y
- Increasing α
 - Innovation is crucial
 - But α cannot be increased indefinitely
- Increasing $G(S)$
- Innovation is not exogenous, out of control (or just dictated by markets). **Its direction towards socially desirable goals** responds to economic incentives and social norms - **missions involve:**
- Factors influencing directly innovation
 - Promotion of adequate technologies
- Factors influencing indirectly innovation
 - Economic instruments (tax, regulation) – “pay for what we use”
 - Large scale behavioral tipping – towards responsible consumption
 - Observation and measurement (knowledge about externalities, natural capital stocks, eco-system value)
- The centrality of a narrative to influence consumers, innovators and investors
- Funding and policy (coordinated push)

Closing the inequality - $N_y/\alpha > G(S)$



- Reducing N_y
- Increasing α
 - Innovation is crucial
 - But α cannot be increased indefinitely
- Increasing $G(S)$

From: Partha Dasgupta <partha.dasgupta@econ.cam.ac.uk>
Sent: Monday, August 12, 2024 5:42 PM
To: Dominique Foray <dominique.foray@epfl.ch>
Subject: RE: special issue of EINT in memory of Paul David
 Dear Dominique,

Many thanks for your email. The matter regarding the efficiency term α is not related to whether one is a pessimist or optimist; it's an analytical issue. Raising α involves investment, and to assume that α can in principle approach infinity over time would be to assume that in the long run the human economy at the margin can free itself from the biosphere, which is another way of saying that asymptotically there will be no additional resource costs in raising α . Why not then start by assuming α can move toward infinity exogenously. But if we were to assume that, we could as well assume that there are no costs in raising α , meaning that we are at one with endogenous growth theorists who claim that if we invest sufficiently, we can enjoy indefinite GDP growth.

I hope this helps.

Warm regards.

Partha

Closing the inequality - $N_y/\alpha > G(S)$



- Reducing N_y
- Increasing α
- Increasing $G(S)$
 - A fundamental distinction
 - Raising $G(S)$ is about investing in Nature – allowing Nature to grow
 - Raising shadow prices of Nature's services
- Provisioning goods – goods that with human effort and ingenuity are transformed into final goods and services
 - Food, water, timber, fuel, fibres, pharmaceuticals, non living materials
- Repair and maintenance services create provisioning goods
 - Carbon sequestration, nitrogen fixation, nutrient recycling, decomposition of waste, pollination, soil regeneration, purification of water, maintenance of the biosphere's gaseous composition
 - We are mostly unaware of the processes that give rise to those services but they are the foundation on which we exist. And because there are several steps removed from our direct experience, we underestimate their significance
- Our strong demand for Nature's provisioning goods has diminished Nature's ability to supply maintenance and regulating services

Closing the inequality - $N_y/\alpha > G(S)$



- Reducing N_y
- Increasing α
- Increasing $G(S)$
 - A fundamental distinction
 - Raising $G(S)$ is about investing in Nature – allowing Nature to grow
 - Raising shadow prices of Nature's services
- Provisioning good vs repair/maintenance services
- Increasing α (substitution, efficiency, recycling, management) is essentially about provisioning goods
 - The long standing question whether labour and produced capital can substitute for natural resources refers to provisioning good not to maintenance and regulating services
- Economists argue that natural resources are becoming more abundant as reflected by the decreasing market prices for these resources
 - But they focus on provisioning goods whose abundance is a function of high substitution, increasing efficiency and effective recycling and management – they don't recognize that the maintenance and regulating services that were damaged in the extraction and production of those provisioning goods were not included in the price of these goods.
 - This is also the problem with the extraction and production of the new provisioning goods (lithium, cobalt, copper, nickel) which are crucial for the "ecological transition" or with fracking
- Increasing α can operate at the expenses of repair and maintenance services

Closing the inequality - $N_y/\alpha > G(S)$



- Reducing N_y
- Increasing α
- Increasing $G(S)$
 - A fundamental distinction
 - Raising $G(S)$ is about investing in Nature – allowing Nature to grow
 - Raising shadow prices of Nature's services
- Investing in Nature is passive in most cases – waiting for its health to improve.
- But waiting is costly, so wetlands, grasslands and forests are at constant threat from bulldozers, drills and chain saws
- Should the preservation of a local forest scupper plans for the development of a new road? The economic case of a new road seems irrefutable.
- It depends how you measure the value (social productivity) and price the local ecosystem
- Estimating social productivity σ (the value of the flow of services provided to society) and social scarcity (or shadow) prices is the relevant approach – although such estimation is a formidable problem
- If shadow or social scarcity price increases relative to produced capital, the waiting may not be costly and restoring the wetland may be a better economic decision than constructing a road

A rough example : healthy ocean



The ocean is a typical global commons : we don't pay for such global public goods as the open seas. Ocean is an open-access resource (the seas that lie beyond exclusive economic zones and are not protected zones).

Global commons are suffering from the "tragedy of the commons" through deep seas fishing, transportation, tourism and pollution from lands (chapter 3)

$$Ny/\alpha > G(S)$$

Observation, measurement (of externalities) and valuation of ecosystems

Technologies
Social norms – responsible consumption
Economic instruments

Technologies (desextinction?)
Economic instruments
Regulation
Protected zones but oceans are mobile
Taxation
taxing ocean transportation, deep sea fishing and the pollutants deposited into oceans by nations = billions of \$/year

How to discount the future benefits of our present investments?



- **Problem** – the value of 100CHF today is different from 100 CHF tomorrow
- Reducing emission or investing in clean infrastructures or investing in Nature involve huge costs now, but the benefits from averting climate disruptions would be enjoyed only 50 to 100 years from now
- How to discount future benefits of our present investments to save the planet
- **Principles – discounting rate**
- When making calculation in t_0 , one divides benefits in future year t by a factor $(1+r)^t$
- The discount rate $(1+r)^t$ denotes $(1+r)$ multiplied to itself t times
- r is the interest rate - The smaller is r , the greater is the weight placed on the benefits of future
- To evaluate public projects, economists use long term interest rates on government bonds (3 – 5%) to discount future benefits and costs and compare what could be earned by investing in government bonds versus the long term project

T_0
Investing 2M

T_{100}
Generating 100M

Net present value of future benefits (100 M in 100 years):

Future benefits *minus* costs with $r = 4\%$

Discounted rate = $(1+4\%)^{*100}$

Discounted benefits or present value:

$$100M / (1+4\%)^{*100} = 1.980\ 000$$

Net present value is negative

$$1.980.000 \text{ minus } 2M = - 20\ 000$$

At $r = 4\%$, the net present value of benefits is negative – it would not be efficient to do it

How to discount the future benefits of our present investments?



- At rates of 4%, the costs of climate investments are greater than the sum of the discounted benefits from decreasing net carbon emissions – it is not optimal to do it!
- Why should we discount future benefits at a positive rate? Because of two arguments to place a small weight on the future benefits of investments
- First – a future benefit would be of less value than the same benefit today because **people are impatient** to enjoy the benefit now
- Second – if **future generations are likely to be richer than us**, there is a case for valuing an extra dollar's worth of their consumption less than an extra dollar's worth of our consumption (consideration of justice and equality across generations)
- Societal impatience is unethical
 - It favours policies that discriminate against future generations on the grounds that they are not present today
- Rising consumption per capita will not happen in a context of a large decumulation of natural capital assets
 - Considerations of justice and equality to favour present generations do not apply
- Two reasons for discounting future benefits at a lower (or negative) rate

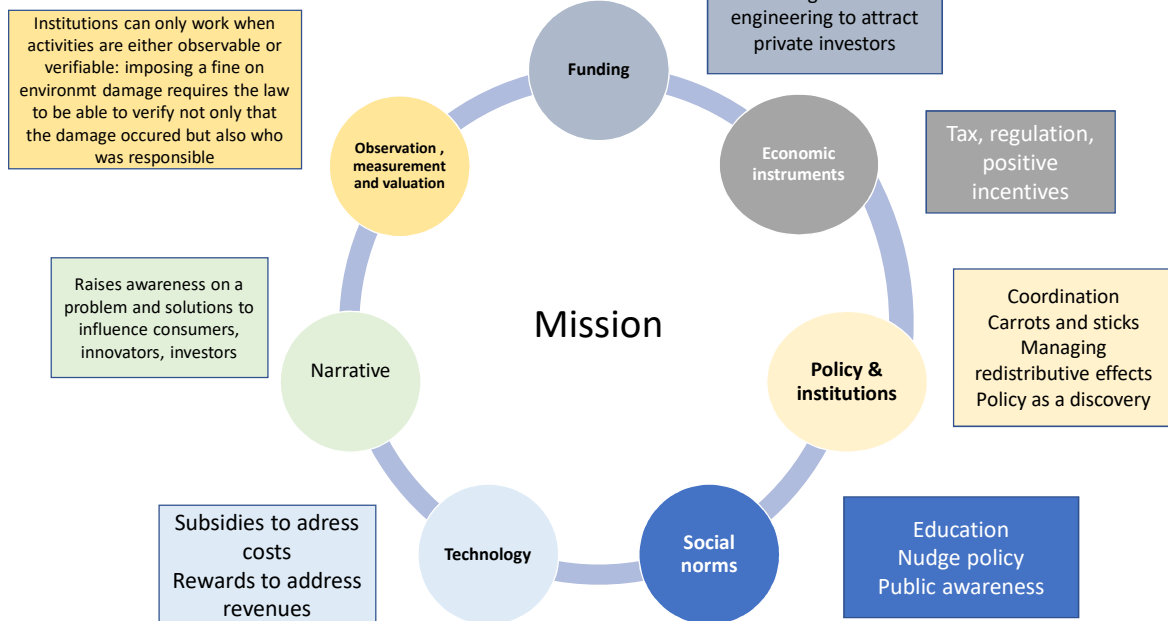


- GDP growth – the usual barometer
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- **Making our greatest achievements sustainable : multiple areas of policy intervention**

Making EWAC sustainable

- Our greatest achievements
 - Mobility, communication, healthcare, culture and education, essential elements of household comfort
- EWAC (*exploring the world at affordable cost*)
- An iconic innovation – low cost flight
 - Admirable! Democratisation, disruption
 - Low cost is not just cheap! This is about simplification and focus on the essential function
 - It generates high social surplus (willingness to pay *minus* price) - examples
- A great innovation but with enormous negative environmental effects
- We don't want to give up EWAC but we have to make it sustainable
 - 7 areas of policy interventions

7 coordinated policy interventions





Take home

- Since 150 years – the world experienced a great enrichment as measured by GDP/capita growth
- Driven by innovation, etc..
- But the great enrichment was partially artificial since it went together with the depreciation of some capital stocks (natural, perhaps human)
- GDP is a gross measure – does not account for capital depreciation – if just watching to GDP, we miss the great decumulation of (natural, human, social) capital assets
- Many activities have two effects: increase GDP *AND* generate environmt damage (or public health issues) which are externalities : this cost is not included in the total cost of the activity and thus is not reflected in pricing – hence tendency to over-use, deplete, mismanage, damage because it does not cost anything
- Solution – pay for what we use but the estimation of the value of what we use (social productivity of capital assets and their social scarcity prices) is a formidable problem
- Global impact inequality – to close it: work on α and on $G(S)$ – working just on α is insufficient since it can't grow infinitely – investing in Nature is crucial
- The key role of present net value of future benefits and discounting rate to place greater weight on future benefits (in 100 years!)
- Missions – making our greatest achievements sustainable – 7 areas



Next steps

- Understanding innovation and its past, present and future role
 - Innovation economics – explaining the great enrichment
 - Classifying and measuring
 - Adressing market failures: capturing value and funding innovation
 - 4 types of innovations at the time of Grand Challenges
- Building roadmaps for missions
 - Developing Narratives
 - Repairing markets
 - Promoting technologies
 - Influencing large scale behavioural tipping
 - Funding missions
 - Designing a policy

