# Exploring options for integrating contributions of ecosystems into TFP measurement

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# Natural capital and TFP

- Production bases: human capital, produced capital and natural capital (e.g., Dashgupta, 2021; or The Changing Wealth of Nations, 2021).
- Productivity growth is measured as the residual between output and input growth. Traditional measures of productivity do not account for natural capital contributions to production.
- The OECD environmentally adjusted MFP (EAMFP) index accounts for the extraction of 14 sub-soil natural resources (fossil fuels and minerals); all traded in the markets. Accordingly, it is possible to calculate their cost shares (OECD, 2018). This adjustment allows to measure how much productivity growth depends on the use of non-renewable resources.
- EATFP also accounts for 8 negative externalities (greenhouse gases and air pollutants). These are considered as bad outputs. Since most pollutants do not have explicit prices, their output shares are approximated by shadow prices derived for different pollutants. This adjustment allows to measure how TFP growth has influenced environmental quality (OECD, 2018).

# Natural capital and agricultural TFP

- A similar procedure can be adopted to measure sustainable TFP in agriculture.
- Recent work by TFPEN has focused mainly on harmonizing the methodologies used in different countries to measure TFP in agriculture and to model negative externalities in agriculture. However, studies on modeling nature/ecosystem contribution to agricultural productivity, especially soil carbon, are also underway.

# Q1: Which contributions to consider?

Agricultural production depends on many nature contributions/ecosystem services (ES):

- Soils (supply of organic matter and nutrients, protection from erosion; etc.)
- Pollination
- Pest and disease control
- Flood control (wetlands)
- Water provision
- Soil decontamination
- Genetic resources
- Air filtration (reduction of O3 pollution by vegetation/trees)
- Climate regulation

**Question 1**: ***Which nature contributions should be considered? Should we set priorities or at least identify low-hanging fruits?***

**Remark:** There are here definitely synergies with the SEEA EA work on economic valuation of ES. We should look for applying consistent approaches across the two frameworks.

# Q2: Pricing natural capital

**Question 2**: ***Should prices of renewable natural resources reflect only their relative scarcity?***

**Remarks**:

- Current technologies have been shaped by Institutional Resource Regimes (IRR) which demonstrate severe deficiencies and do not prevent environmental degradation (Gerber et al., 2009).
- According to Barbier (2011), the lack of institutions to allocate natural capital intertemporally may be the greatest barrier to sustainable management of natural capital. In most cases, ES shadow prices are derived by defining a short-run optimization problem.
- By generalizing Jorgenson's (1963) capital asset pricing approach, Fenichel et al. (2015) have developed an accounting price approach for pricing renewable natural resources that accounts for biophysical and economic feedbacks.
- Fenichel et al. (2015) demonstrate how technological innovations can destroy a natural capital stock by making it appear less scarce.

# Q3: Pricing natural capital ext.

**Question 3**: ***Is it sufficient to pursue the weak sustainability concept when exploring options for natural capital pricing?***

**Remarks**:

- Considering the strong dependence of agriculture on natural resources, it is illusory to believe that we would be able to substitute many of nature contributions to agricultural production by produced capital.
- In particular, should we look for approaches that enable integration of the information on absolute scarcity of renewable natural resources? This may be of a particular relevance considering non-convexities and tipping points in ecosystems.
- The example of GTAP-InVEST model* demonstrate that some valuable insights can be produced by integrating into economic modelling ecological models of ecosystem services.

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* GTAP – Global Trade Analysis Project; InVEST – Integrated Valuation of Ecosystem Services and Tradeoffs

# Example: Valuing pollination ES in SEEA EA framework

**Classes for dependence of crops on pollination services**

| Degree of dependence | Production reduction in absence of pollinators | Crops |
|---|---|---|
| Essential | > 90% | Courgette, pumpkin |
| Great | 40% - 90% (65) | Raspberries, blackberries, other berries, annual fruit cultivation, perennial fruit cultivation (e.g. pear, apple, cherry) and summer rapeseed, and winter rapeseed |
| Modest | 10% - 40% (25) | Strawberries, eggplant, redcurrants, blackcurrants, summer oilseed rape, winter oilseed rape, and sunflower |
| Little | 0% -10% (5) | Other beans and other oilseeds |
| No increase | no reduction (0) | Other crops |

Source*:* Klein et al. (2007).

# Q4: Measuring output

- Subsidies are considered to be the part of the farm agricultural output in the TFP measurement. Historically, a large share of producer support was associated with production of specific commodities.
- But the nature of agricultural producer support has been changing. Some countries have already introduced selected measures incentivizing farmers to comply with conservation measures and sustainable natural resource management practices.
- Direct payments in the latter case can be considered as net present values of future social costs associated with environmental degradation. As they ususally influence the choice of management practices, they impact production technology and farm productivity.
- A study into technical efficiency of dairy farms in Switzerland (Mamardashvili et al., 2014) could not reject the separability hypothesis for farm output and direct payments.

**Question 4**: ***How should direct payments that remunerate sustainable management practices be treated in the TFP measurement?***

# Q5: Sustainable productivity growth concept

Bob Chambers' basic problem definition (October 30, 2019):

- *Goal*: Properly account for agricultural output growth
- *Strategy*: Eliminate Solow residual (technical change)

**Last question:** ***If we will manage to explain the residual output growth, it will be zero. Should we then still speak about productivity growth?***