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

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Agenda

- Motivation & Objectives
- Theory of cost pass-through in an oligopoly setting
- Vector Error Correction (VEC) models
- 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:** list of sectors and subsectors (at the NACE-4 level) which are deemed to be exposed to a significant risk of carbon leakage (EU, 2009).
-BUT the use of a rather simplified catalogue of exposure criteria by the Commissions resulted in the very comprehensive list

Motivation: Previous Research

- **Economic theory:** price adjustments are at the core of the analysis of driving forces behind carbon leakage: (decreasing) market shares and profit margins
- **Simulation studies:** Pass-through rates are of major importance – results related to competitiveness and carbon leakage crucially depend on the ability of the sector to pass-through additional costs to the consumers (Demailly and Quirion, 2008) .
- **Econometric studies:** limited number of papers – Zachmann and Hirschhausen (2008) and Sijm (2005, 2006a, 2006b) on electricity; Walker (2006) on cement; Gerald et al., (2007) on energy-intensive sectors (but at the very low level of sectoral disaggregation); Oberndorfer et al. (2010) on energy-intensive industries in the UK but in the short-run equilibrium.

Objectives

- **To estimate** potential passing through capacity of additional costs in few EII sectors and sub-sectors.
 - **To identify** the sectors which seem to be exposed to carbon leakage risks
- ⇒ Select a model which addresses the reality in the sectors subject to the EU ETS:
1. Heterogeneous goods
 2. Domestic and foreign goods are imperfect substitutes
 3. Oligopolistic market structure with few large firms

Theory of cost pass-through in an oligopoly

- Model of monopolistic competition with domestic and foreign firms: Dixit-Stiglitz (1977) and Dornbusch (1987):
- Representative consumer maximizes the following separable utility function:

$$U = U[x_0, V(x)] \quad \text{s.t.} \quad x_0 + \sum_{i=1}^n x_i = I \quad (1)$$

x_0 is a numéraire homogeneous commodity, x_i $i = 1, \dots, n$ are the different varieties of a CES composite good and I is the exogenously given income of the representative household

- There are n^D domestic firms and n^F foreign firms in (our) home market supplying some variant (brand) each – the latter are identical to each other but not to the domestic firms

Theory of cost pass-through in an oligopoly

- The profits of a representative domestic firms k are given by:

$$\pi_d = (p_d - c_d) x_d \quad (2)$$

- x_d is the output and c_d are the unit costs of a domestic firm
- Individual firms are sufficiently large to affect the industry price $P = \left[\left(\sum_{d=1}^{n^D} p_d^{1-\sigma} \right) + \left(\sum_{f=1}^{n^F} p_f^{1-\sigma} \right) \right]^{1/(1-\sigma)}$
- Strategic interactions between the firms are introduced by conjectural variation ω mit $0 < \omega < 1$
- First-order condition of profit maximization for an individual domestic producer:

$$x_k + [p_k - c_k] \left[\left(\frac{\partial x_k}{\partial p_k} \right) \right] + \left[\left(\frac{\partial x_k}{\partial P} \right) \left(\frac{\partial P}{\partial p_k} \right) \right] = 0 \quad (3)$$

Theory of cost pass-through in an oligopoly

- Let ε denote the elasticity of the aggregate price level with respect to the single supplier's own price

$$\varepsilon \equiv (dP/P) / (dp_k/p_k) \quad (4)$$

- The first-order condition can be simplified to:

$$1 + (p_k - c_k) \cdot (\sigma) \cdot (\varepsilon - 1) / p_k = 0 \quad (5)$$

- The elasticity is derived as:
$$\varepsilon \equiv \frac{1}{\omega + (1 - \omega)[n^D + n^F (p_d/p_f)^{1-\sigma}]} \quad (6)$$

- The profit margin can be written as:
$$1 + v_k = (1 - \omega) \left[1 - \left(n^d + n^f \left(\frac{p_f}{p_d} \right)^{1-\sigma} \right) \right] \quad (7)$$

Theory of cost pass-through in an oligopoly

- Domestic firm's reaction function:

$$p_d = F(p_f / p_d, \sigma, \omega, n^d, n^f) \cdot c_d = (1 - \omega) \left[1 - \left(n^d + n^f \left(\frac{p_f}{p_d} \right)^{1-\sigma} \right) \right] \cdot c_d \quad (8)$$

- Foreign firm's reaction function:

$$p_f = F(p_d / p_f, \sigma, \omega, n^d, n^f) \cdot c_f = (1 - \omega) \left[1 - \left(n^d + n^f \left(\frac{p_d}{p_f} \right)^{1-\sigma} \right) \right] \cdot c_f \quad (9)$$

Theory of 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:

$$p_i^d = (1 - \phi_i)c_i + \phi_i p_i^f \quad (10)$$

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

Estimating the model

- Why estimating the model using the German data?
 - **In the theory:** Individual firms are sufficiently large to affect the industry price
 - **In practice:**
 - German firms are significantly large in the key EU ETS sectors such as chemical and non-metallic minerals (i.e. BASF and Heidelberg cement)
 - Anecdotic evidence at the sectoral level suggests that firms in Germany compete in prices and not in quantities (i.e. cement production)

Data issues

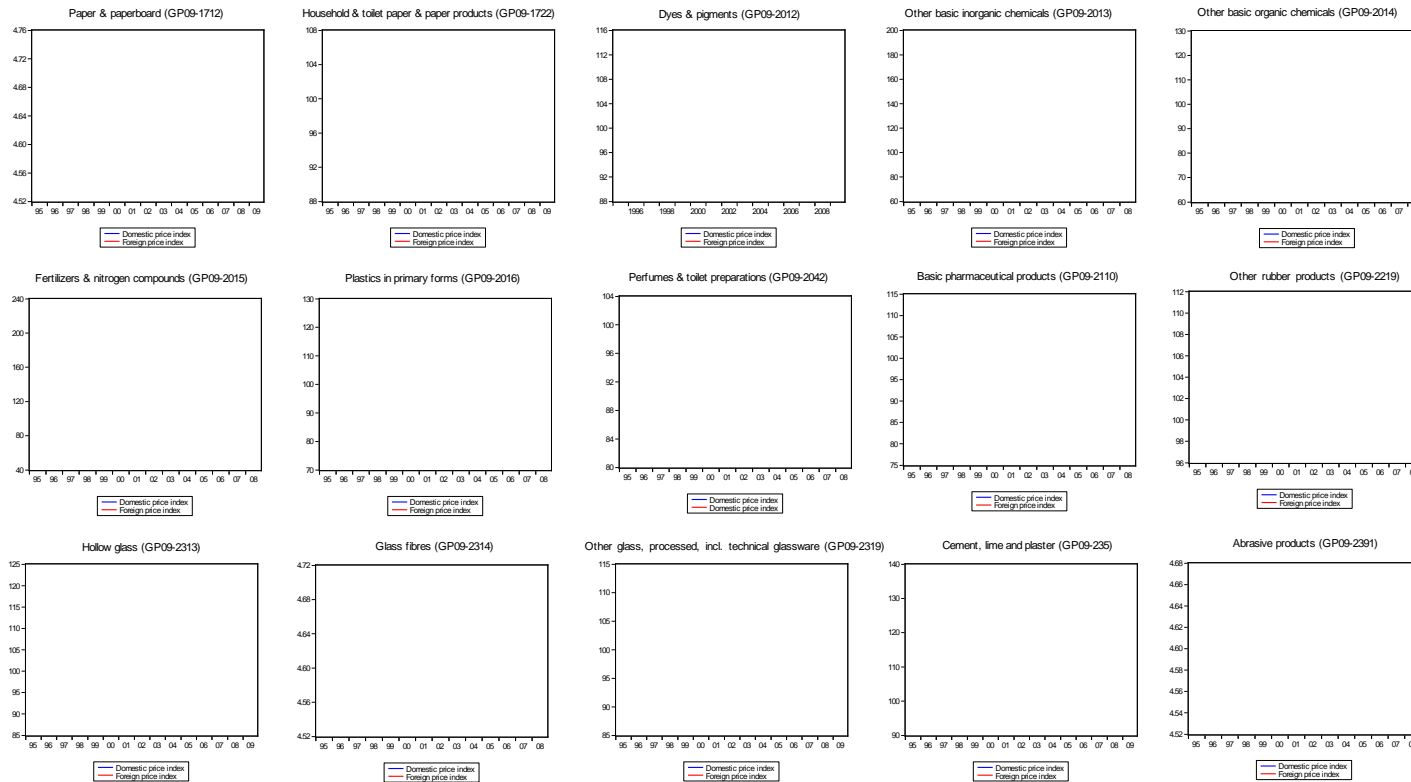
- Not possible to estimate the pass-through of CO2 costs => Find other proxies
- Data from the German Statistical Office:
 - Monthly data on output prices of German producers (producer price index)
 - Monthly data on output prices of foreign firms (producer price index)
 - Monthly data on input prices for energy (i.e. electricity and gas) and **sector-specific** material and labour
 - Sectoral data on energy, labor and material shares
- Time horizon:
 - Input and output prices: January 1995 – December 2008

Sectors

- German EII sectors: 4-digit level in GP-2009 classification (Graichen et al., 2008)
- 16 energy-intensive sub-sectors, particularly paper & pulp, chemicals, rubber & plastics, non-metallic minerals

Code GP 2002	Sector
17	Manufacture of pulp, paper and paper products
1712	Manufacture of paper & paperboard
1722	Manufacture of household & toilet paper & paper products
20	Manufacture of chemicals and chemical products
2012	Manufacture of dyes & pigments
2013	Manufacture of other basic inorganic chemicals
2014	Manufacture of other basic organic chemicals
2015	Manufacture of fertilizers & nitrogen compounds
2016	Manufacture of plastics in primary forms
2042	Manufacture of perfumes & toilet preparations
21	Manufacture of pharmaceutical and comparable products
2110	Manufacture of basic pharmaceutical products
22	Manufacture of rubber and plastic products
2219	Manufacture of other rubber products
2229	Manufacture of other plastic products
23	Manufacture of non-metallic mineral products
2313	Manufacture of hollow glass
2314	Manufacture of glass fibres
2319	Manufacture of other glass, processed, incl. technical glassware
235	Manufacture of cement, lime and plaster
2391	Manufacture of abrasive products

Co-movement of domestic and foreign prices



Econometric procedure

- This VAR may be rewritten as a vector-error-correction model (VECM) for each energy-intensive sector as:

$$\Delta \mathbf{x}_{it} = \Pi_i \mathbf{x}_{it-1} + \sum_{k=1}^{p-1} \Gamma_{ik} \Delta \mathbf{x}_{it-k} + \mathbf{B}_i \mathbf{y}_{it} + \boldsymbol{\varepsilon}_{it} \quad (2)$$

- where Δ represents the first-difference operator and Π_i contains information about the long-run relations among endogenous variables. Thereby, $\text{rank}(\Pi_i) = 1$ suggests the existence of unique cointegration relationship among respective variables at the sectoral level

Cost pass-through and strategic pricing: Long-run relationships

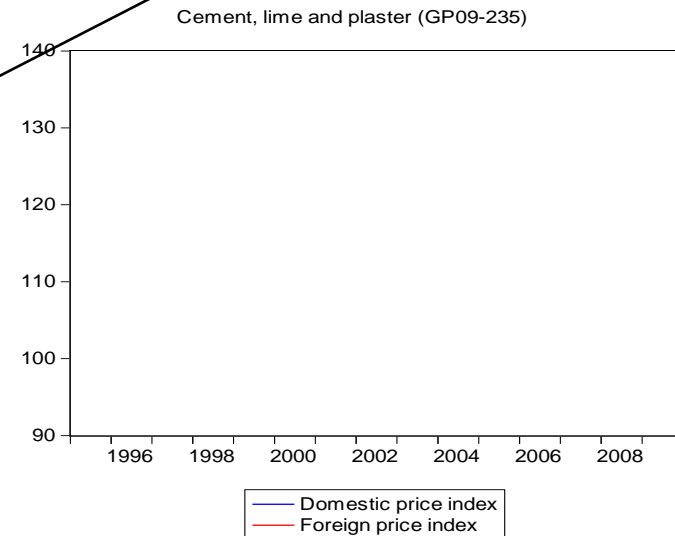
Results from the VEC model:

<i>Manufacture of cement, lime and plaster (235)</i>				
P_{235}^{dom}	P_{235}^{for}	P_{20}^{mat}	P_{23}^{lab}	P^{ele}
-1.00	0.37 (0.03)***	0.11 (0.07)**	0.39 (0.08)***	0.18 (0.02)***

Labour, material and energy shares in 2007:

Labour	Material	Energy
37.0	36.2	18.5

Source: Statistisches Bundesamt (2010)



Cost pass-through and strategic pricing: Long-run relationships

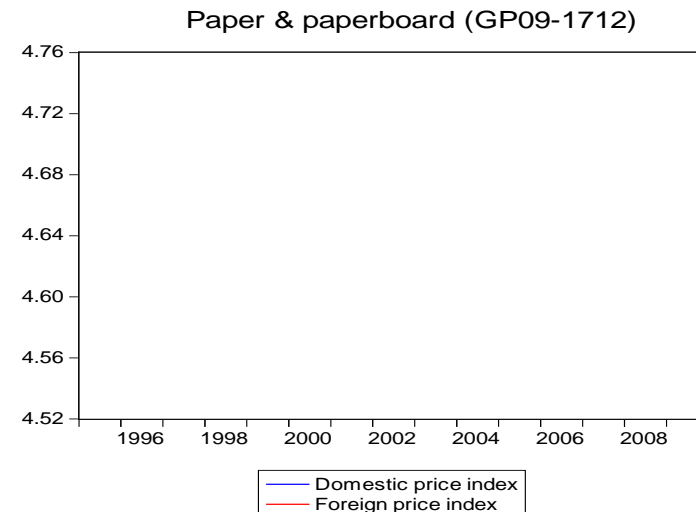
Results from the VEC model:

<i>Manufacture of paper & paperboard (GP 1712)</i>				
P_{1712}^{dom}	P_{1712}^{for}	P_{222}^{mat}	P_{17}^{lab}	P^{ele}
-1.00	1.12 (0.09)***			

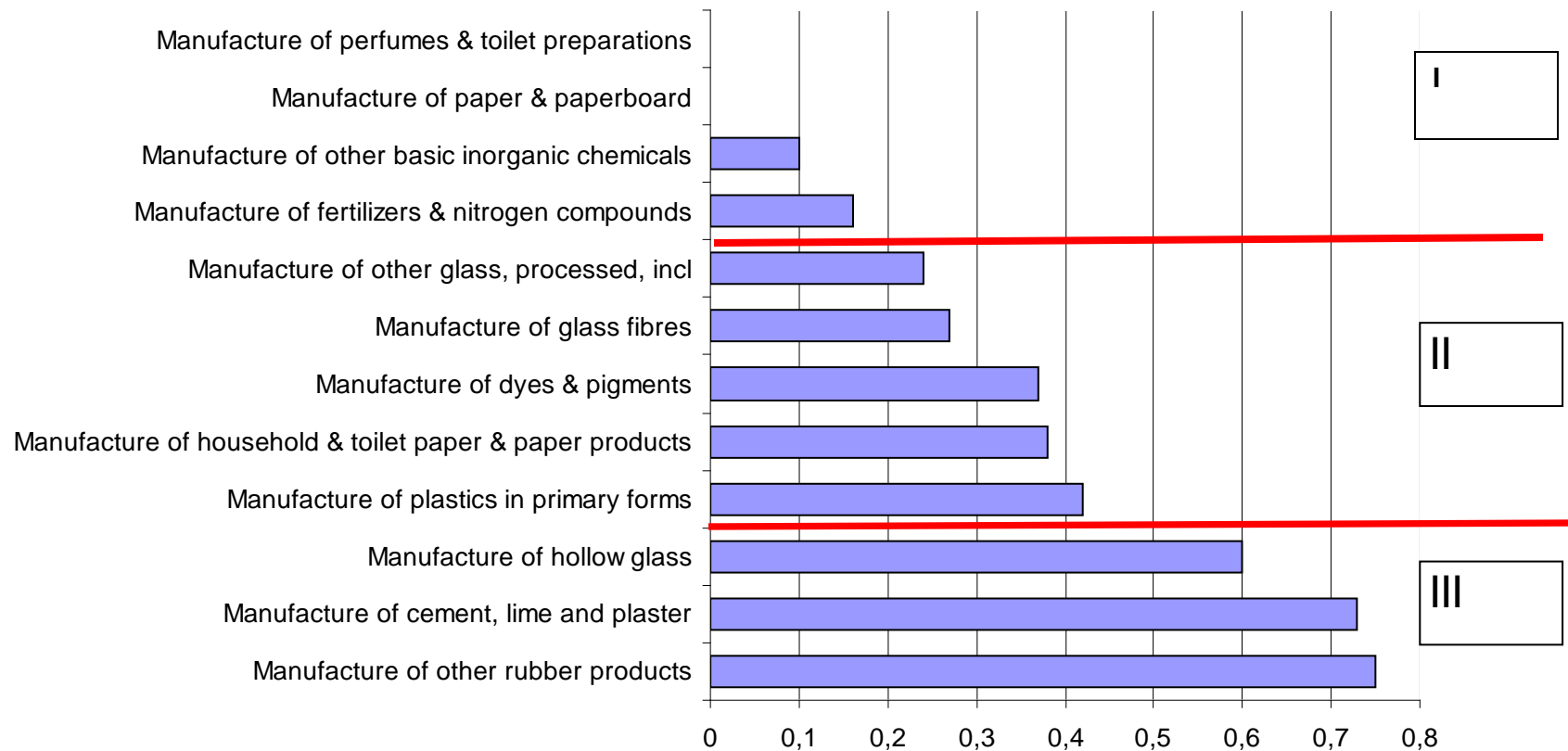
Labour, material and energy shares in 2007:

Labor	Material	Energy
24.9	46.9	10.8

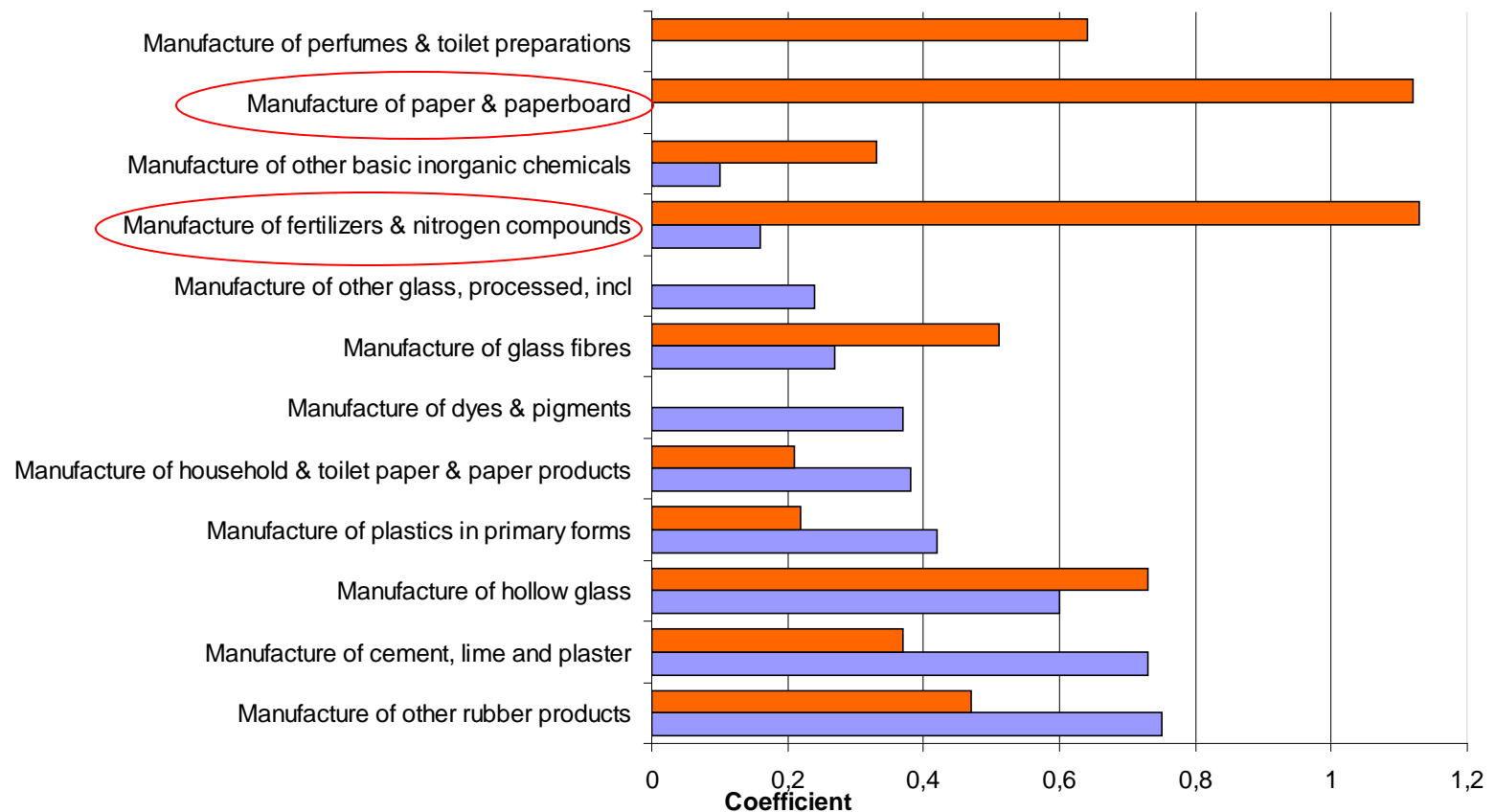
Source: Statistisches Bundesamt (2010)



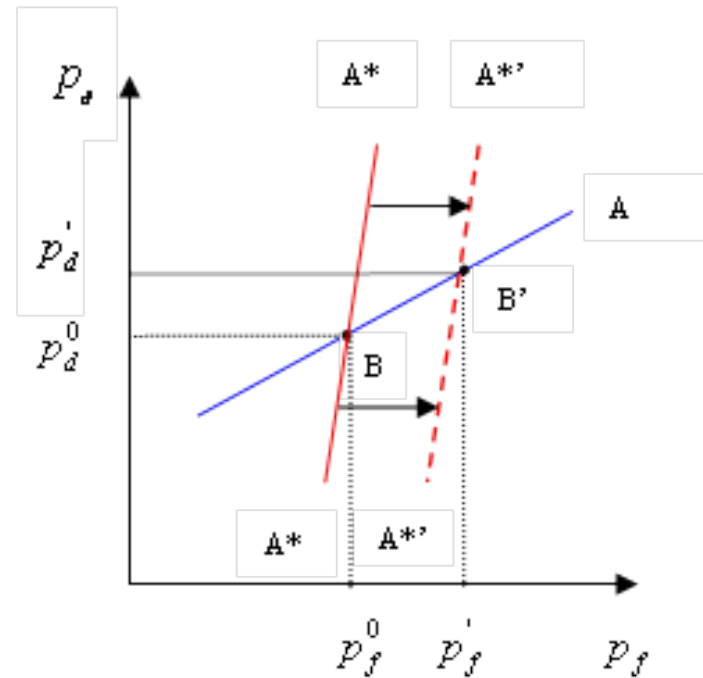
Cost pass-through rates in the long-run



Cost pass-through rates and responsiveness to foreign prices in the long-run



Excuse: Applying the results to the EU climate change policy



Increasing domestic prices if BTA or GSA are applied to the foreign producers

Conclusions

- Econometric estimates give support for *high pass-through* in limited number of sectors in Germany in the long-run:
 - Manufacturers of three (out of twelve) product sub-categories – that is production of **cement, lime and plaster, other rubber products** and **hollow glass** – are capable to pass-through up to 75% of total cost increases.
 - In contrast, **producers of paper and paperboard**, other basic inorganic chemicals, **fertilizers & nitrogen compounds** and **perfumes & toilet preparations** are capable to pass only a small fraction of domestic cost shocks (if any at all).
 - Remaining sectors pass-through between 20% and 40% of total costs to consumers.

Conclusions

- 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.
 - **Political relevance:** The policy implications of the results are that strategic interaction between domestic and foreign firms could be a critical factor in applying offsetting instruments to address carbon leakage domestically.
- ⇔ Accounting for oligopolistic structures – with and without strategic interactions – should be a central issue within the broader context of how market structure affects the climate change policies.