

**EPFL**

- **GDP growth – measure as usual?**
- Productive base, GDP and sustainable development
- The global impact inequality (focus on natural capital)
- Multiple areas of policy intervention
- Making our greatest achievements sustainable



- The extraordinary power of science, technology and innovation has triggered a **great enrichment** – as measured by GDP growth and GDP/capita increase
- Global GDP has increased more than 15 fold since 1950 to over \$120 trillion and the proportion of people in extreme poverty has declined from more than 60% to less than 10%
- However people worry about the growth of our use of natural resources over the past century
  - Some of this reflects the higher resource demand from a growing population
  - It also reflects the growth of per capita output and consumption
  - Technologies bite back
- “Our trajectory of economic growth is irresponsible”
- What is GDP?



## Gross domestic product

*GDP was adopted after WW2 as a common metric to measure the size of national economies and economic growth. It became possible to compare countries. Because you manage and take care of what you measure, governmental policies tend to focus on GDP growth*

The Gross Domestic Product is a **monetary** measure of the economy's total output – e.g. the market value of all the final goods/services that are produced by the residents of a country

There are different approaches to calculate the value of GDP – each of which yields the same result

**The added-value approach – which sums up the outputs of every class of enterprises to arrive at the total**

Estimate the gross value of domestic output out of the many economic activities (as classified into sectors)

Determine the intermediate consumption (the costs of material, supplies and services used to produce the final goods and services)

Deduct intermediate consumption from gross value to obtain the gross value added

The sum of the gross added value in the various economic activities is known as GDP at factor cost

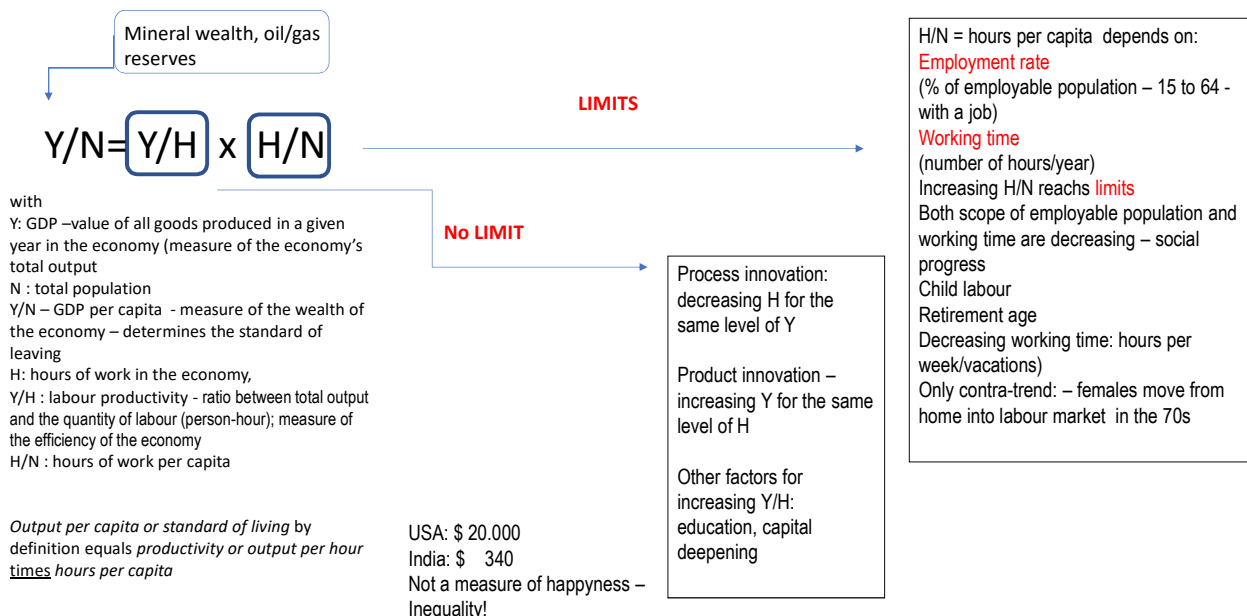
**Growth of GDP = economic growth**

**GDP/population or Y/N = standard of living (proxy for the wealth of a country)**

## Various problems with GDP

- GDP measures **just** the size of a nation's economy - nothing else
  - Problem with operations and activities which are not increasing welfare but as transactions they are counted. *If a firm is paid by a municipality to dig holes and then is paid to fill them again (because this was a wrong decision) – the value of the two services are added to the GDP while the impact is 0*
  - Problem with activities which are essentially "free" – produce large surplus but not counted into GDP
  - Problem to capture quality effect on GDP while the considered innovation substitutes to many activities which contributed to the growth of total output (e.g. smartphone)
  - GDP is not a measure of human well-being (issue of inequality)
  - **GDP is not NDP**: it does not include the depreciation of capital. Moreover, GDP is a flow (so many dollars of final products a year), whereas we need to study movements of capital stocks
    - « *It is only by studying movement in our stock of capital that we can obtain an informed picture of the Anthropocene* »
    - This is why we will do by introducing the concept of productive base

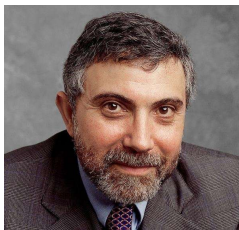
## The standard of living drivers



$$Y/N = Y/H \times H/N$$

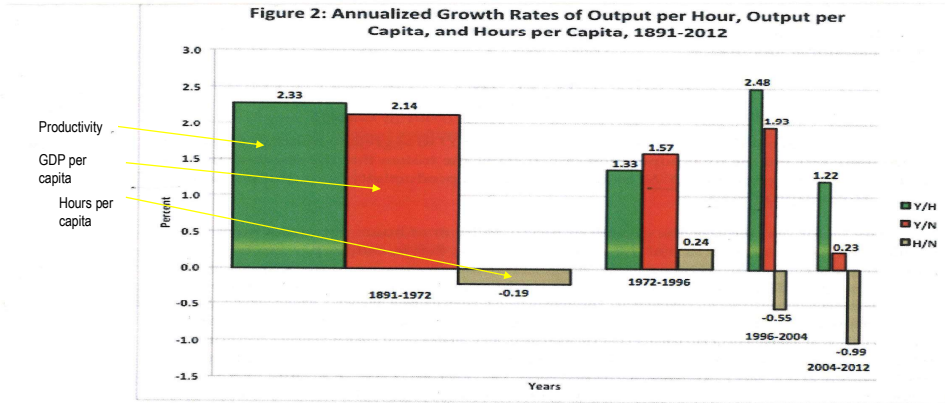
- What are the drivers of productivity?
- Innovation is how productivity growth happens without any limit.
  - « *The only limit is our imagination* »
- There is a great consensus about the fundamental importance of innovation
  - Product innovation – new or better product (services) – increases diversity; meets uncovered needs
  - Process innovation – more efficient methods to produce and distribute (incl organizational changes)
  - Business model innovation – combines product, process and new consumer experiences
- Process innovation reduce production costs (H) by making more efficient use of input factors, product innovation raise the quality of the output or lead to entirely new products and services (Y), business model innovation improves both sides of the ratio

## Productivity and standard of living



- **Krugman** : « *Productivity isn't everything, but in the long run it is almost everything* »
- Because a country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker –
- Most countries don't have extensive mineral wealth or oil reserves..so the only way to become wealthier (to improve the standard of living) is to keep getting more (or better) output from the same number of inputs

# Gordon – growth accounting



$$Y/N = Y/H \times H/N$$

# A century of productivity improvement – 1870 - 1979

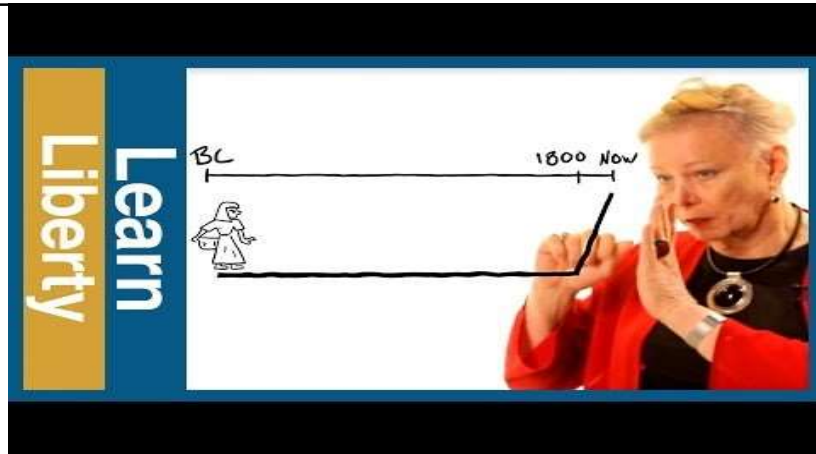


Country	Growth in real GDP per capita (wealth) in %	Growth in real GDP per person-hour (productivity) in %
UK	325.0	585.0
Switzerland	472.0	830.0
United States	691.0	1,085.0
Italy	493.0	1,220.0
Germany	1,396.0	1,510.0
France	694.0	1,590.0
Finland	1,016.0	1,710.0
Sweden	1,084.0	2,060.0
Japan	1,653.0	2,480.0

*Living standard: hours of work per capita, productivity*

*Efficiency of the economy: educating, capital deepening, innovating*

Output per labor hour increased from 585% in the UK to 2480% in Japan (second column) after no substantial increase for at least 15 centuries! This rise in productivity was sufficient to permit a rise in output per capita of more than 300% in the UK to more than 1,600% in Japan



D.McCloskey

## The great enrichment

- « *Modern humans first emerged about 100,000 years ago. For the next 99,800 years or so, nothing happened. Well, not quite nothing. There were wars, political intrigue, the invention of agriculture, arts and cathedrals – but none of that stuff had much effect on the quality of people’s lives. Almost everyone lived on the modern equivalent of \$400 to \$600 a year, just above the subsistence level...Then – just a couple of hundred years ago – people started getting richer. And richer and richer still* ».
- « *There was almost no economic growth for four centuries and probably for the previous millenium prior to 1750. Human population growth and social development were nearly flat until the steam engine came along* » (Gordon, ibid.)
- Role of innovation? Chapter 1

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

# ECOLOGICALLY SUSTAINABLE ECONOMIC POLICY IN THE 2020s

1 June 2022

Kuva: Niccolò Caranti



## From GDP to the productive base

- *Our trajectory of economic growth is irresponsible*
- For a long time we did not see it – but our productive base (not GDP) is contracting (rather than expanding)
- An economy's productive base is the stock of capital assets and institutions:
  - Produced capital – roads, buildings, ports, machines, technologies
  - Human capital – health and education
  - Natural capital – wetlands, grasslands, woodlands, forests, lakes, mangroves, coral reefs, and biomes (atmosphere, oceans, soils, subsoil resources), biodiversity
  - Social capital (?) – trust, communities, networks
  - Institutions – legal structure, enforcement of laws and regulations, markets, governments' policy
- An economy's productive base declines if the decumulation of assets is not compensated by the accumulation of other assets

## From GDP to the productive base

- An economy's productive base declines if the decumulation of assets is not compensated by the accumulation of other assets
- The case of a decline of some fish species. Compensation depends on:
  - \*other forms of capital
    - Produced capital (technology) : *More efficient fishing technologies to avoid unnecessary capture – This can compensate but only up to a point* - Increasing technological efficiency has some limits (human economy can't free itself totally from the biosphere)
    - Human capital (education, social norms) : *responsible consumption*
    - Social capital : *collective rules to manage a commons*
    - Institutions : *tax, regulation (protected zones or species, quotas)*
  - \*the quantity of the concerned asset the economy has in stock (*higher efficiency of fisheries may compensate the decline of a fish species – if the stock is still sufficiently large to secure a satisfactory regeneration rate*)

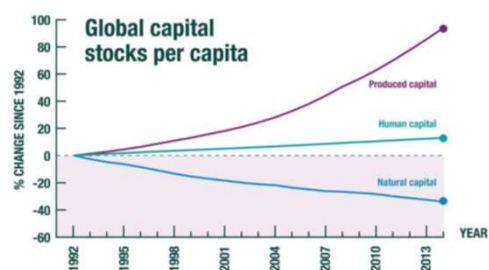


## Productive base and sustainable development

- For developing a concept of sustainable development, we must include not only the well-being of those who are present but also of those who will be here in the future
- Sustainable development requires that relative to their population each generation provide to the next ones at least as large **productive base** as it has itself inherited
  - Weak principle of intergenerational justice: next generation has no less – it demands nothing more
- A development that meets the needs of the present without compromising the ability of future generations to meet their own needs

## Productive base and GDP – a growing gap

- An economy's productive base will shrink if its stock of capital assets depreciate and the economy is not able to improve sufficiently to compensate for that depreciation
- It is possible for a country's productive base to shrink during a period when GDP grows
- But nobody will notice it if every's eyes are riveted on GDP
- GDP growth reflects an extraordinary enrichment which is partially artificial



## Productive base and GDP – a growing gap – *cont.*

- Mechanisms of the growing gap: these are the same activities which have both a positive effect on GDP and a negative effect on the productive base
  - Industrial fishing - new fishing methods (trawling) increase massively labour productivity (Y/H) and GDP. However the economic growth here has a big environmental cost which is resource depletion (*tragedy of the commons*) which leads to natural capital **decumulation**
  - Gigantic leisure cruises
  - Plastic products
  - Air transportation
  - The car industry
  - Building another highway
  - .../...
- Because they have positive effects on GDP, they are developed intensively but show deleterious effects on the productive base
- Explanation : negative externalities

## Negative externalities

- **A phenomenon that arises when an individual or a firm takes an action but does not bear all the costs**
- Examples – firms and consumers use intensively the ocean - for transportation, leisure cruises, deep sea fishing and as a sink for pollutants from land – and thereby inflict great stress on it.
- There are huge environmental costs - enormous pressures on ocean ecosystem while oceans are vital for our existence - which remain **external**
- Companies pay for labour (wages), equipment (ships), energy (fuel), using the port infrastructure (tax), but not for “consuming” the ocean
- **Concerning natural resources – in most cases, we don’t pay for what we use**
- In presence of externalities - we don’t pay for our use of Nature – we are not interested in managing and economizing on it and tend to overuse it
- What we pay for, we manage, what is freely available, we don’t manage
  - The car factory



A negative effect  
which is not paid by  
the one generating it :  
the cost remains  
"external"  
Why perfect  
internalisation does  
not happen  
spontaneously?

- A car factory generates toxic discharges - All resources used to produce cars (steel, labour, machineries) have a price as they are traded on a market – the factory has the correct incentives to economize on them.
  - It can economize on people (automation), on steel (process innovation), on energy (process efficiency & optimization)
- One resource 'used' has no price; hence there is no incentives to economize it: **clean air**
- The factory destroys the resource – clean air – but does not pay for it
- This means that the factory will not consider the full cost of its activity – one cost is external (it is transferred to society)
- Hence the firm will not try to correct the problem through innovation and will prefer the status quo : a situation where its private cost is lower (the cost of clean air destruction is not included) than the full social cost it generates

**EPFL**

- There are externalities because markets for the considered asset don't function well or don't exist and there is, therefore, no price for the natural resource
- Let's be specific! What is the capital asset which is subject to negative externalities?
- Not the *fish*: there is a market for fish and so market prices (determined by production costs and demand)
- But *fish abundance*: there is no market (and so no market price) for *fish abundance* which is an ecosystem providing maintenance and repairing services to the ocean: cleaning and recycling as well as securing a sufficient resource regeneration rate.
  - So industrial fishing which is likely to inflict great stress on fish abundance doesn't pay for this cost
- Need for putting a value on *fish abundance* – social productivity of capital asset – which determines a "shadow price"
- Same argument for the car factory – the capital asset is *clean air*

## Pay for what we use!

All prices (of products and services) need to reflect the full costs – including external (environmental, etc..) costs: pay for what we use!

- « *If we did, then the system of prices people face would be so different from what it is today that technological change would display a very different character: new technologies and new activities would be far less rapacious of nature* » Dasgupta
- It will become more costly to pollute, to do overfishing, to build another highway or even to market unhealthy funds (full cost includes here public health)..
- **Two big issues** (focus on global ecosystem – ocean, forest..)
  - Cost estimation - the cost of “consuming” an ecosystem = how much should we pay for it?
  - Institutional mechanism: implementing payment systems for consuming global public goods requires global agencies empowered with legal and technological capacities to evaluate damages, identify who is responsible and impose taxations

## How much?

Social productivity of a capital asset : the capitalized value of the flow of services an extra-unit of it would provide to society

- Economists call it shadow price which is different from prices that are observed in the market
- The right approach is to estimate the social productivity of the ecosystem to establish its shadow price.
- Such estimation is a formidable problem (provisioning goods and maintenance/repairing services)
- If the shadow price increases relative to produced capital, preserving the ecosystem (instead of building the highway) may be a better economic decision



*Momentum on valuing ecosystems is unstoppable – Nature - 2021*

*The UN statistical commission laid out the principles for measuring ecosystem health and calculating a monetary value. They will provide a template for payments for ecosystem services*

## How much? Other approaches



- Calculate the monetary equivalent of the negative effect; convert the externality into monetary terms as:
  - Avoidance costs – costs of preventing pollution by avoiding the release of an additional unit of pollutant
  - Damage costs – costs incurred by the pollution – agricultural production loss due to a decrease in crops yields
  - Abatement costs – the costs of reversing the damage caused by the pollution, such as healthcare spending
    - Depollution of La Seine for the Olympic Games: 1.4 Billions (could be used as a proxy for other cases of activities which are polluting other rivers)

Stratégies de Spécialisation Intelligente

## To cap it all

- Negative externalities lead to overexploitation of Nature and a decumulation of the stock of natural capital (depletion, overuse, enormous strain on ecosystems)
- Because environmental costs are not internalized, they are not subtracted from revenues and GDP growth does not reflect that at the same time the productive base is shrinking
- A country can grow its GDP while the productive base is shrinking and no one will note it if everyone is watching GDP figures
- Our Dealings with the various forms of capital are full of negative externalities
- Minimizing negative externalities implies putting a value on what is subject to the negative externalities or estimating the cost of the effect (damage, abatement, avoidance)
- **Paying for what we use is crucial but not sufficient – as facing new cost structures**
  - firms will need new (cleaner) technologies or business models,
  - consumers need to shift to responsible consumption and new social norms

## Most of our missions have a similar problem's structure



Capital assets	Natural capital	Human capital	Social capital
<b>Arguments</b>			
Activities having positive effects on GDP growth AND negative effects on the productive base	Industrial fisheries Car factory Building a highway Agro-industry (pesticide)	Food industry Addictive drugs Addictive digital activities Agro-industry (pesticide)	Digital social networks Unfair AI
Capital assets (productive base) decumulation	Fish abundance Clean air Local ecosystem	Public health	Trust, communities, willingness to cooperate, habit of contributing to a common effort
External costs	Environmental problems, Climate change, biodiversity loss	Obesity Opioid crisis Mental issues Cancer	The societal foundations for social sharing and collective action are shrinking
Remedies - Evaluating external costs Tax, enforced regulation Technologies (compensation by produced capital) Social norms	Tax, enforced regulation Technologies, social norms	Tax, enforced regulation Technologies, social norms	Tax, enforced regulation Technologies, social norms



- GDP growth – the usual barometer
- Productive base, GDP and sustainable development
- **The global impact inequality (focus on natural capital) – just two slides for today**
- Multiple areas of policy intervention
- Making our greatest achievements sustainable

## Global impact inequality

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

$N$  = global pop.,  $y$  = global GDP per capita (global standard of living);

$\alpha$  = the efficiency with which natural resources are converted into goods and services

$Ny/\alpha$  = 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 – poverty, equal access to the essential elements of daily life comfort – great achievements (mobility, communication, etc.) for all
- Increasing  $\alpha$ 
  - Innovation is crucial – produced capital compensates for natural capital (or human capital) decumulation (substitution, management, efficiency, recycling, medical progress)
  - But  $\alpha$  cannot be increased indefinitely
- Increasing  $G(S)$ 
  - A fundamental distinction – provisional good vs repairing & maintenance services
  - Raising  $G(S)$  is about investing in Nature – allowing Nature to grow
  - Raising shadow prices of Nature's services

