What's in performance? Alternatives to incorporate environment outputs into productivity measurement

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Outline

1. Introduction – the need to incorporate environmental outputs into productivity measurement
2. Some concepts
3. Some problems
4. The road ahead

COMMON AGRICULTURAL POLICY
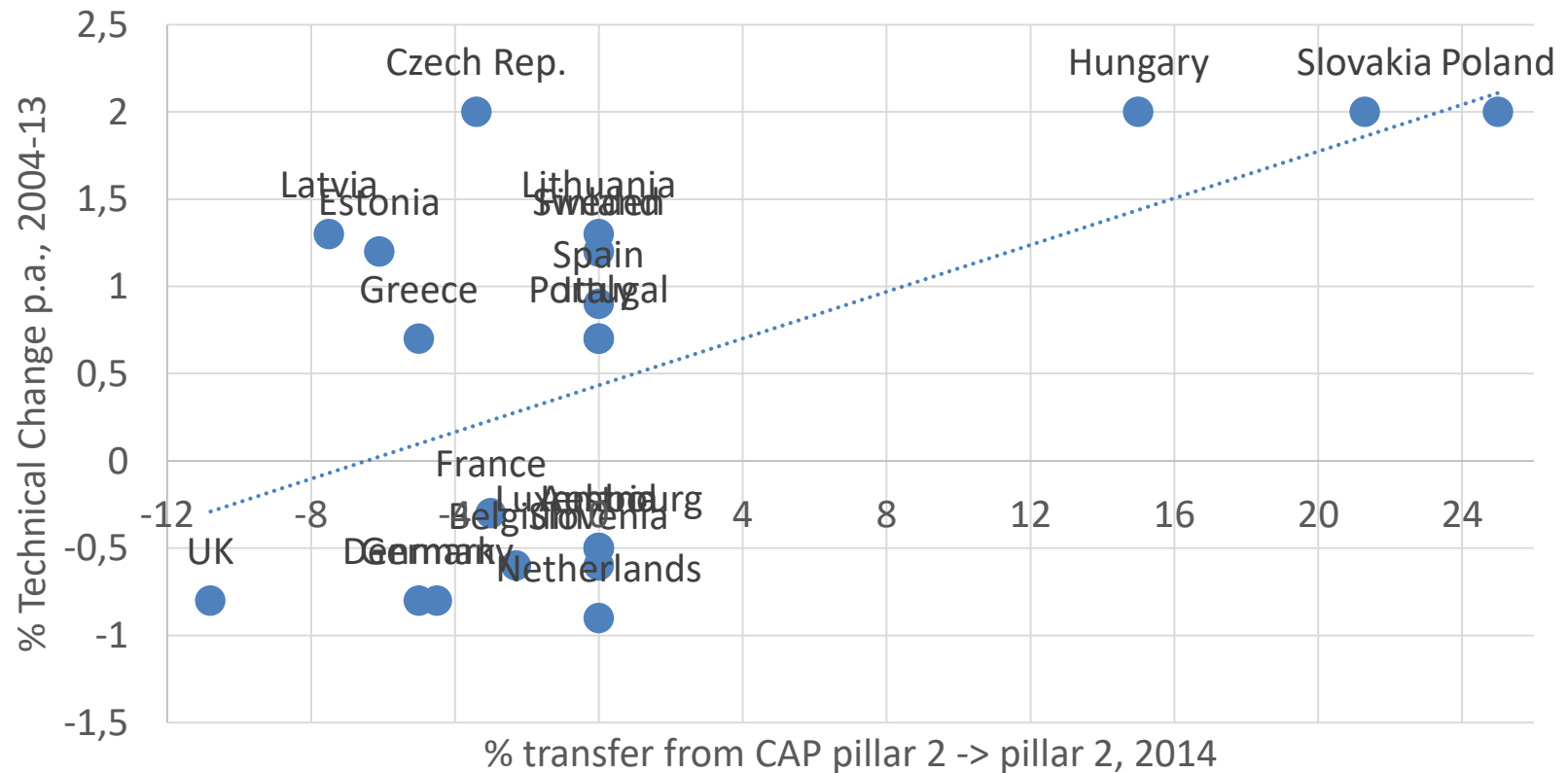## post-2020
the new green architecture

New objectives for Ag Policy

- GHG emissions
- Nutrient cycling
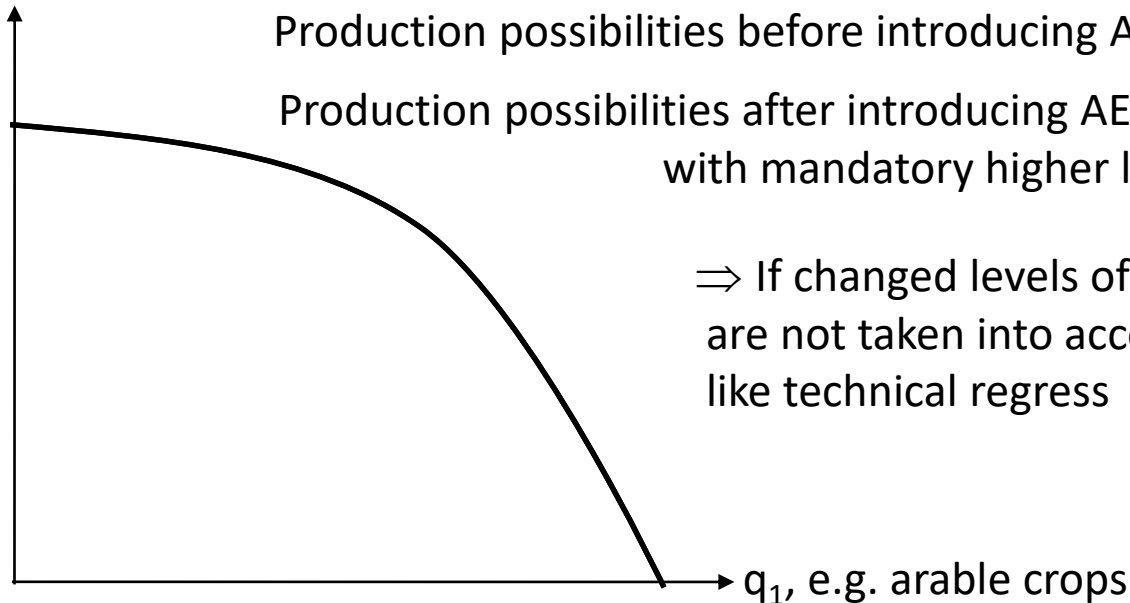- Biodiversity
- Water
- Soil quality

- Animal welfare
- …

Implications for productivity analysis: What drives observed technical change?

Graphical illustration

q_2, e.g., livestock

Production possibilities before introducing AE / AW policies

Production possibilities after introducing AE / AW policies
with mandatory higher level of AE goods / AW

$\Rightarrow$ If changed levels of non-market goods
are not taken into account, this looks
like technical regress

q_1, e.g. arable crops

Implications for productivity analysis

- Comprehensive analysis of **all** outputs and inputs
  - Including environmental goods and bads
  - Including quality differentiation
  - Decomposition of TFP growth into its sources
    - Technical change
    - Technical efficiency change including environmental goods and bads
- Straightforward idea: Estimate production of societally desirable non-market goods by amount of subsidies (???)
- Better: farm-level data on production of non-market goods (heterogeneity is taken into account)
- Environmental efficiency analysis / Total Resource productivity

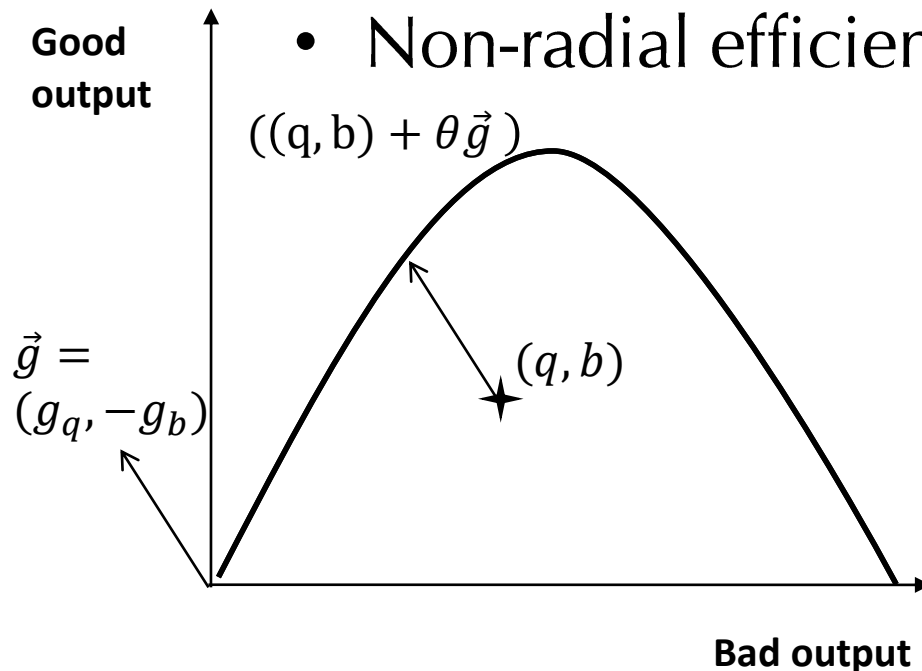# Classification of economic approaches

Technology modelling / efficiency

- Treat environmental bad as an input: Hyperbolic efficiency measure (Färe et al, 1986)

- Treat EB as a weakly disposable output: Directional distance function-based measure (Färe et al., 2005)

Directional output distance function

- Output set with weak disposability for bad output(s)
- Discarding bad output might be costly
- Non-radial efficiency measurement

Good output

$((q, b) + \theta\vec{g})$

$\vec{g} = (g_q, -g_b)$

(q, b)

Bad output

$$\overrightarrow{D_O}(x, q, b; \vec{g})$$
$$= \max \{\theta: ((q, b) + \theta\vec{g}) \, \epsilon \, P(x)\}$$

But what about materials balance?

Classification of economic approaches

Technology modelling / efficiency

- Treat environmental bad as an input: Hyperbolic efficiency measure (Färe et al, 1986)

- Treat EB as a weakly disposable output: Directional distance function-based measure (Färe et al., 2005)

- Treat EB as byproduct of the production process: Technology as the intersection of production and pollution technology (Murty et al., 2012)

- Special case: Materials balance (Pethig, 2006)

Productivity ≠ Efficiency

- Total resource productivity growth = total factor productivity plus (TFP+)
- Set of outputs or inputs extended by relevant environmental dimensions
- E.g., outputs: ecosystem services and disservices
        inputs: natural capital, pollutants
- Malmquist, Hicks-Morsteen, Luenenberger Productivity index, …
- Excellent theoretical foundations

Problems with environmental goods or bads

- Data
  - Quite a few agri-environmental indicators (EU, US, OECD, FAO)

Output

Means, standard deviations, and correlation is identical across all three datasets (R datasauRus package)

Pollutant
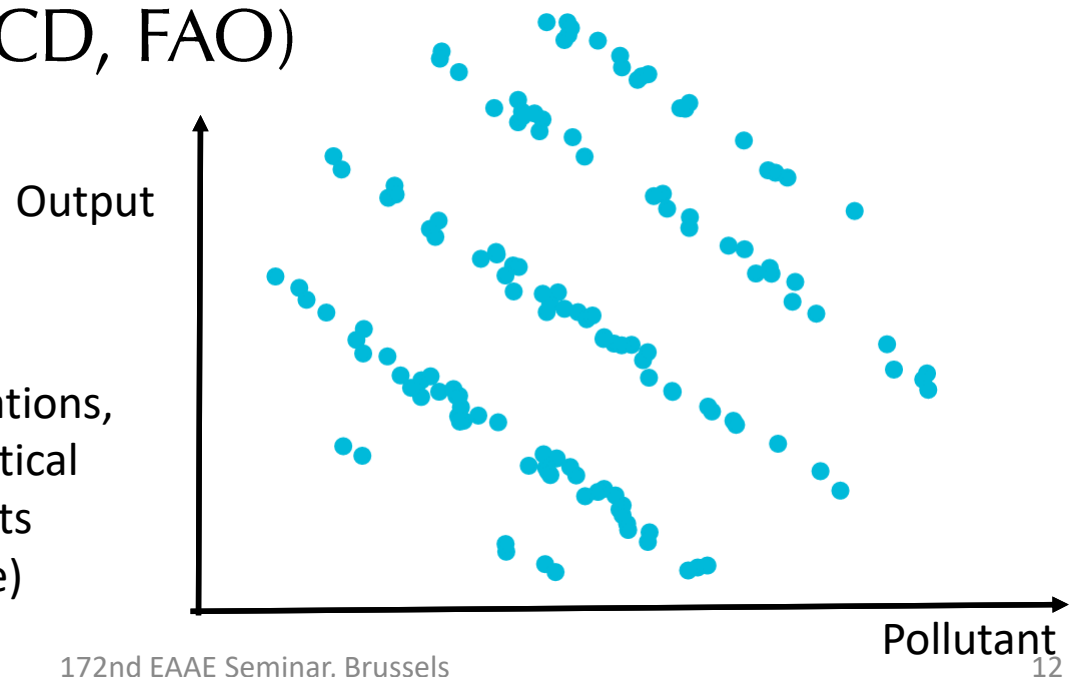
Problems with environmental goods or bads

- Environmental productivity measurement requires intensive modelling of the complete technology
- Partial productivity measures likely to be even more misleading
- New layer of issues: scaling (aggregation, heterogeneity, upscaling)

The road ahead

- More farm-level data needed – FADN as a basis?
- Big data, community-based data, monitoring data from new CAP?
- Interdisciplinary approach inevitable
- Modelling techniques quite well developed
- Communication of results?

Thanks a lot for listening!

Comments, questions, differing opinions are highly welcome!

Selected references

Färe, R., S. Grosskopf, C. Pasurka (1986). Effects of relative efficiency in electric power generation due to environmental controls, Resources and Energy 8: 167–184.

Färe, R., S. Grosskopf, D.-W. Noh, W. Weber (2005). Characteristics of a polluting technology: theory and practice, Journal of Econometrics 126: 469–492

Murty, S., R. R. Russell, S. Levkoff (2012). On modeling pollution-generating technologies. Journal of Environmental Economics and Management 64: 117–135.

Pethig, R. (2006). Non-linear production function, abatement, pollution and materials balance reconsidered. Journal of Environmental Economics and Management 51: 185–204.