Fifty Shades of Green:

Revisiting Decoupling by Economic Sectors and Air Pollutants

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Decoupling in the EU

- **Absolute decoupling**: Environmental indicators fall while economic indicators rise in absolute terms. **Relative decoupling**: Environmental indicators fall at a faster rate than economic indicators. In 2014, absolute decoupling was achieved, where global carbon dioxide (CO_2) emissions remained constant while global GDP increased.
- The EU is the third biggest emitting region following China and the United States. In the EU energy use and production–based CO_2 emissions in the EU have remained relatively stable since 2006 even showing some decline (Figure 1) (OECD 2002).
- Decoupling analysis is usually restricted to Energy use and CO_2 which does not fully highlight the relationship between GDP growth and environmental damages. Different pollutants could follow substantially different patterns.
- We analyze trends across 6 aggregated sectors (Electricity, Manufacturing, Transport, Agriculture, Services, Other), 6 environmental indicators including 4 pollutants: Energy Use and CO_2 emissions, Sulphur Oxides (SO_X), Nitrogen Oxides (NO_X), Ammonia (NH_3), and Particulate Matter (PM_{10}).
- OECD defines decoupling as

$$D_t = 1 - \frac{E_t/Y_t}{E_0/Y_0}$$

Or the change in one unit of environmental indicator E w.r.t. economic indicator Y. In the absence of any decoupling, $D_t = 0$. A value of $D_t = 1$ implies perfect decoupling. Negative values, $D_t < 0$, imply coupling.

The Data

- World Input-Output (WIOD) database from 1995-2008 (Timmer et. al. 2015)
  - Detailed sectoral Input-Output accounts
  - Satellite accounts: Air use, emissions
- Eurostat database for real output indicators and other missing values
- Both datasets are homogenized from NACE rev 1.1 to NACE rev. 2 and converted to 6 broad sectors - Electricity, Manufacturing, Transport, Agriculture, Services, Other.
- Figure 2 shows trends across top two emitting countries (Germany and France) and top two emitting sectors (Electricity and Manufacturing) across the six environmental indicators.
- To analyze whether decoupling trends increased or declined, we investigate two sub–periods 1995–2001 and 2001–2008.
- Figure 3 shows broad decoupling indicators across the 6 environmental indicators for the six sectors across the full sample and the two sub-periods.

The Analysis

- Figure 4 shows various decoupling states based on Tapio (2005)'s definitions.
- Figure 5 highlights changes in decoupling states across countries between the two sub-periods for the two highest emission sectors.
- Figure 6 displays the full data set for all the decoupling states (shown in shades of green) across all the countries, environmental indicators, and time periods.
- To understand the differences in patterns across the two sub-periods we look at the environmental policy stringency (EPS) indicator developed by (Botta and Kozluk, 2014) using the following distributive lag egression estimation:

$$\ln(E_{ct}) = \beta_1 \ln(VA_{ct}) + \sum_{r=-2}^{4} \beta_r EPS_{c,t-r} + \alpha_c + \gamma_t + \epsilon_{ct}$$

- Results in Figure 7 show no pre–existing trends exist but there are statistically significant effects of environmental policy stringency. The effects take two to three years to fully materialize.

Fig 7: Effect of environmental policy stringency

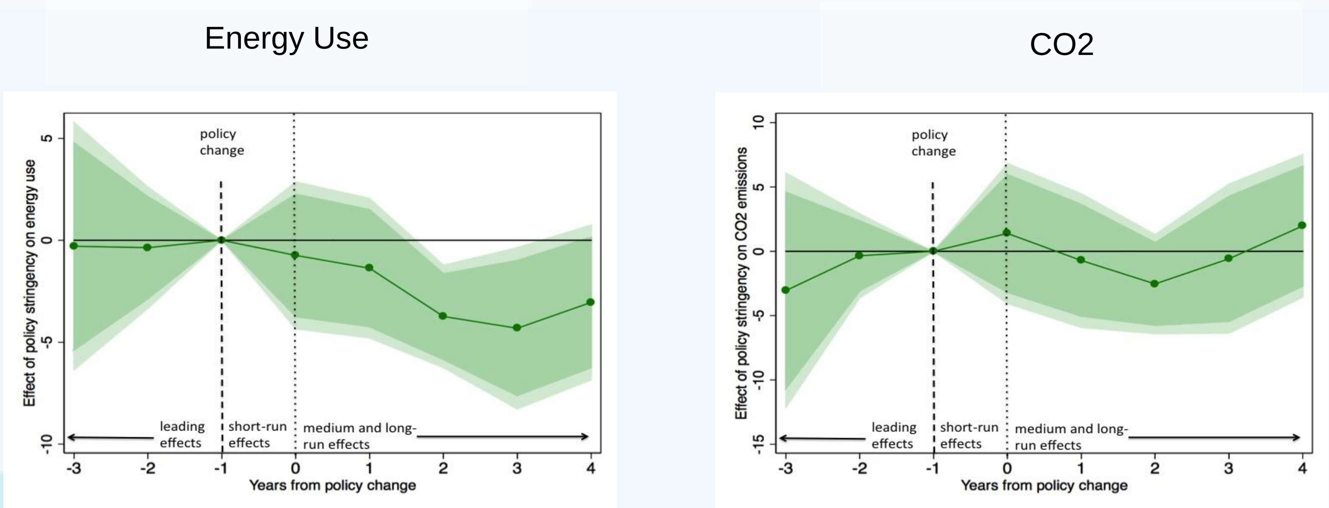


Fig 1: Decoupling in the EU

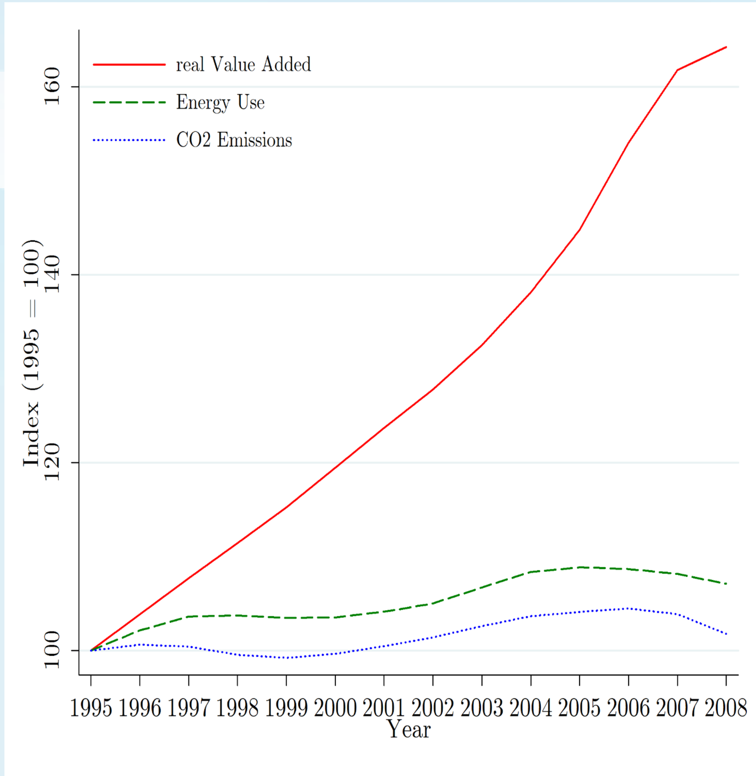


Fig 2: Top emitters and emitting sectors

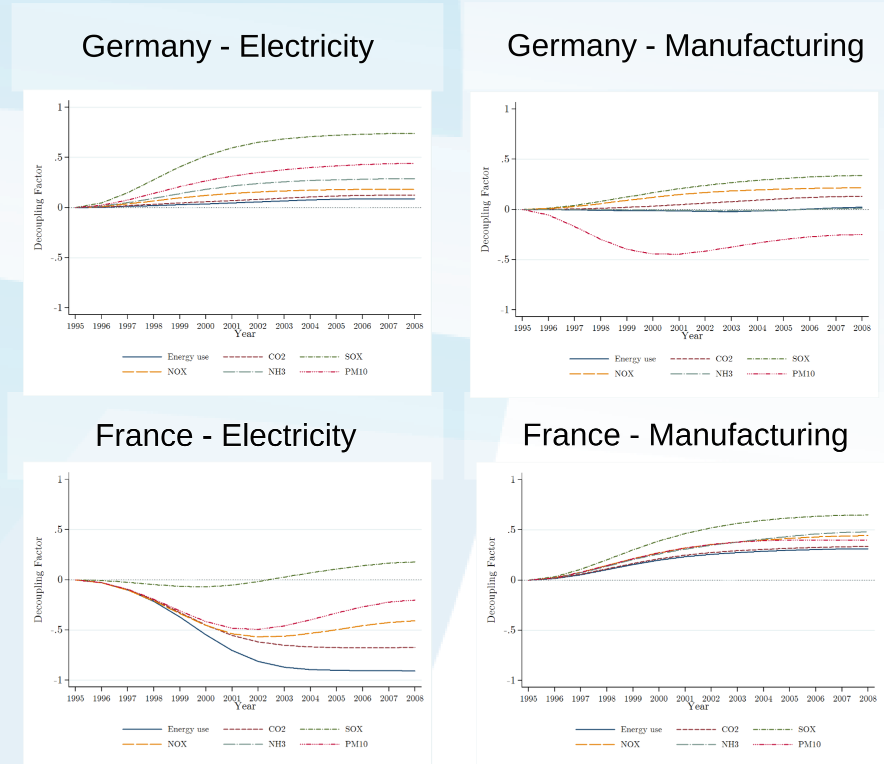


Fig 3: Decoupling indicators

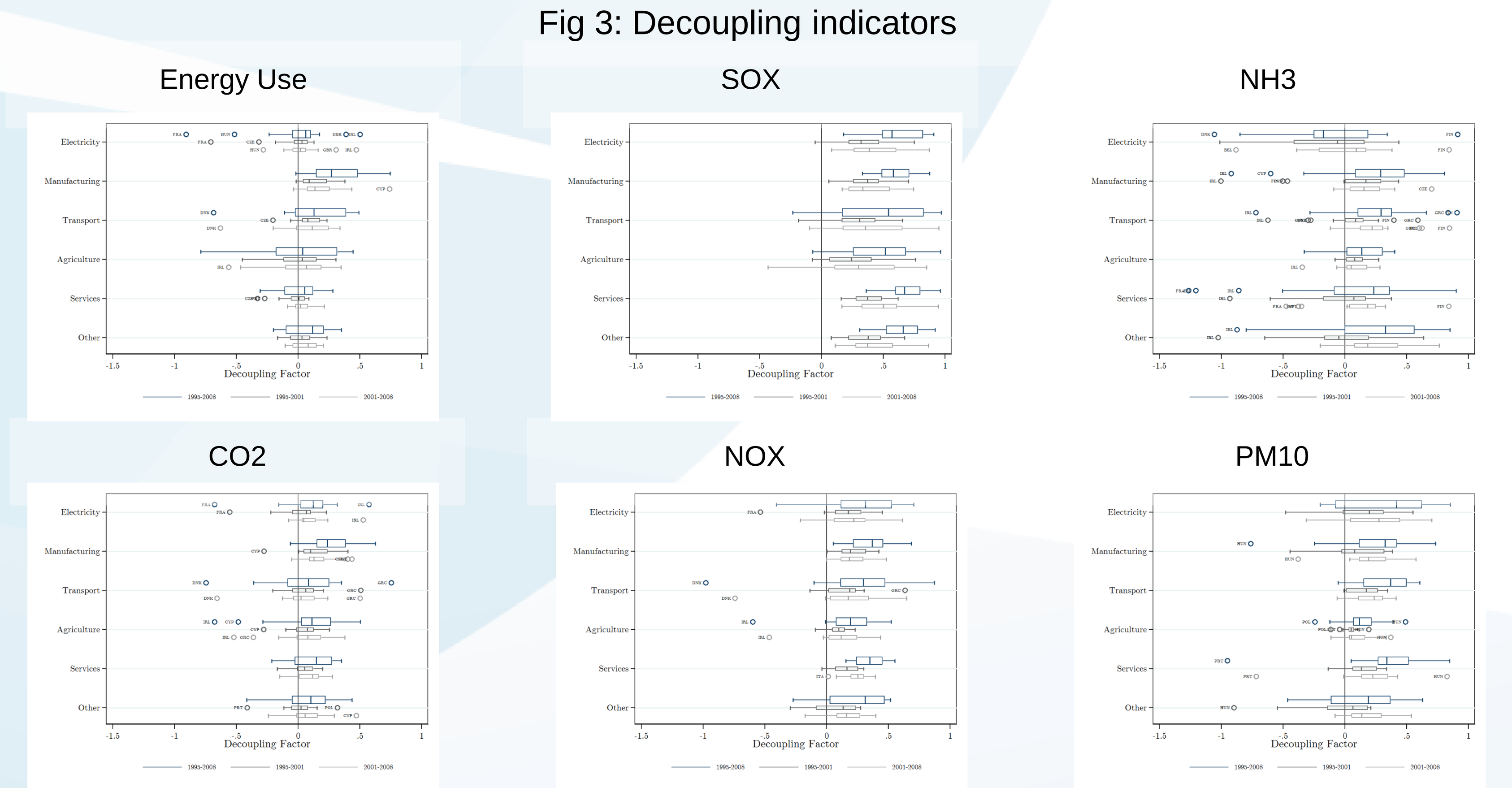
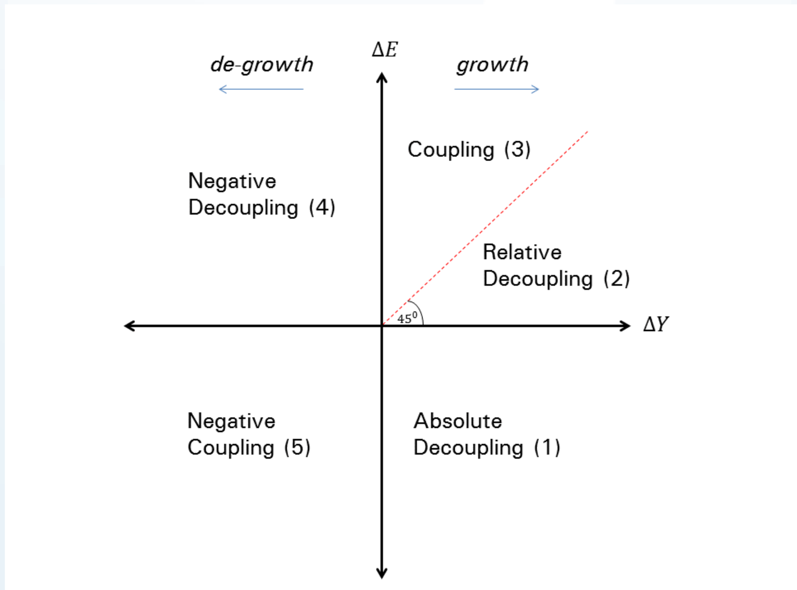


Fig 4: Decoupling States



Own presentation based on (Tapio, 2005). Ranking given in brackets.

Fig 5: Changes in Decoupling States

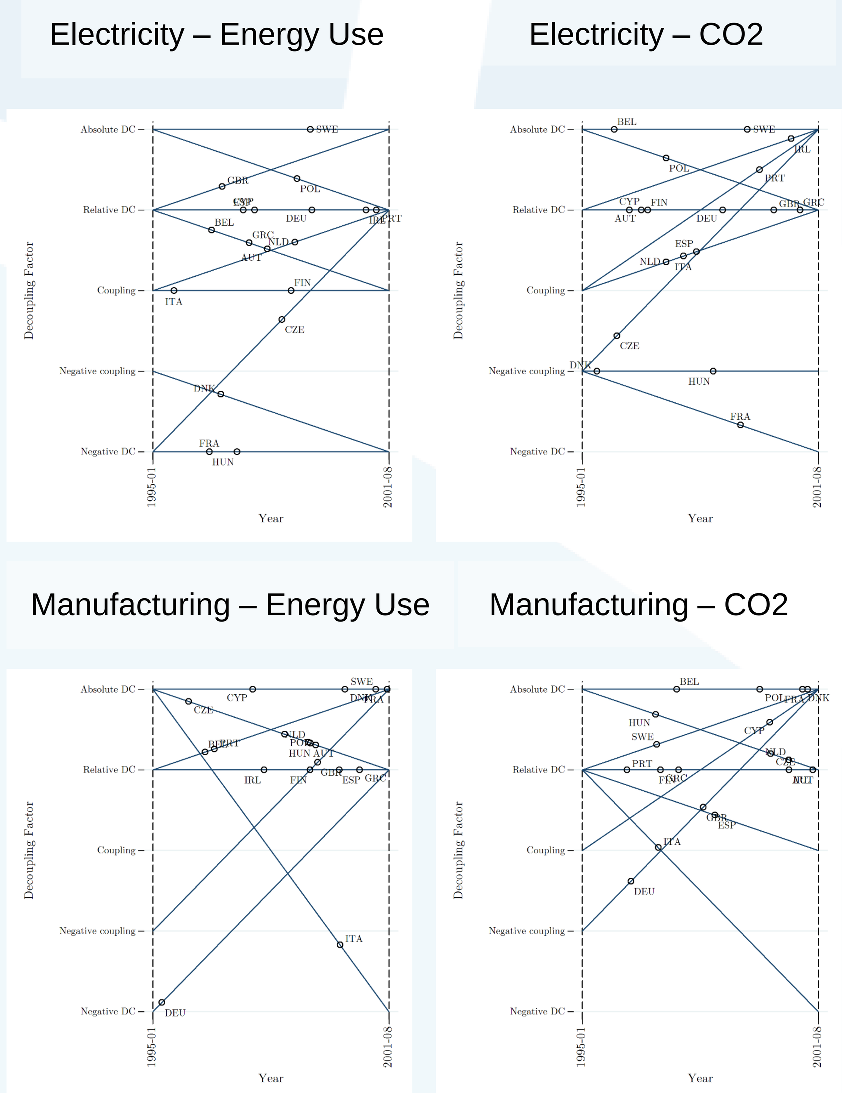
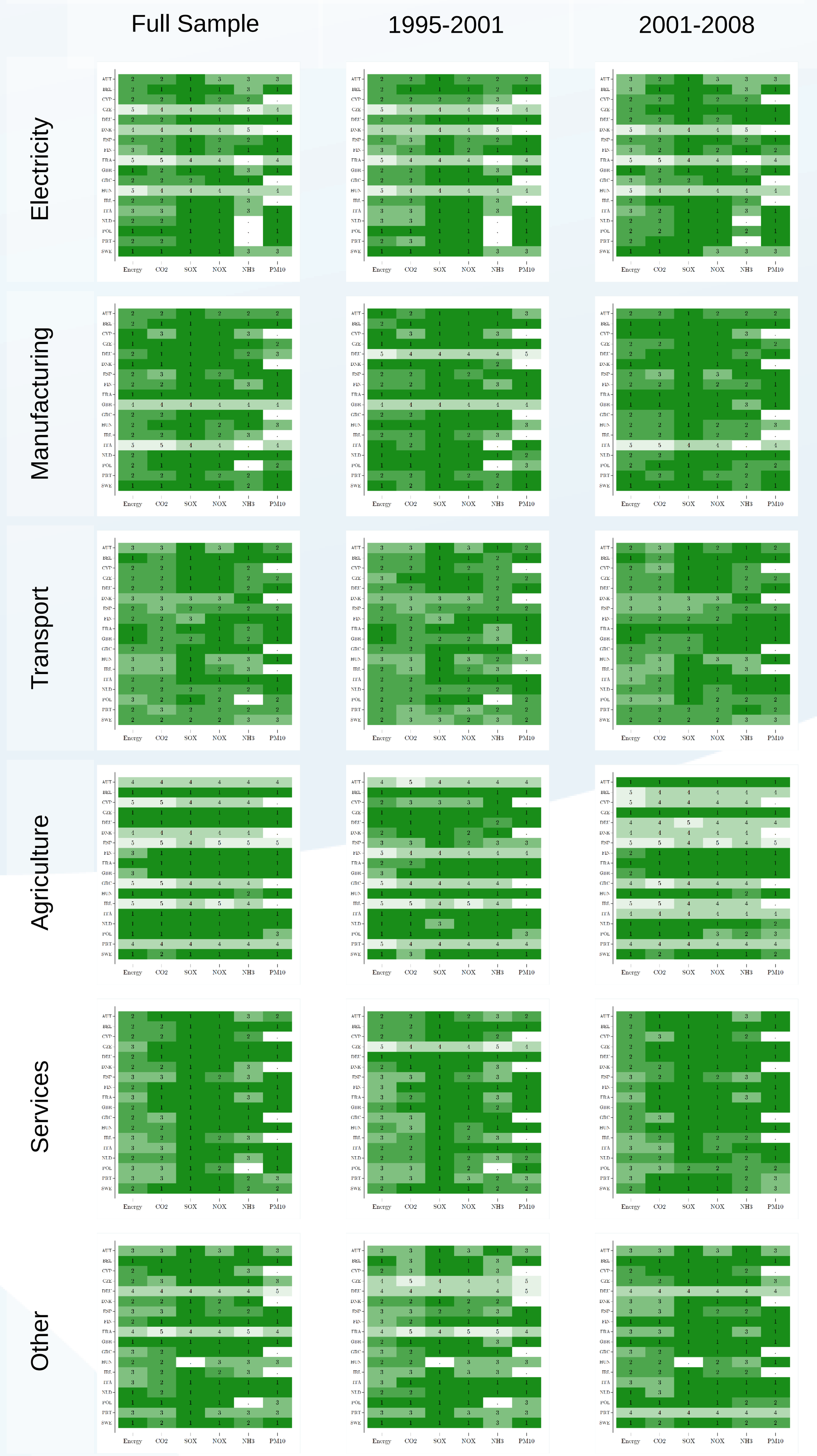


Fig 6: All sectors, countries, and pollutants



Note: Own calculations based on Figure 2, 1 = Absolute Decoupling, 2 = Relative Decoupling, 3 = Coupling, 4 = Negative Decoupling, 5 = Negative Coupling, . = No data

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