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The impact of carbon pricing on European electricity prices

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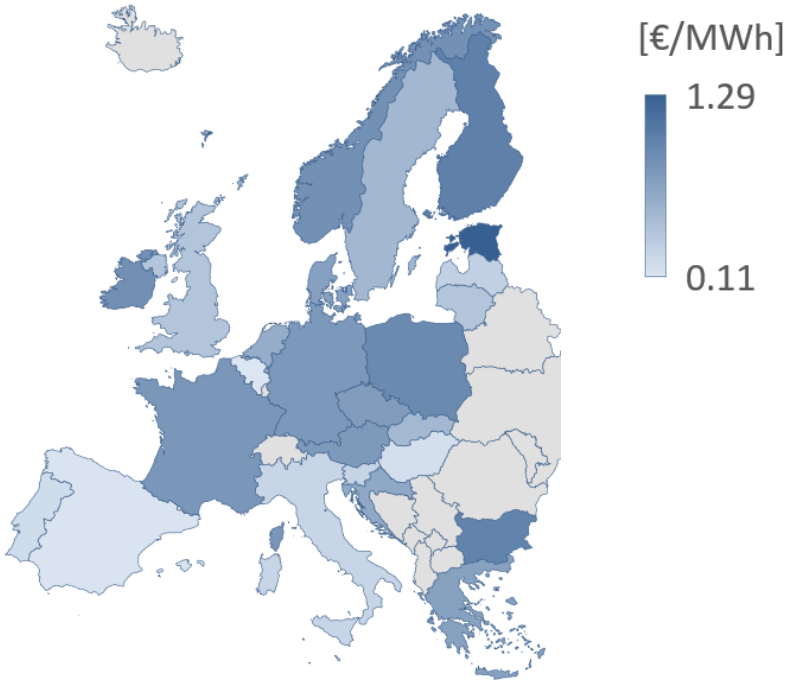
One carbon price – different price impacts

(Almost) uniform carbon price [€/t CO_2]

Heterogeneous impact on electricity prices



- What is the electricity price impact of carbon prices?
- What drives the differences?

Overview

Literature and Contribution

Impact of carbon price on electricity prices

- Kirat & Amada, 2011; Freitas & da Silva, 2015; Hirth, L., 2018; Erikkson 2018; Wolff & Feuerriegel 2019

Contribution

- 25 European countries
- Hourly electricity market data
- Recent sample period: 2015-2020

Related but different: Cost pass-through literature

- Hintermann, 2016; Fabra and Reguant, 2014; Guo and Gissey, 2021; Bai & Okullo, 2021

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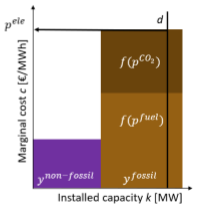
Data & Method



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Results

Summary & Conclusions

1. Carbon pricing: up to 40€/MWh higher electricity prices
   - Highest increase observed in coal-based markets
   - Imports and non-fossil generation decrease impact
2. Impact on electrification of other sectors?

Literature and Contribution

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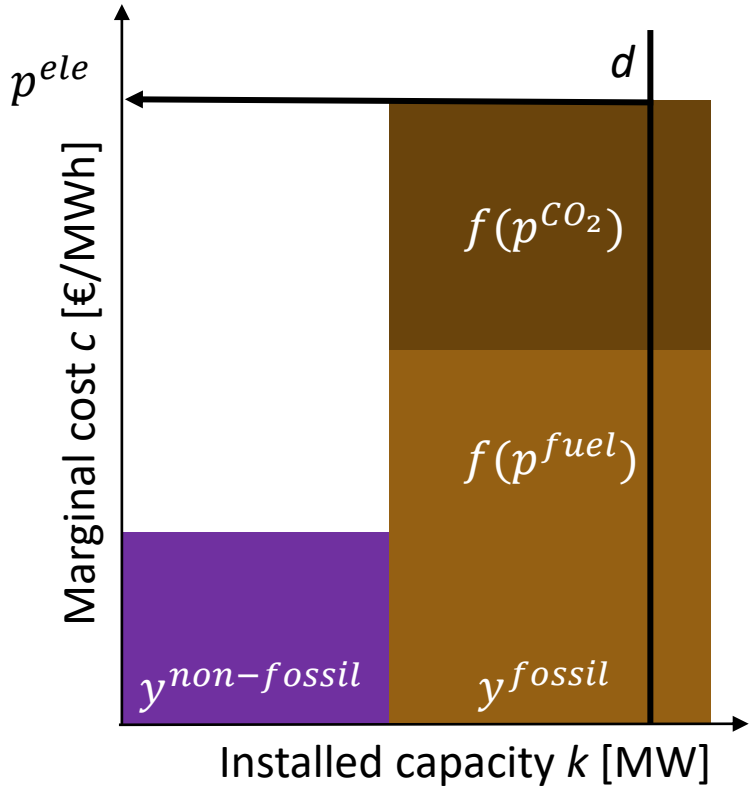
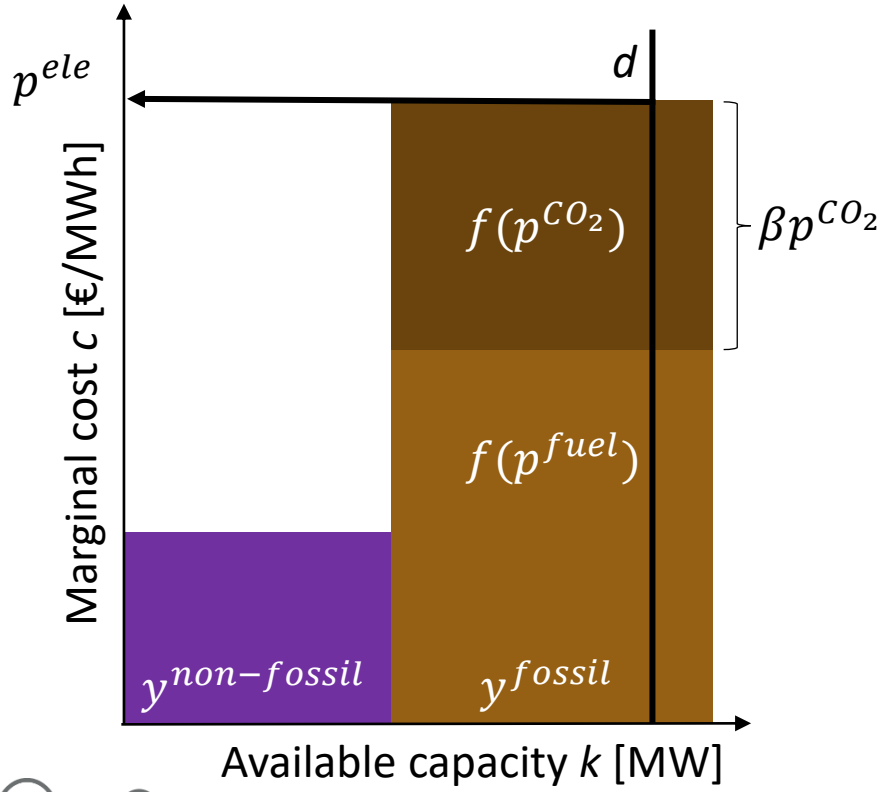
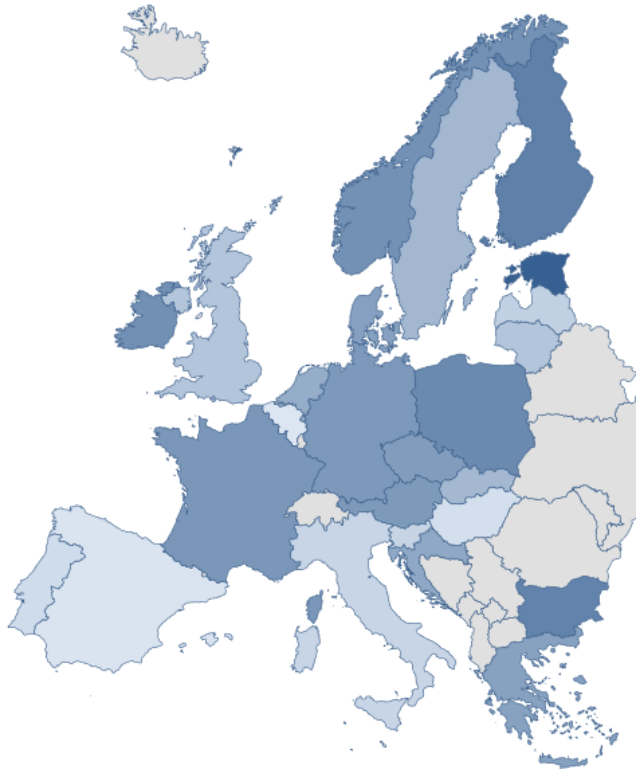


Method: Estimation of carbon price impact

$$p^{ele} = \beta p^{CO_2} + \gamma_1 p^{coal} + \gamma_2 p^{gas} + \gamma_3 d + \gamma_4 y^{non-fossil} + FE + \epsilon$$



Data: Overview



- 25 European countries
- Sample period: 2015 - 2020
- Data
  - Hourly (day-ahead) wholesale market prices
    Source: ENTSO-E
  - Hourly demand and non-fossil generation
    Source: ENTSO-E
  - Daily coal, gas and carbon (EUA and CPS) prices
    Source: ICE

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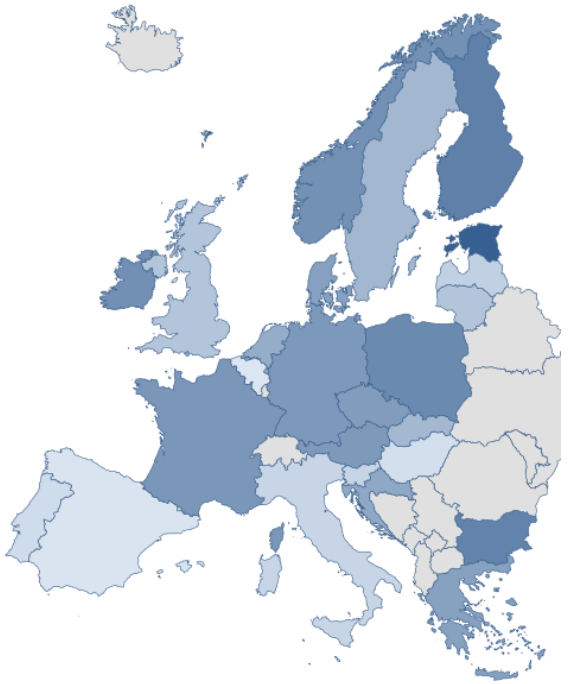
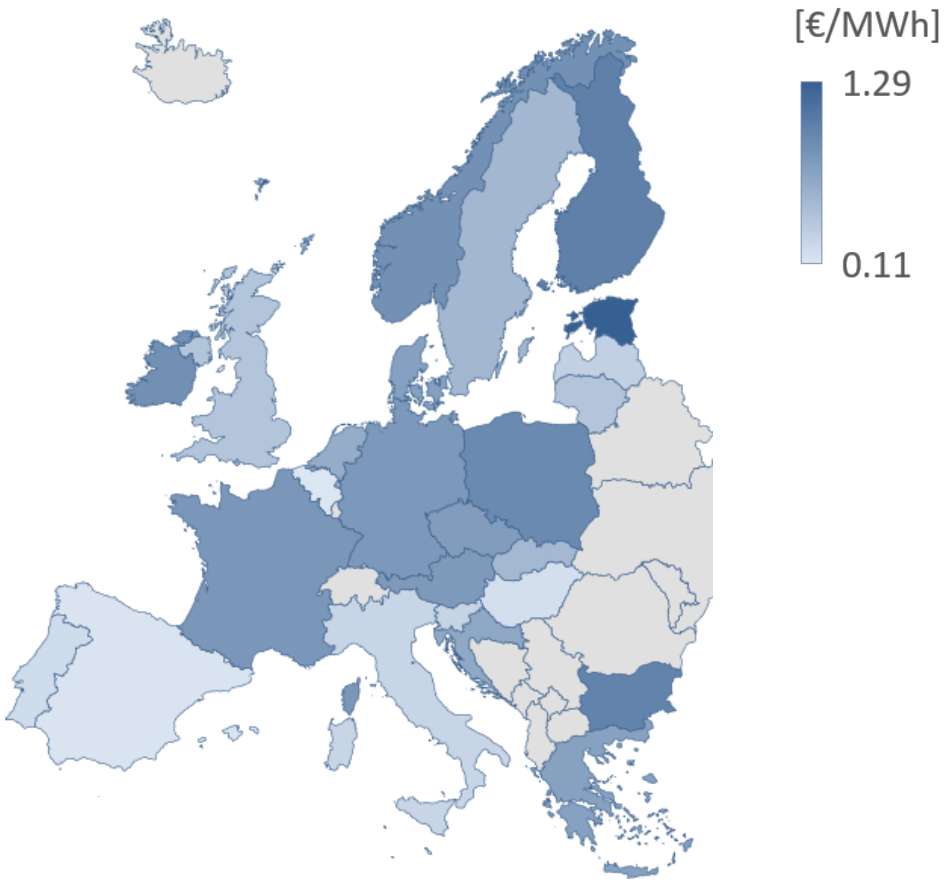
Results



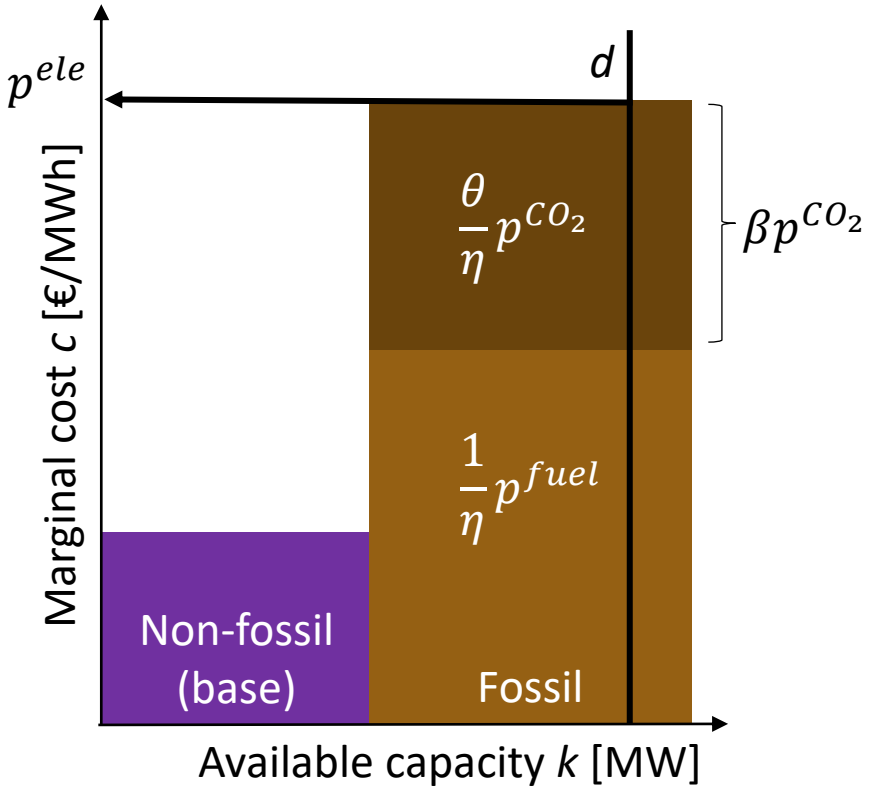
Carbon price impact 2015-2020



- Marginal impact (β)
  0.1 - 1.3 €/MWh
- Observed carbon prices (p^{CO_2})
  4 - 30 €/t (higher in UK)

➢Total impact (βp^{CO_2})
0.5 - 40 €/MWh

What drives regional differences?



$$p^{ele} = mc^* = \frac{1}{\eta}\left(p^{fuel} + \theta p^{CO_2}\right)$$

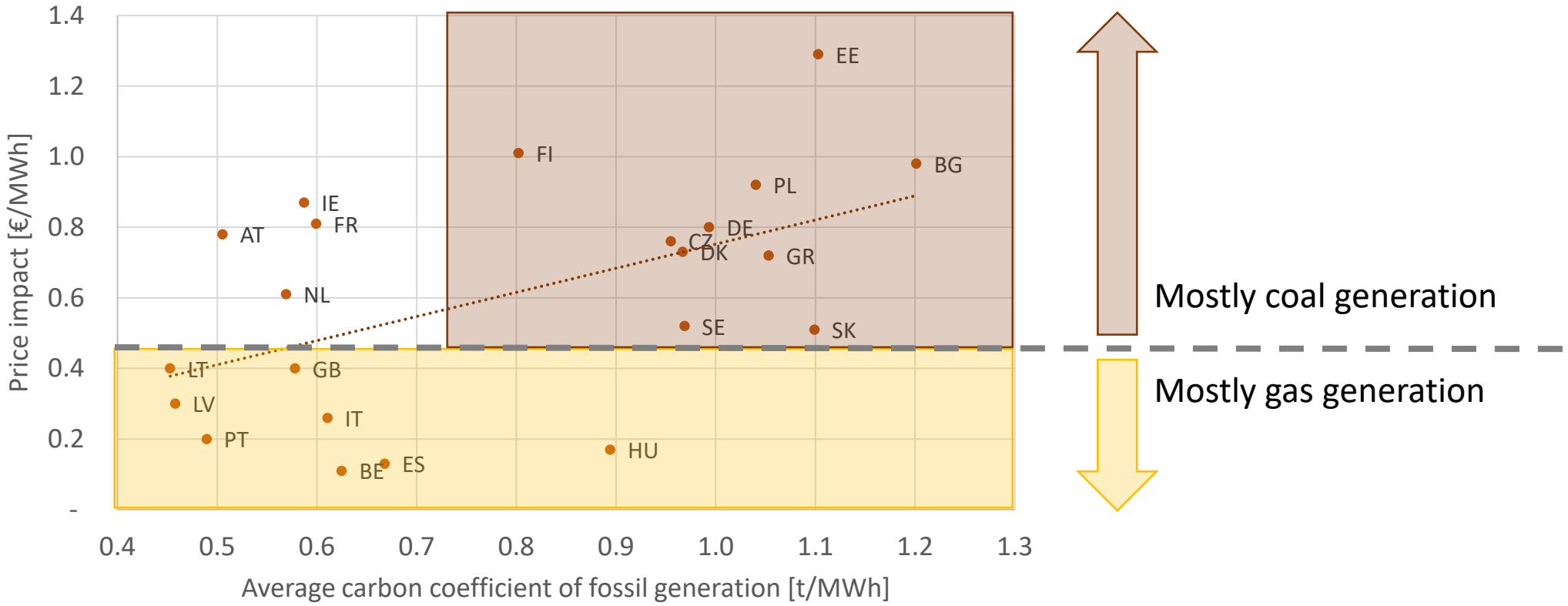
$$\frac{\partial p^{ele}}{\partial p^{CO_2}} = \frac{\theta}{\eta} = e^* \Rightarrow \bar{e}^* = \beta$$

- Average marginal emission coefficient, $\bar{e}^*$, determines price impact

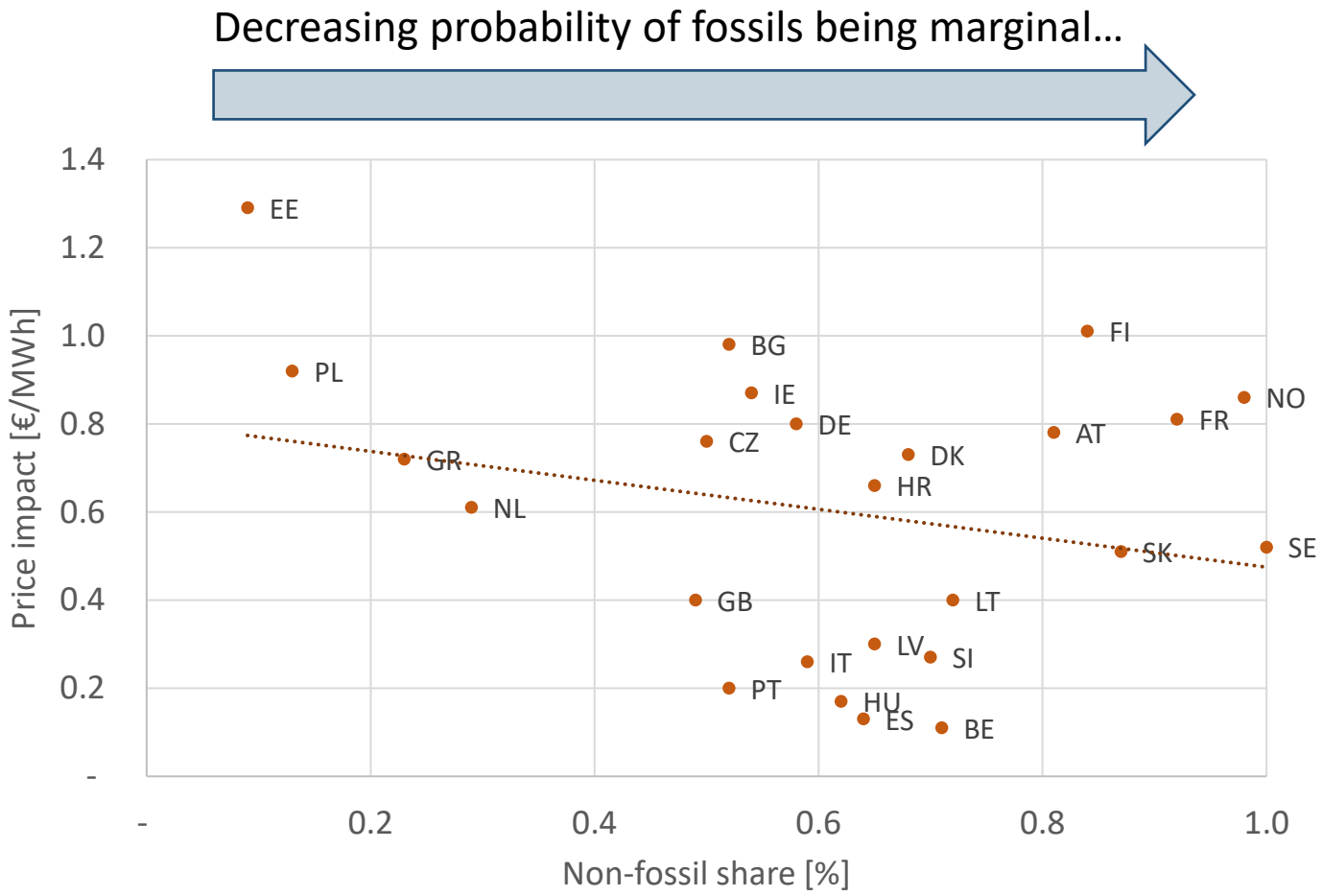
What influences $\bar{e}^*$?

1. How "dirty" is the fossil generation?
   - Average emissions of fossil generation [t/MWh]
2. How often are fossil plants marginal?
   - Share of non-fossil generation [%]
   - Import share [%]

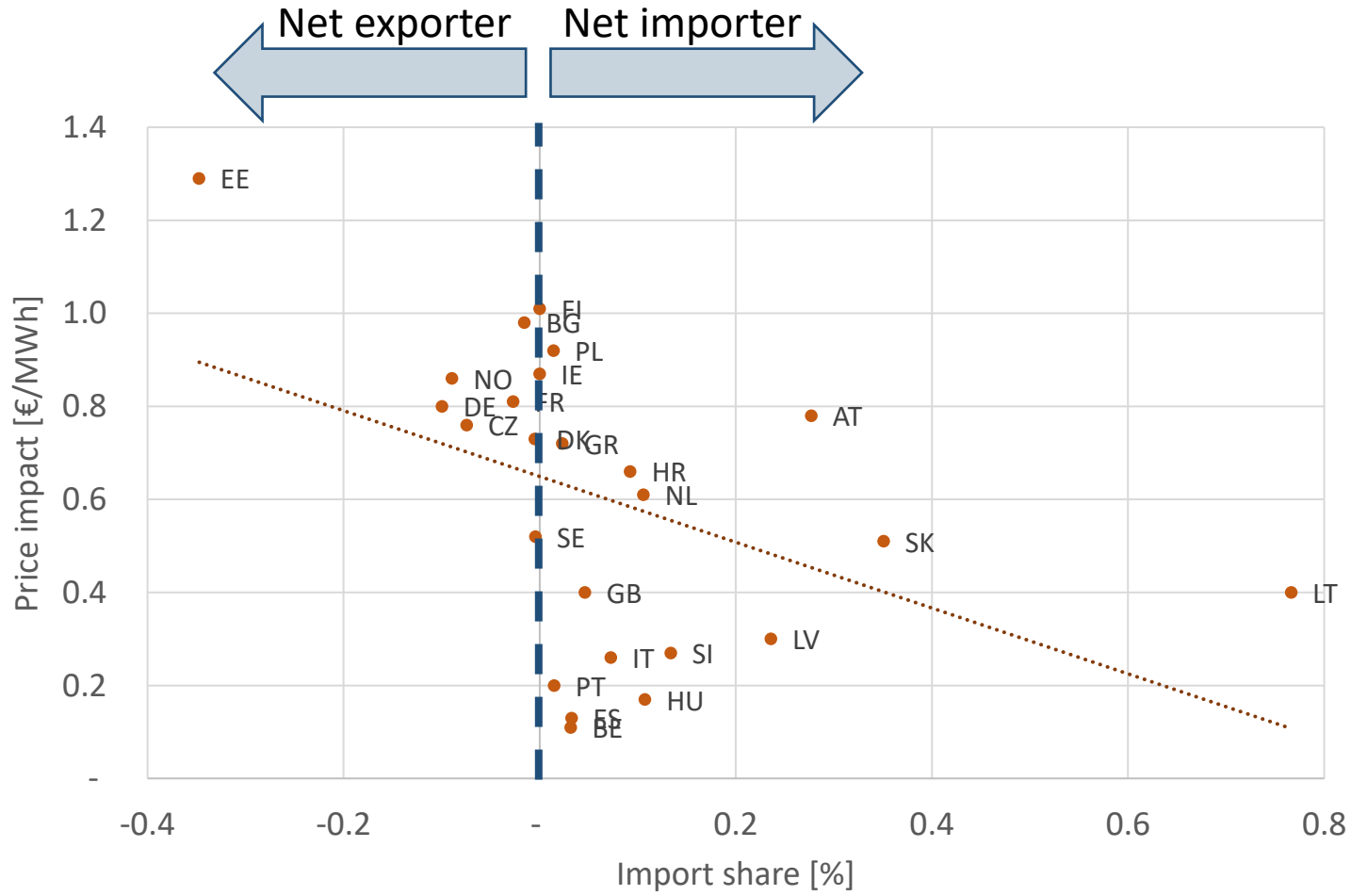
Price impact increases with carbon coefficient



Price impact decreases with non-fossil share



Price impact decreases with import share



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