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Substitution elasticity of energy and other production factors: An empirical estimation for EU 27 member states and other major economies

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Decarbonization process

- The **timely** decarbonisation of the global energy system is necessary to avoid the negative implications of climate change
- The clean energy transition is a **capital-intensive process** through which low value-added products (fuels) are substituted by investments in high value-added products (wind turbines, PV panels, energy efficient appliances and machines).
- This process takes place in a dynamic context where prices, consumer preferences and production technologies change.

Elasticity of substitution

- CGE models are extensively used to assess the economic impact of alternative climate and energy policies, however their results largely depend on the easiness of firms to adopt new technologies (to substitute production factors)
- In this study we focus on firms production functions and the elasticity of substitution between energy and value added.
- The level of substitutability (weak or strong) between these factor indicates the easiness of replacing energy with value added (adoption of more energy efficient technologies / less carbon intensive).

Literature

- Econometric methods have been used in different type of data (time series, panel) to estimate the elasticity of substitution for specific functional forms of the production function.
- Most of the studies support that the energy and value added are **weak substitutes**, an estimated elasticity value below one.
- Structural breaks and asymmetric relationship between energy and value added have not examined.

Econometric estimations

- A wide-range of econometric techniques has been employed, by using the WIOD dataset to estimate the elasticity of substitution between energy and value added:
  - Time series
    - Linear and non-linear cointegration relationships
    - With or without structural break
    - Asymmetric relationship
  - Panel data

Estimates

- We provide estimates for:
  - 39 Countries: All EU27-member states plus selected non-EU countries
  - 34 Sectors
  - Total cases examined: 1326
  - Time period: 1995–2009

Model selection based on diagnostic tests

Time-series analysis

		Qratio			
		I(0)	I(1)		
Pratio	I(0)	OLS, OLS – FD, ARDL, NARDL	OLS – FD, ARDL, NARDL		
	I(1)	OLS – FD, ARDL, NARDL	Cointegration	no	OLS – FD, ARDL, NARDL
				yes	ECM, ECM – GH, OLS – FD, ARDL, NARDL

$$\ln\frac{QE_t}{QKL_t} = a + \varphi \cdot t - \sigma \cdot \ln\frac{PE_t}{PKL_t} + u_t$$

Where:

- QE: Total energy in TJ
- QKL: Gross value added (in million $, 1995)
- PE: Energy price index (computed as the ratio of the cost of energy use by sector divided by the total energy use in TJ by sector)
- PKL: Gross value-added price index
- σ: Hicksian elasticity of substitution

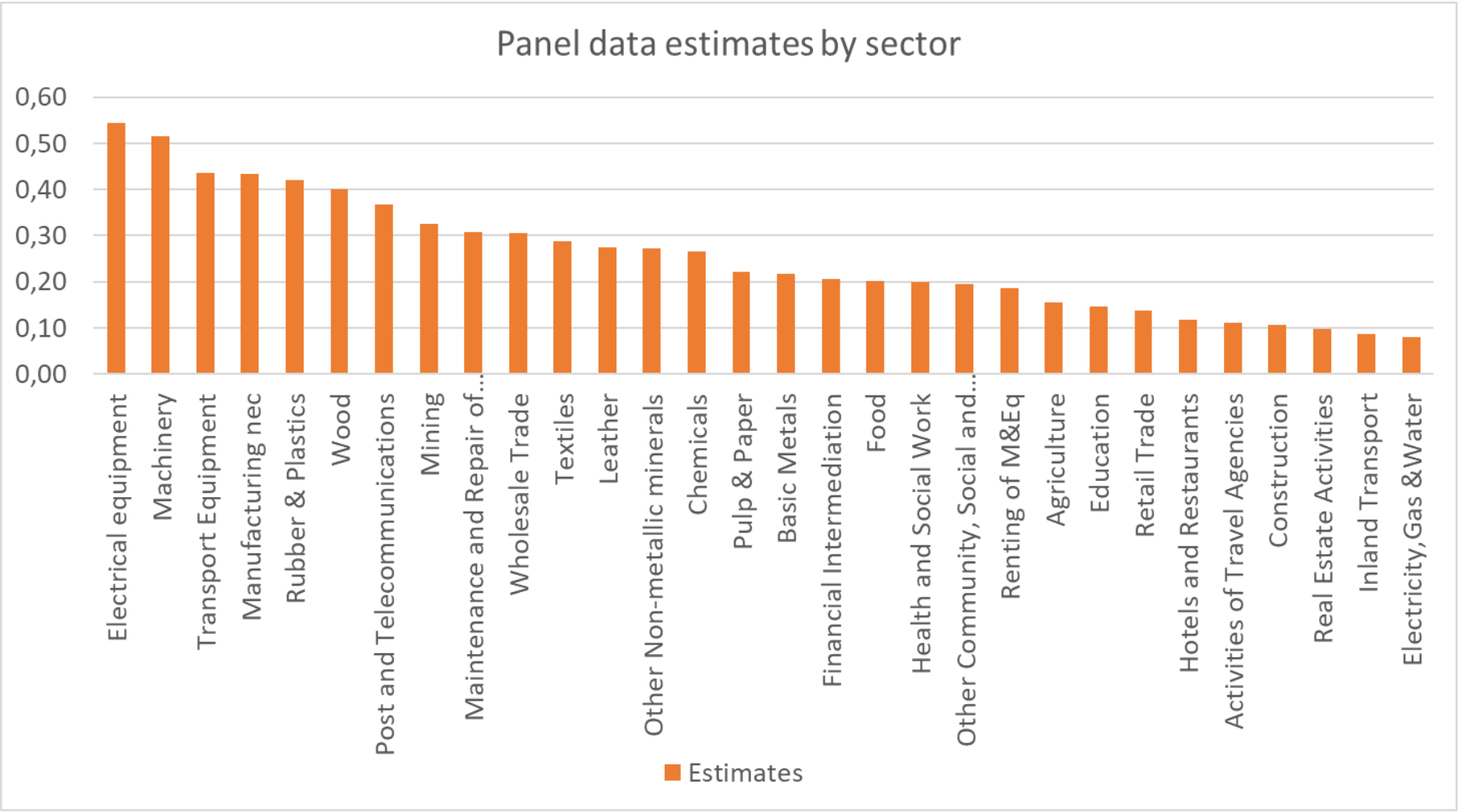
Panel data analysis

- Unit root tests (Levin, Lin, Chu and Im, Pesaran, Shin)
- Cointegration tests developed by Pedroni and Kao
- OLS estimation with panel corrected standard errors

Key results

- Both timeseries and panel data analysis strongly supports the **weak substitutability between energy and gross value added**
- By applying the Zivot-Andrews test and the Gregory and Hansen cointegration test it is found that in most cases there are enough statistical evidences that support the **existence of a structural break** at the constant term
- By using the NARDL model it is found that in **some cases there is an asymmetric adjustment to the long-run equilibrium** which is **more intense in periods that there is a decrease in the relative ratio** or prices of energy to gross value added

Key results



- The estimates range between 0,54 (Electrical equipment) and 0,08 (Electricity, gas and water supply)

Photo

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Thank you for your attention!

Paldies par uzmanību!