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Energy Cost Pass-Through and Strategic Pricing: Sectoral Evidence for the EU ETS

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Agenda

- Motivation & Objectives
- Theory of (energy) cost pass-through in an oligopoly setting
- Hypothesises, data and econometric procedure
- Estimation results
- Conclusions

Motivation: Policy Issues

- The overall EU's target of at least 20% emissions reduction by 2020.
- Tightening emission caps in carbon-intensive sectors and introducing auctions as the basic principle for allocation of carbon allowances beyond 2012 within the EU ETS (EU, 2008a, 2008b).
- European Council: Preferential treatment of those sectors that are potentially exposed to carbon leakage.
- European Commission is obliged to finalize the list of vulnerable sectors until June 2010, assessing *market characteristics* and implications for *profit margin* as a potential indicator of relocation decisions (EU, 2008c).

Motivation: Previous research

- Economic theory suggests that price adjustments should be at the core of the analysis of driving forces behind carbon leakage: (decreasing) market shares and profit margins.
- **Assumptions** on the cost pass-through rates with two extremes:

  - cost increases are **fully borne by the consumers**, i.e. profit margins of the producers remain unchanged but output level is adjusted (Klepper and Peterson, 2004; Alexeeva-Talebi and Anger, 2007).

  - cost increases are **fully borne by the producers,** i.e. sustaining output level but decreasing profit margins (Reinaud, 2008; Hourcade et al., 2007)

  - cost pass-through rates **between 0 and 100%** (Demailly and Quirion, 2008)

- Empirical studies are **scarce** Sijm (2006), Zachmann and Hirschhausen (2008).

Objectives

- **To estimate** potential passing through capacity of additional energy costs in the EII sectors and sub-sectors.
- **To assess** strategic interactions between domestic and foreign firms, i.e. analyzing price adjustments of domestic firms to both increasing and decreasing competitor's prices.
- **To identify** sectors that are potentially exposed to a *significant risk of carbon leakage* and to better understand the role of market structure for the design of offsetting instruments to address carbon leakage domestically.

Theory of (energy) cost pass-through in an oligopoly

- Model of monopolistic competition: Dixit-Stiglitz (1977) and Dornbusch (1987):

  ⇔ Focus on **cost pass-through relationships** in an oligopoly setting with strategic interactions between domestic and foreign firms.

$$p_k = \left[1 - \frac{1}{\sigma \cdot (1-\varepsilon)}\right]^{-1} \cdot e_k = \left(1 + \underbrace{\nu_k}_{\substack{profit \\ margin}}\right) \cdot e_k \qquad (1)$$

$$\nu_k = \frac{1}{\sigma(1-\varepsilon)-1} \qquad (2)$$

$$\varepsilon \equiv \frac{1}{w + (1-\omega)[n^D + n^F (p_d / p_f)^{1-\sigma}]} \qquad (3)$$

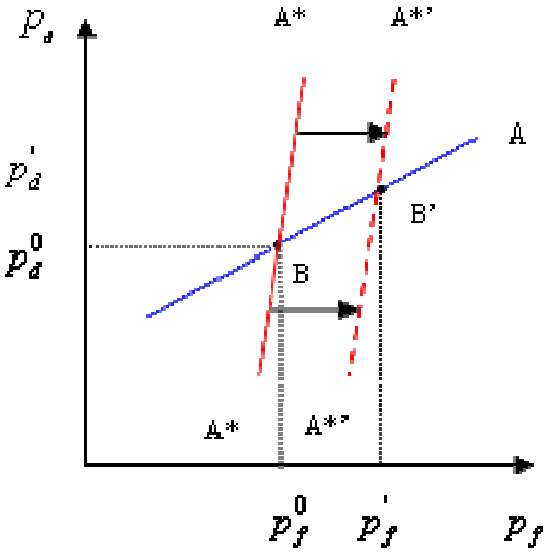
Theory of (energy) cost pass-through in an oligopoly

- Strategic interactions of domestic firms with foreign firms limits the cost pass-through ability. Optimal price response equation with p_d and p_f as prices of domestically produced and imported variants:

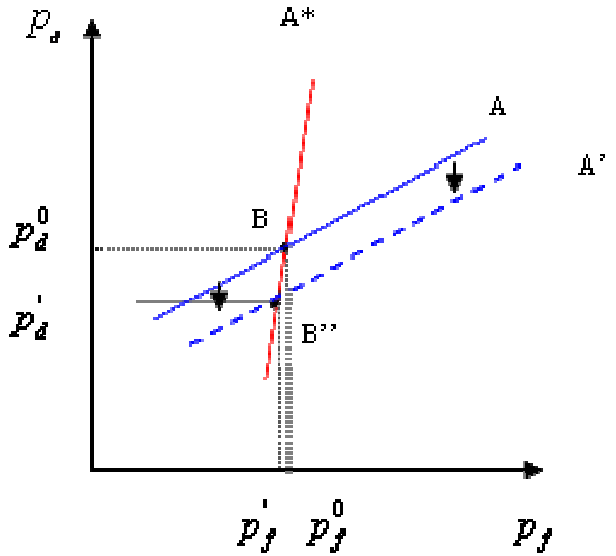
$$p_i^d = (1-\phi_i)e_i + \phi_i p_i^f \qquad (4)$$

e_i are the unit energy costs of the domestic firm and ϕ_i is a coefficient for competitive pressure.

Excurse: Applying the framework to the EU climate change policy



Case 1: Increasing *foreign and domestic prices* if BTA or GSA are applied to the foreign producers



Case 2: Decreasing *domestic and foreign prices* if carbon costs in domestic prices are partly subsidized (i.e. free allocation)

Hypothesises

- *Hypothesis 1*: Energy cost pass-through is incomplete in the short run, albeit every sector is capable to pass-through at least one type of energy cost shocks.

- *Hypothesis 2:* Energy-intensive sectors *have a flexible mark-up over energy costs*, i.e. they take explicitly foreign competitor's prices into consideration. Asymmetric price adjustments to *increasing* and *decreasing competitor's prices* may attenuate or aggravate profit losses induced by the incomplete pass-through rate. .

Data

- Data from the German Statistical Office:

  - Monthly data on output prices of German producers (producer price index)

  - Monthly data on input prices for electricity, coal, gas and oil

  - Monthly data on output prices of foreign firms (producer price index)

  - Sectoral data on energy intensities for electricity, coal, gas and oil

- Time horizon:

  - Input and output prices: January 2000 – December 2008

  - Energy intensities: 2002

Sectors

- German EII sectors: 3-digit level in GP classification (Graichen et al., 2008)
- 17 energy-intensive sub-sectors, particularly paper & pulp, printing services, chemicals, rubber & plastics, non-metallic minerals, basic metals

Sector	Code GP 2002
Manufacture of pulp, paper and paper products	**21**
Manufacture of pulp, paper and paperboard	211
Manufacture of articles of paper and paperboard	212
Publishing, printing, reproduction of recorded media	**22**
Printing and service activities related to printing	222
Manufacture of coke, refined petroleum products and nuclear fuel	**23**
Manufacture of refined petroleum products	232
Manufacture of chemicals and chemical products	**24**
Manufacture of basic chemicals	241
Manufacture of pharmaceuticals, medicinal chemicals and botanical products	244
Manufacture of soap, detergents, cleaning, polishing	245
Manufacture of other chemical products	246
Manufacture of rubber and plastic products	**25**
Manufacture of rubber products	251
Manufacture of plastic products	252
Manufacture of non-metallic mineral products	**26**
Manufacture of glass and glass products	261
Manufacture of non-refractory ceramic products	262
Manufacture of ceramic tiles and flags	263
Manufacture of cement, lime and plaster	265
Manufacture of other non-metallic mineral products	268
Manufacture of basic metals	**27**
Manufacture of basic iron and steel and of ferrous-alloys	271
Manufacture of basic precious and non-ferrous metals	274

Energy intensities

Code GP 2002	Sector	Coal	Gas	Oil	Electricity	Total[1]
21	**Manufacture of pulp, paper and paper products**					
211	Manufacture of pulp, paper and paperboard	0.8	5.1	0.4	**5.7**	13.0
212	Manufacture of articles of paper and paperboard	0.0	1.5	0.4	**1.8**	4.3
22	**Publishing, printing, reproduction of recorded media**					
222	Printing and service activities related to printing	0.0	0.8	0.4	**2.4**	3.6
23	**Manufacture of coke, refined petroleum products and**					
232	Manufacture of refined petroleum products	n/a	n/a	n/a	n/a	n/a
24	**Manufacture of chemicals and chemical products**					
241	Manufacture of basic chemicals	0.1	2.5	0.6	**3.5**	8.7
244	Manufacture of pharmaceuticals, medicinal chemicals and	0.1	0.7	0.4	**0.8**	2.3
245	Manufacture of soap, detergents, cleaning, polishing	0.0	0.8	0.3	**1.2**	2.6
246	Manufacture of other chemical products	0.0	0.9	0.0	**1.4**	3.2
25	**Manufacture of rubber and plastic products**					
251	Manufacture of rubber products	0.0	0.8	0.0	**1.7**	3.1
252	Manufacture of plastic products	0.0	0.6	0.4	**2.4**	3.5
26	**Manufacture of non-metallic mineral products**					
261	Manufacture of glass and glass products	0.0	**5.2**	1.5	4.5	11.3
262	Manufacture of non-refractory ceramic products	0.0	**5.3**	0.5	2.6	8.5
263	Manufacture of ceramic tiles and flags	0.0	**15.1**	0.0	5.8	21.4
265	Manufacture of cement, lime and plaster	0.0	4.5	5.8	**17.4**	43.0
268	Manufacture of other non-metallic mineral products	0.5	**2.3**	1.5	2.2	6.5
27	**Manufacture of basic metals**					
271	Manufacture of basic iron and steel and of ferrous-alloys	**7.5**	4.4	0.9	5.2	18.3
274	Manufacture of basic precious and non-ferrous metals	0.1	1.2	0.2	**3.2**	5.1

Source: German Statistical Office (2005)

Econometric procedure

- Autoregressive distributed lag models (ARDL) allow tackling the issues of ability of cost pass-through by explicitly linking input and output prices (including asymmetries).
- Equation to be estimated:

$$\Delta p_{i,t}^{d} = \alpha_i + \delta_{i,l} \sum_{l=1}^{n} \Delta p_{i,t-l}^{d} + \lambda_{i,l} \sum_{l=1}^{n} p_{i,t-l}^{f+} + \rho_{i,l} \sum_{l=1}^{n} p_{i,t-l}^{f-} + \zeta_{i,y} \sum_{y=0}^{n} \Delta e'_{t-y} + d_{i,t} + \varepsilon_{i,t} \qquad (2)$$

$e_t^{'} = (p_t^o, p_t^c, p_t^e, p_t^g)$: Input prices for oil, coal, gas and electricity

$$\Delta p_t^{f+} = \begin{cases} \Delta p_t^f, if \Delta p_t^f > 0 \\ 0, otherwise \end{cases} \qquad \Delta p_t^{f-} = \begin{cases} \Delta p_t^f, if \Delta p_t^f < 0 \\ 0, otherwise \end{cases}$$

Increasing and decreasing prices of foreign competitors

Results: Model with one lag for cement & lime production

Dependent Variable: FIRST_LOG_DOM_265
Method: Least Squares
Date: 02/04/09 Time: 19:12
Sample (adjusted): 2000M03 2008M12
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000351	0.001107	-0.317356	0.7517
FIRST_LOG_DOM_265(-1)	0.142327	0.117823	1.207970	0.2301
F_LOG_P_EINF_265(-1)	-0.025411	0.142922	-0.177794	0.8593
F_LOG_N_EINF_265(-1)	0.142670	0.061288	2.327876	0.0221
FIRST_LOG_STROM	0.379321	0.100435	3.776773	0.0003
FIRST_LOG_STROM(-1)	-0.111670	0.115299	-0.968527	0.3353
FIRST_LOG_GAS	-0.049343	0.035727	-1.381129	0.1705
FIRST_LOG_GAS(-1)	-0.000891	0.035151	-0.025335	0.9798
FIRST_LOG_OIL	-0.001049	0.009196	-0.114085	0.9094
FIRST_LOG_OIL(-1)	-0.004422	0.010005	-0.442019	0.6595
FIRST_LOG_COAL	0.044143	0.023796	1.855069	0.0668
FIRST_LOG_COAL(-1)	-0.012603	0.025037	-0.503376	0.6159
CO2_DUMM	0.003648	0.001564	2.331715	0.0219

R-squared	0.332002	Mean dependent var	0.001141
Adjusted R-squared	0.245809	S.D. dependent var	0.008432
S.E. of regression	0.007323	Akaike info criterion	-6.881235
Sum squared resid	0.004987	Schwarz criterion	-6.554587
Log likelihood	377.7055	Hannan-Quinn criter.	-6.748843
F-statistic	3.851839	Durbin-Watson stat	2.087066
Prob(F-statistic)	0.000089		

Results: Cost pass-through rates

- Econometric estimates give support for relatively *high pass-through* for the majority of the energy-intensive sectors in Germany in the model specifications with up to six lags:
  - Manufacturers of *three* (out of seventeen) product sub-categories – that are *articles of paper and pulp, rubber and non-refractory ceramics* – are capable to (more than) **completely** pass-through all types of energy price increases.
  - In six sub-sectors – that are *basic chemicals, soap & cleaning, paper and pulp, cement & lime, ferrous metals* – producers are capable to pass-through a significant fraction (**more than 50%)** of energy price increases within this time horizon.
  - All remaining energy-intensive sectors – that are manufacturers of *printing service, pharmaceuticals, plastic, glass, ceramic & tiles, other non-metallic minerals and non-ferrous metals* – bear the biggest fraction of energy price increases.

Results: Adjustments to the competitor's prices

- Empirical evidence suggests that **most** of the German EU ETS sectors **strategic interact** with foreign competitors, i.e. these sectors vary the profit margin depending on the behavior of the competitors.
- Sectors differently adjust to increasing and decreasing competitor's prices.
- Only manufacturers of *non-refractory ceramics* and *ceramic tiles & flags* appear to have a fixed mark-up as they do not take into consideration the prices of the foreign competitors.

Conclusions

- Relatively *high pass-through* rates for most energy-intensive sectors in Germany in the short-run. Nevertheless, only few sectors are capable to pass-through all types of energy price shocks.
- Strategic interactions of domestic producers with foreign firms (selling their products in Germany) might be important.
- *Different patterns* of asymmetric adjustment to the competitor's prices might attenuate or aggravate profit losses induced by the incomplete pass-through rate in the short-run.

  ⇔ The price reactions towards the competitor's prices might be used as an **additional criterion for the vulnerability of the EU ETS sectors.** Producers of *rubber* and *producers of glass* might build extremes on the vulnerability scale.