Reliability

Innovation

Expertise

Do energy-intensive industries pass through the opportunity cost of CO2 allowances ?

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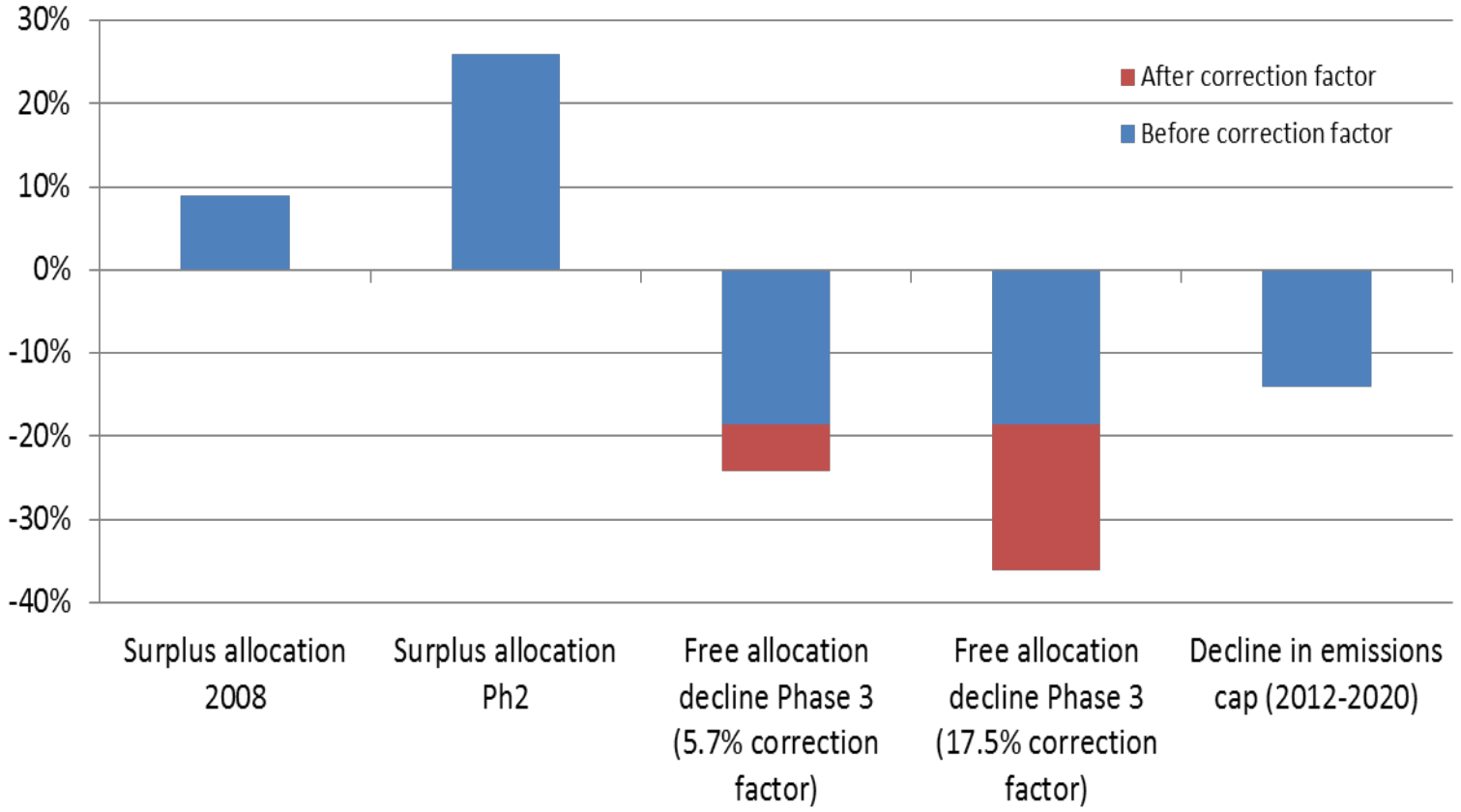
Policy context

- **EU ETS began in 2005. 3 phases so far:**
  - **Trial Phase (2005-2007), Kyoto Phase (2008-2012), Phase 3 (2013-2020)**
- **Covers ~13000 large-emitting installations & ~50% of EU CO2 emissions**
- **Main sectors covered:**
  - **Electricity, heat , oil refining, iron & steel, cement, pulp & paper, glass, cokery, ceramic & brick, chemicals, non-ferrous metals, domestic aviation & all large combustion,**
- **Emissions objectives:**
  - **Trial Phase = -3% (cap not binding due to poor data)**
  - **Phase 2 = -8% vs 2005**
  - **Phase 3 = -21% vs 2005 by 2020 (cap falls 1.74% p.a.)**

Policy context

- **A classical cap-&-trade scheme**
  - **EU collectively issues allowances each year equivalent to the cap.**
  - **Firms must surrender CO2 allowances equivalent to their verified emissions for year t by 30th May of year t+1**
- **Allocation**
  - **In Phase 1 & 2, 95% allowances issued to installations for free.**
  - **In Phase 3: 100% auctioning for electricity (derogations new MS), ~80-120% free allocation of emissions for energy-intensive industries (depends on economy).**
- **Banking, borrowing & use of Kyoto offset credits allowed for compliance, subject to certain rules**

Free Allocations for non-electricity sector in Phase 2 vs. Phase 3

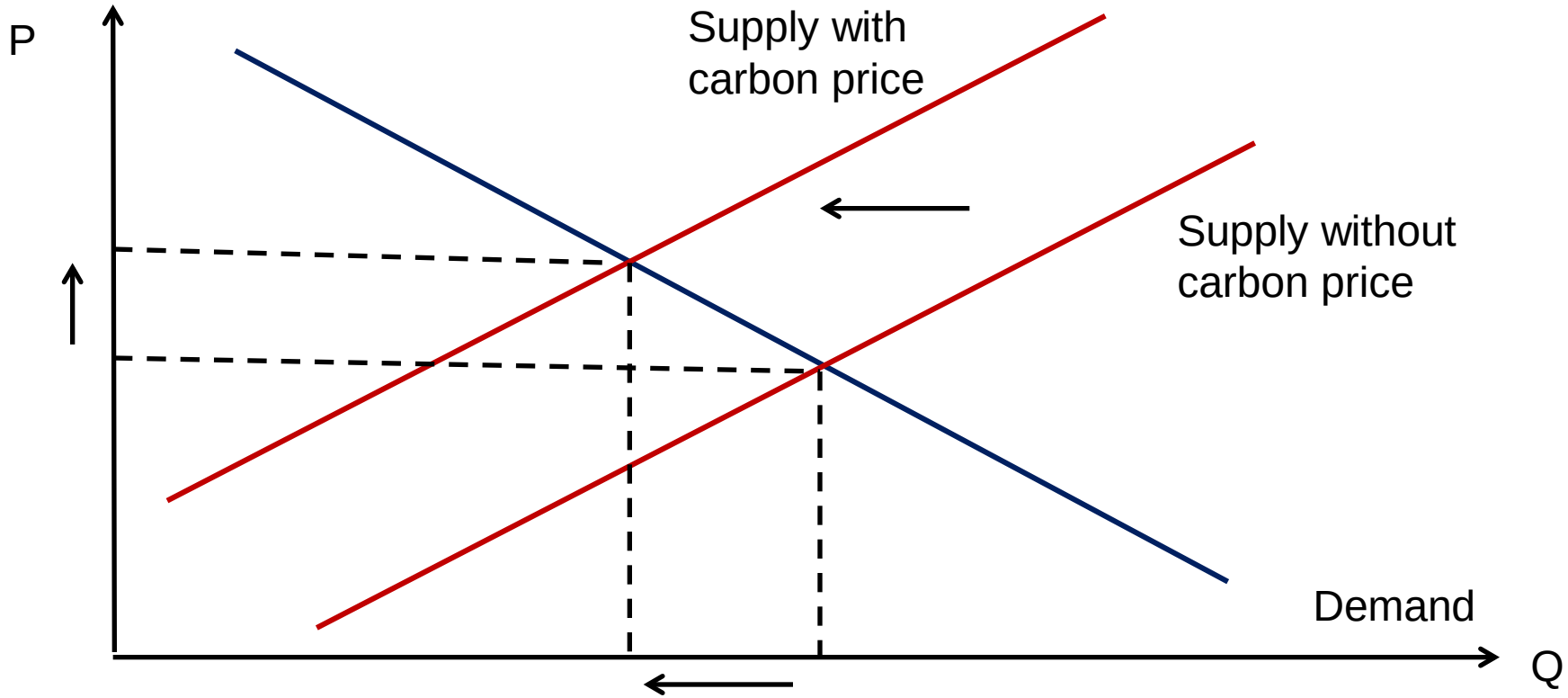


- **Note: aggregate figures for steel, cement, lime, glass, ceramic & brick, refining, coke, pulp & paper (20 EU countries)**

How does free allocation affect incentives?

- **Free allocation is currently a lump sum payment at beginning of each year**
  - **The amount given was determined based on *past* ,but not *current,* output in Phases 1 & 2**
  - **It is still largely independent of current output in Phase 3**
    - (except for large changes in capacity or utilisation rates below 50%)
- **It can be thought of as a subsidy on capacity. but not output, so…**
  - **Should affect investment & closure decisions**
  - **But in theory should not change marginal incentives**
  - **If firms profit-maximise, marginal production & abatement decisions should still reflect the opportunity cost of free allowances**

How does free allocation affect incentives?



- **Hence, even 100% free allocation should not necessarily prevent higher prices or lower output**
  - **Efficient from a carbon abatement perspective**
  - **But ineffective at addressing carbon leakage via trade competition**

Empirical evidence to date (Electricity Sector)

- **Conclusive evidence that electricity sector passes through carbon costs:**
  - **Sijm et al (2006) – pass-through rates of between 60-120% in the DE & NL electricity sectors.**
  - **Walker (2006) – evidence of pass-through in Spanish electricity market.**
  - **Jouvet & Solier (2013) – also find evidence of pass-through in a number of EU countries.**
  - **However, most electricity generators were underallocated allowances in Phases 1 & 2.**
  - **So do results reflect pass-through of real or opportunity cost at the margin?**

Empirical evidence to date (Non-electricity sectors)

➢ Ex-ante modelling literature

- ❖ ***Smale et al. (2006):***
  - 30€/tCO_2 + 100% free allocation – increase gross earnings by 25% for cement, 18% for steel, 15% for newsprint, 0.6% for petroleum
- ❖ ***Demailly and Quirion (2006):***
  - 20€/tCO2 + 90% free allocation – increase gross profits by 20% for cement for the EU.

➢ But empirics inconclusive

- ❖ ***Walker (2006)***
  - Cement sector passes through ~14% of CO2 price. But…sample small (~20 observations w/ CO2 price) & very noisy (trade value data).
- ❖ ***De Bruyn et al (2011)***
  - Cold-rolled steel, hot-rolled steel, gasoil and diesel pass-through 100% of CO2 costs in the EU ETS…but do not control for energy prices, etc.
- ❖ **Abrell et al (2011) –** allocation affects abatement… (!)

Empirical Strategy

2 approaches

1. **Estimate the pass-through rate of CO2 prices using a semi-structural approach and firm-level profit, revenue and cost data.**
2. **A robustness check using trade data (à la Walker 2006) but with a much longer data sample.**

Estimation approach #1: Developing a testable hypothesis

- **Assume Cournot oligopoly competitive framework**
- **Appropriate for cement/steel; (Kreps & Sheinkman, 1983)**
- **Cournot firm's profit maximisation problem:**

$$\max_{q,ua} \Pi_1 = P(Q).q_1 - q_1.c_1(ua_1) - P_{CO2}.(e_1 - f_1)$$

$$e = q.(ue - ua)$$

- **First order conditions:**

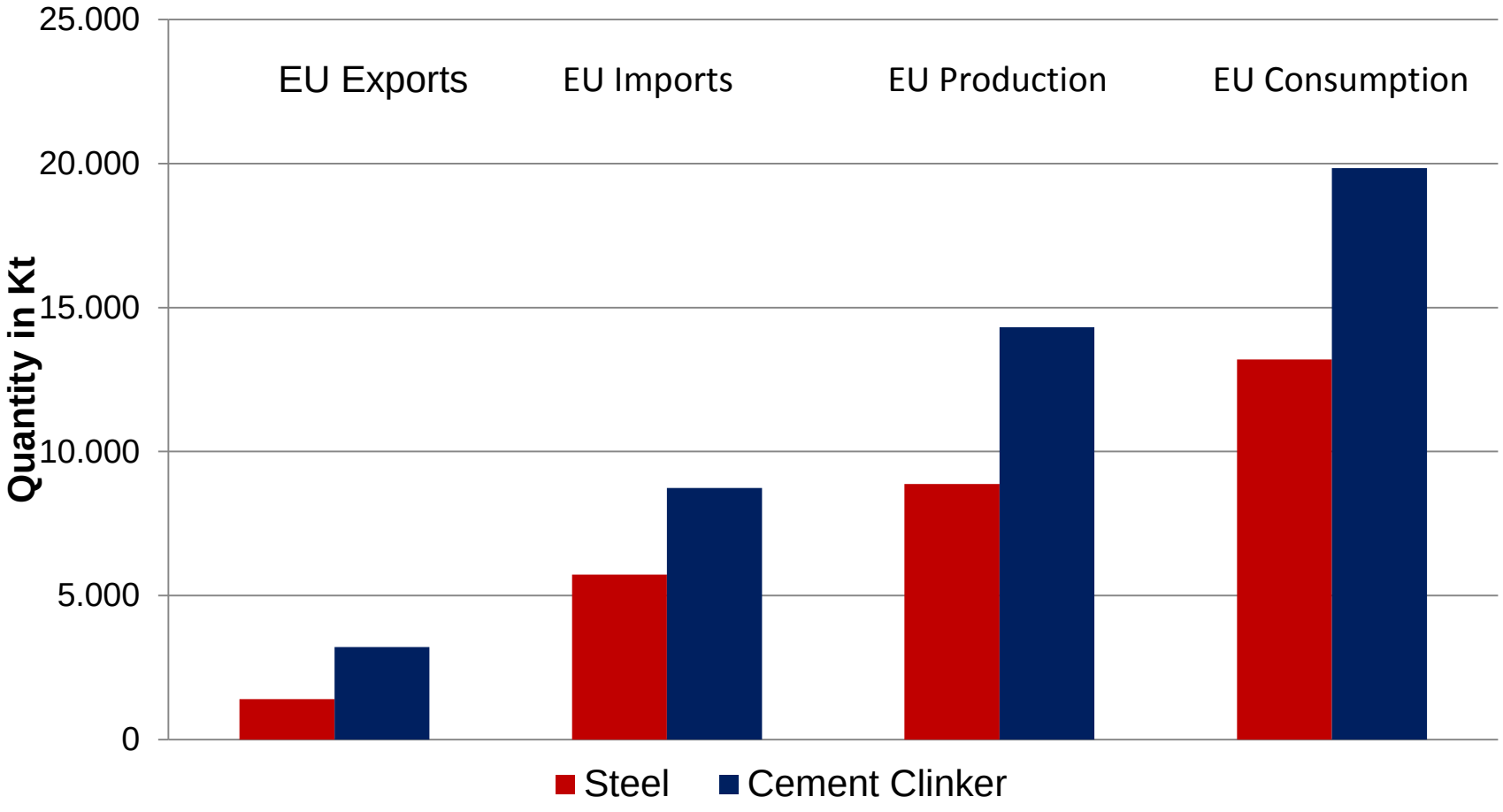
$$\frac{\partial P(Q)}{\partial q_1} q_1 * + P(Q) = c_1(ua_1) + P_{CO2}.(ue_1 - ua_1)$$

$$q_1.\frac{\partial c_1(ua_1)}{\partial ua_1} = P_{CO2}.\frac{\partial e_1}{\partial ua_1}$$

- **Assuming linear demand, *P(Q)=a – bQ*, leads to market equilibrium price, P* of:**

$$P*(Q*) = \frac{a}{n+1} + \frac{n.(c(ua*) + P_{CO2}.(ue - ua*))}{n+1}$$

Foreign share of EU markets for production and consumption of cement clinker & semi-finished steel products



2008 data, Eurostat

Estimation approach #1: Developing a testable hypothesis

- **But we do have some international competition, so…**
- **Following Varian (1992), it can be shown, under a linear demand, Cournot setting, that defining *x* = share of firms facing a cost increase, yields a pass-through rate of *x/(n+1)***
- **Applying this, we have:**

$$P*(Q*) = \frac{a}{n+1} + \frac{x.(c(ua*) + P_{CO2}.(ue - ua*))}{n+1}$$

- **The price change in response to a change in PCO2:**

$$dP*(Q*) = \frac{x}{n+1}((ue - ua*).dP_{CO2} - P_{CO2}.dua* + dc(ua*))$$

- **And the change in profits:**

$$d\Pi = \frac{x}{n+1}((ue - ua*).dP_{CO2} - P_{CO2}.dua* + dc(ua*)).q$$
$$- q.dc(ua*) - (e - f)dP_{CO2} + P_{CO2}.q.dua*$$

…

Estimation approach #1: Developing a testable hypothesis

- **The dπ ultimately simplifies to:**

$$(f - e.(1 - \frac{x}{n+1})).dP_{CO2}$$

  - **Where (x/n+1) is the pass-through rate.**

- **Two components :**
  - **(f – e).PCO2 – represents real cost of compliance with ETS**
  - **(x/n+1).e.PCO2 – represents effect of price pass-through on freely allocated allowances into profit.**
  - **Have data to construct both variables, specify model:**

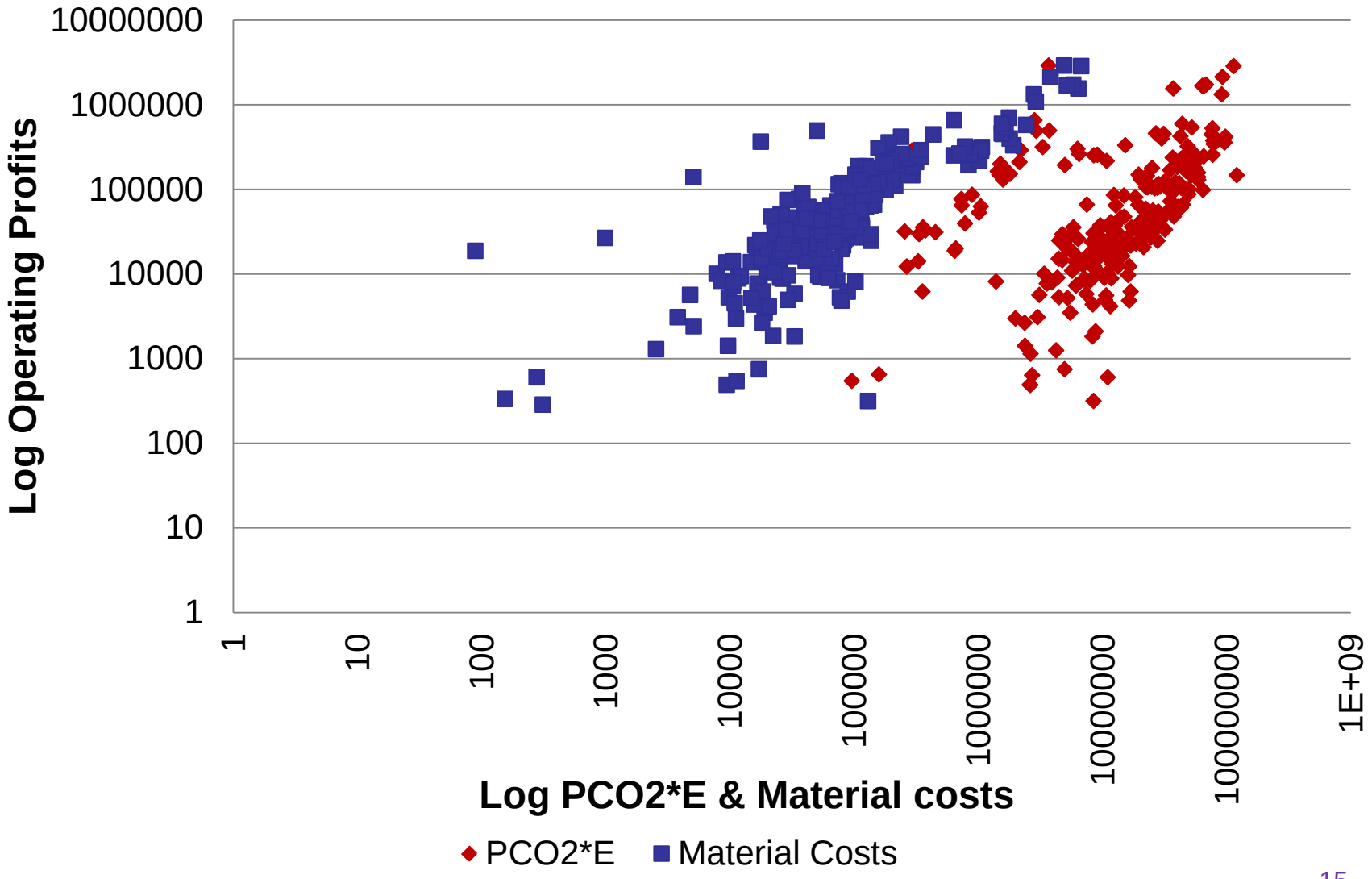
$$\pi_{it} = \alpha + \beta_1.(f_{it} - e_{it}).P_{CO2,t} + \beta_2.[e_{it}.P_{CO2,t}] + \sum_{k=1}^{m} \beta_k x_{it\,k} + \varepsilon_{it}$$

  - **Need to control for energy prices, demand, prod. quantity.**

Data description

- Installation emissions & free allocation from EUTL.
- Was matched and aggregated to firm-level data on profits, sales, material & employee costs in Orbis company accounts data-base, using names & addresses of operator account holder in EUTL.
- CO2 prices are average annual Dec futures contract prices from ICE.
- Brent crude oil, Rotterdam coal, Zeebrugge NatGas prices taken as a measure of energy prices (Reuters)
- EU15 & EU27 construction index from Eurostat
- National industrial production index from Eurostat

Data description



Estimation approach #1: Preliminary results

Regression on Firm Operating Profits of EU Cement Firms

Coefficient (all variables in logs)	Coeff. estimate #1	Coeff. estimate #2
Material costs	0.44**	0.44**
EU Construction index	3.24****	2.48***
Construction index (national)	2.38****	2.20****
Brent price	NS	NS
PCO2*Allocation surplus (deficit)	-0.16	-0.18
PCO2*Emissions	-0.01	-
PCO2	-	0.01
Regression Statistics		
Firm fixed effects	YES	YES
R-sq (within estimator)	0.41	0.40
N	250	250

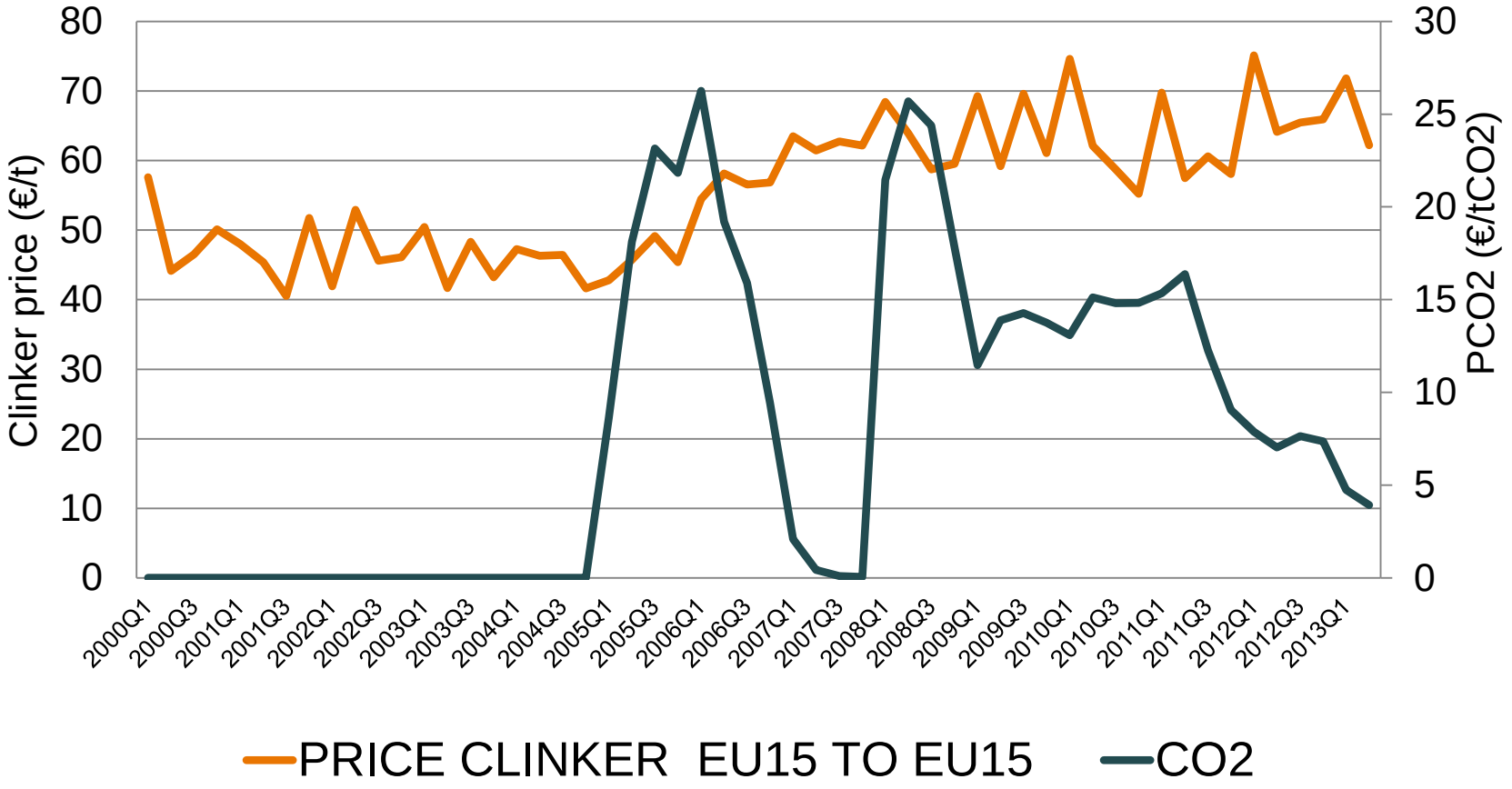
**Statisticall significant at 10%, ***5% ****1%
Estimated using Newey-West (heterosk. robust) standard errors.

Estimation approach #2

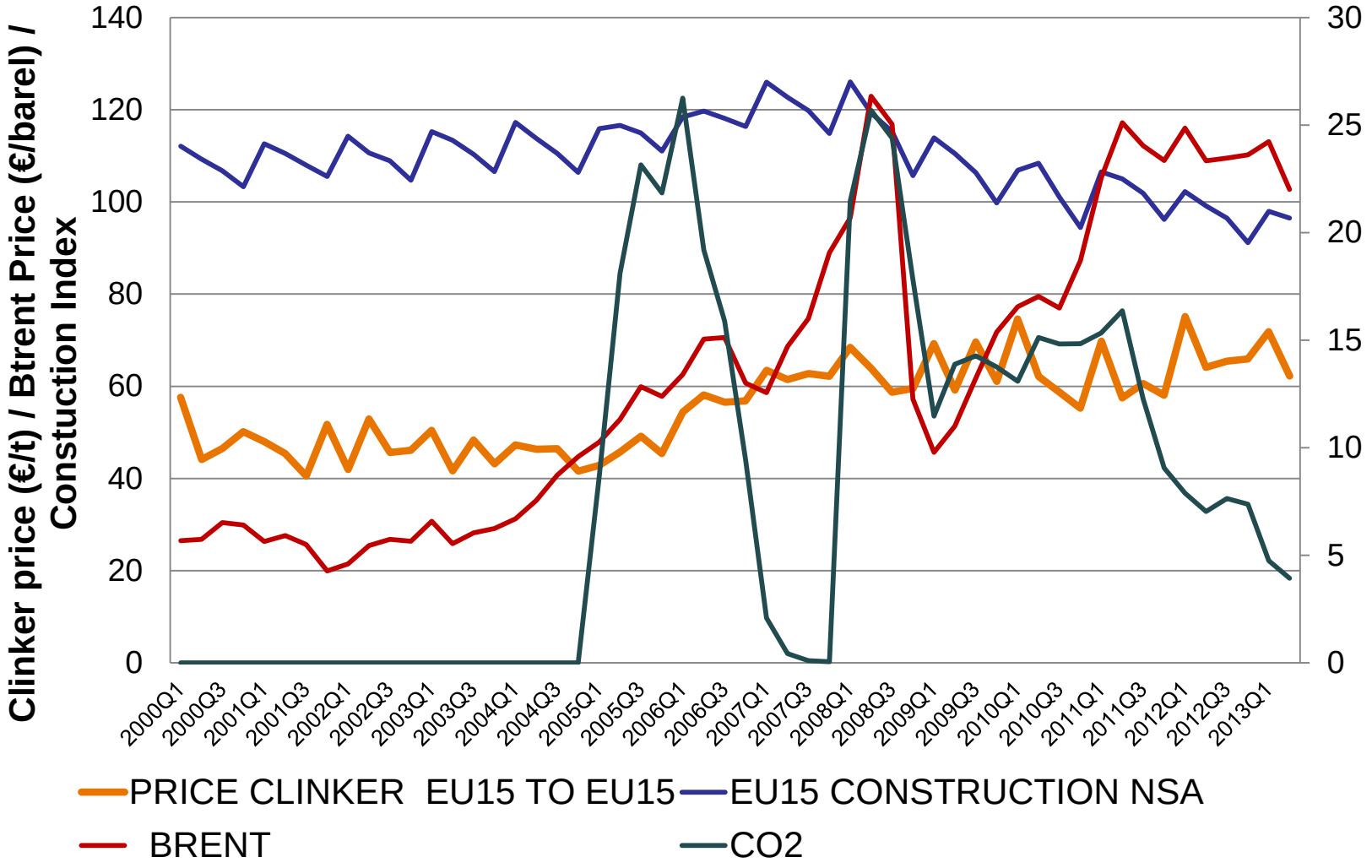
- **An analysis of implied cement clinker prices in trade data**
  - **Uses data on intra-EU15 trade values & volumes from Comext database**
  - **Use quarterly data to smooth monthly noise and capture possible lag effects.**
  - **So average quarterly CO2 price used**
- **Reduced-form Model:**

$$\Delta \text{Clinker Price}_t = \alpha + \beta_1 . \Delta \text{PCO2}_t + \beta_2 . \Delta \text{Brent Price}_t + \beta_3 . \Delta \text{EU15Construction}_t + \beta_4 \Delta \text{Imports}_t/\text{Prod}_t + \sum^{m}_{i=x} \beta_x \text{QuarterDummy}_x + \sum^{n}_{j=y} \beta_y \Delta u_{t-j} + u_t$$

Raw Data


Clinker price (€/t)
PCO2 (€/tCO2)
80
70
60
50
40
30
20
10
0
30
25
20
15
10
5
0
2000Q1
2000Q3
2001Q1
2001Q3
2002Q1
2002Q3
2003Q1
2003Q3
2004Q1
2004Q3
2005Q1
2005Q3
2006Q1
2006Q3
2007Q1
2007Q3
2008Q1
2008Q3
2009Q1
2009Q3
2010Q1
2010Q3
2011Q1
2011Q3
2012Q1
2012Q3
2013Q1
PRICE CLINKER EU15 TO EU15
CO2

Raw Data


Clinker price (€/t) / Btrent Price (€/barel) / Constuction Index
140
120
100
80
60
40
20
0
30
25
20
15
10
5
0
2000Q1
2000Q3
2001Q1
2001Q3
2002Q1
2002Q3
2003Q1
2003Q3
2004Q1
2004Q3
2005Q1
2005Q3
2006Q1
2006Q3
2007Q1
2007Q3
2008Q1
2008Q3
2009Q1
2009Q3
2010Q1
2010Q3
2011Q1
2011Q3
2012Q1
2012Q3
2013Q1
PRICE CLINKER EU15 TO EU15
EU15 CONSTRUCTION NSA
BRENT
CO2

Estimation approach #2: Preliminary Results

Coefficient	Coeff. Estimate #1	Coeff. estimation #2
Regression on Δ ln Clinker Price (all variables in logs)	Change on Same Quarter of Previous Year	Change Previous Quarter
Constant	0.000	0.000
ΔEU15 Construction	0.730***	1.263***
ΔBrent price	NS	NS
ΔPCO2	-0.006	-0.016
ΔImports/Consumption	NS	-.0077***
Quarter Dummies	NS	NS
Δe_{t-1}	-0.833	-0.736***
Δe_{t-2}	NS	NS
Regression Statistics		
Chi2	321.00	70.02
N	50	53

*Statisticall significant at 20%, **5% ***1%
Estimated using Newey-West (heterosk. robust) standard errors.

So, why no pass-through?

- **Are cement firms irrational/not profit maximisers?**
  - **E.g. Do cement firms price goods based on average rather than marginal costs in the cement sector?**
- **Institutional inertia?**
  - **Are current accounting/pricing conventions innappropriate to recognising opportunity cost as a cost of production?**
- **Other strategic reasons?**
  - **Privileging of market share over short-term profits?**
  - **Strategic behaviour to ensure free allocation continues?**
  - **Concern about raising suspicions of competition regulators?**

Conclusions & Next steps

- **Price pass-through & the treatment of opprtunity costs of free allowances by industrial firms matters for the efficiency and effectiveness of EU ETS.**
- **We currently don't know enough.**
- **This study finds no evidence that the cement sector has been passing-through the opportunity cost of free allowances in ETS Phase 1 & 2.**
- **This conclusion is confirmed by analyses from two different data sets and approaches**
- **However, it's not yet 100% clear why not.**
- **We need to better understand the mechanism behind the results.**