Near-term trade impacts of asymmetric climate change mitigation policies

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Centre for Climate Change Economics and Policy
LSE The London School of Economics and Political Science
E·S·R·C Economic & Social Research Council

Do heterogeneous carbon prices impact trade (export competitiveness of sectors) in the near-term?

Background (1)

- More and more carbon pricing policies being enacted globally.
- Concerns about competitiveness and carbon leakage impacts need to be addressed, in order for leader countries to pursue stronger policies.
- Estimation of carbon leakage effect from CGE and partial equilibrium models (e.g. Gerlagh & Kuik 2007, Babiker 2005) -> wide range of results (5-130%)
- Lack of empirical evidence to date.

Background (2)

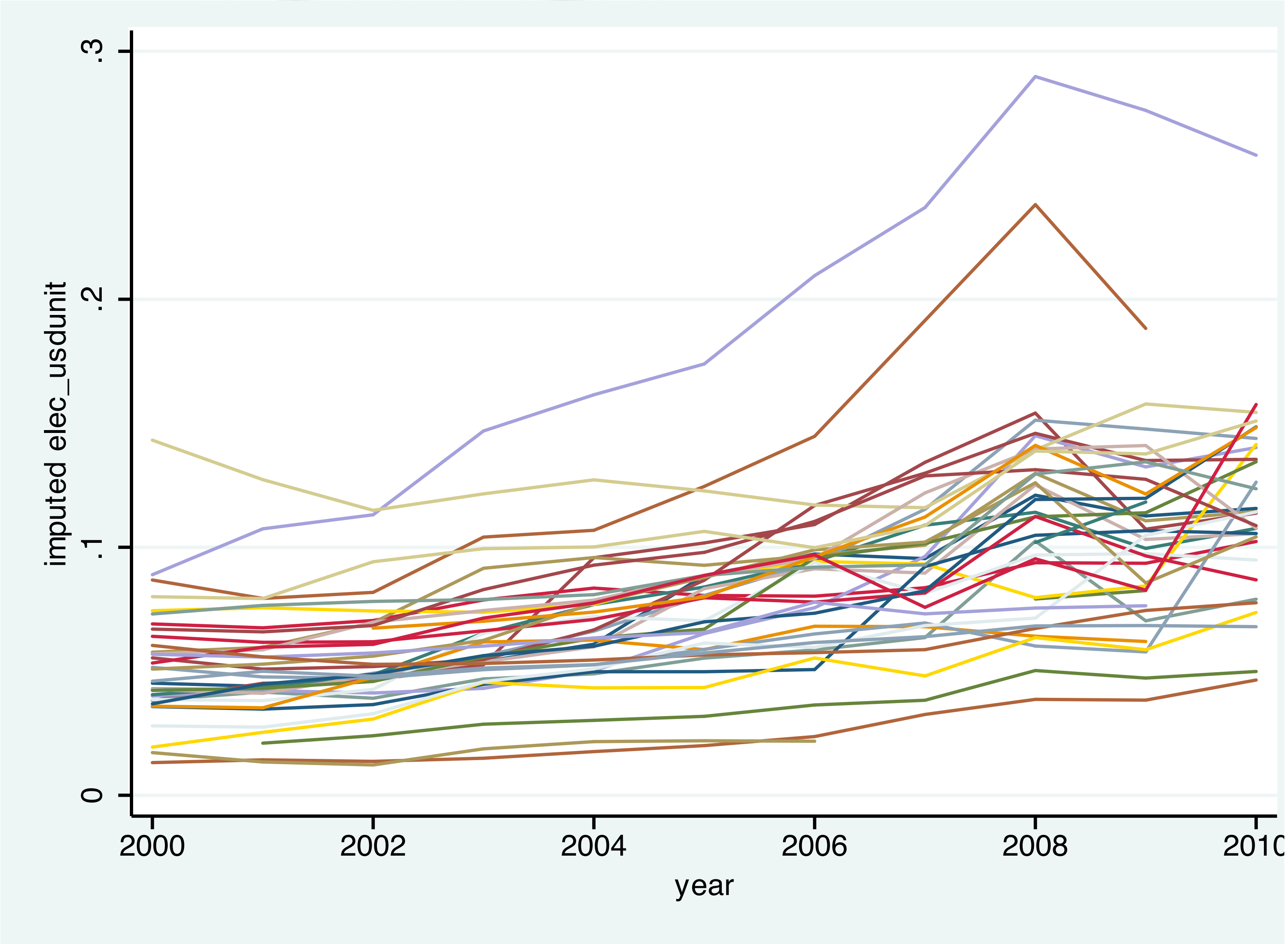
- Well established empirical literature impact of environmental regulation stringency on trade (e.g. Levinson and Taylor 2001, Cole and Elliott 2003).
- Some recent econometric studies on climate policies:
  - Impact of Kyoto Protocol, Achiele and Felbermayr (2010)
  - Industrial energy prices impact on US industry Aldy and Pizer (2011)

Data

- Trade data from UN COMTRADE
  - bilateral trade data (values) for 53 countries including OECD plus major trading partners (2730 pairs of countries), 66 products, 11 years (2000-2011)
- IEA Industrial energy prices and taxes.
  - industrial electricity prices as proxy of carbon prices
  - Electricity price gap

$$epgap_{ijt} = ln(EP_{it}) - ln(EP_{jt})$$

Industrial electricity price variation across sample countries



Model – fixed effect panel

- Basic model

$$lnX^s_{ijt} = \beta_0 + \beta_1 epgap_{ijt} + \beta_2 gdpsum_{ijt} + \beta_3 gdpsim_{ijt} + \beta_4 lrfac_{ijt} + \sum_{p=1}^{n} \lambda_p lnX^s_{ij(t-p)} + \alpha_t + \omega^s_{ij} + \varepsilon_{ijt}$$

- Controls
  - Overall country size $gdpsum_{ijt} = ln(GDP_{it} + GDP_{jt})$
  - Relative country size

$$gdpsim_{ijt} = ln\left[1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)^2\right]$$

  - Difference in factor endowments

$$lrfac_{ijt} = \left| ln\left(\frac{GDP_{it}}{CAPITA_{it}}\right) - ln\left(\frac{GDP_{jt}}{CAPITA_{jt}}\right)\right|$$

Estimation results 1. All sectors

	(1) OLS	(2) Poisson	(3) ppml	(4) Arellano-Bond GMM
Electricity price gap	0.17***	0.13***	0.14***	0.02
	(0.01)	(0.01)	(0.02)	(0.02)
Relative factor endownment	-0.24***	-0.31***	-0.07**	0.06
	(0.03)	(0.03)	(0.02)	(0.05)
GDP total	0.68***	1.44***	0.30***	0.45***
	(0.05)	(0.07)	(0.07)	(0.10)
GDP similarity	1.07***	3.54***	0.50**	0.96*
	(0.24)	(0.32)	(0.19)	(0.46)
trade_ij(t-1)				0.55***
				(0.02)
Country-Pair, sector effects	Yes	Yes	No	Yes
Country-specific effects	No	No	Yes	No
Year effects	Yes	Yes	Yes	Yes
Observation number	741387	724192	741387	318659

Robust Standard errors in parentheses: * p<.05, ** p<.01, ***p<0.001

Model – with sector group interactions

- Interacting sector with electricity price gap

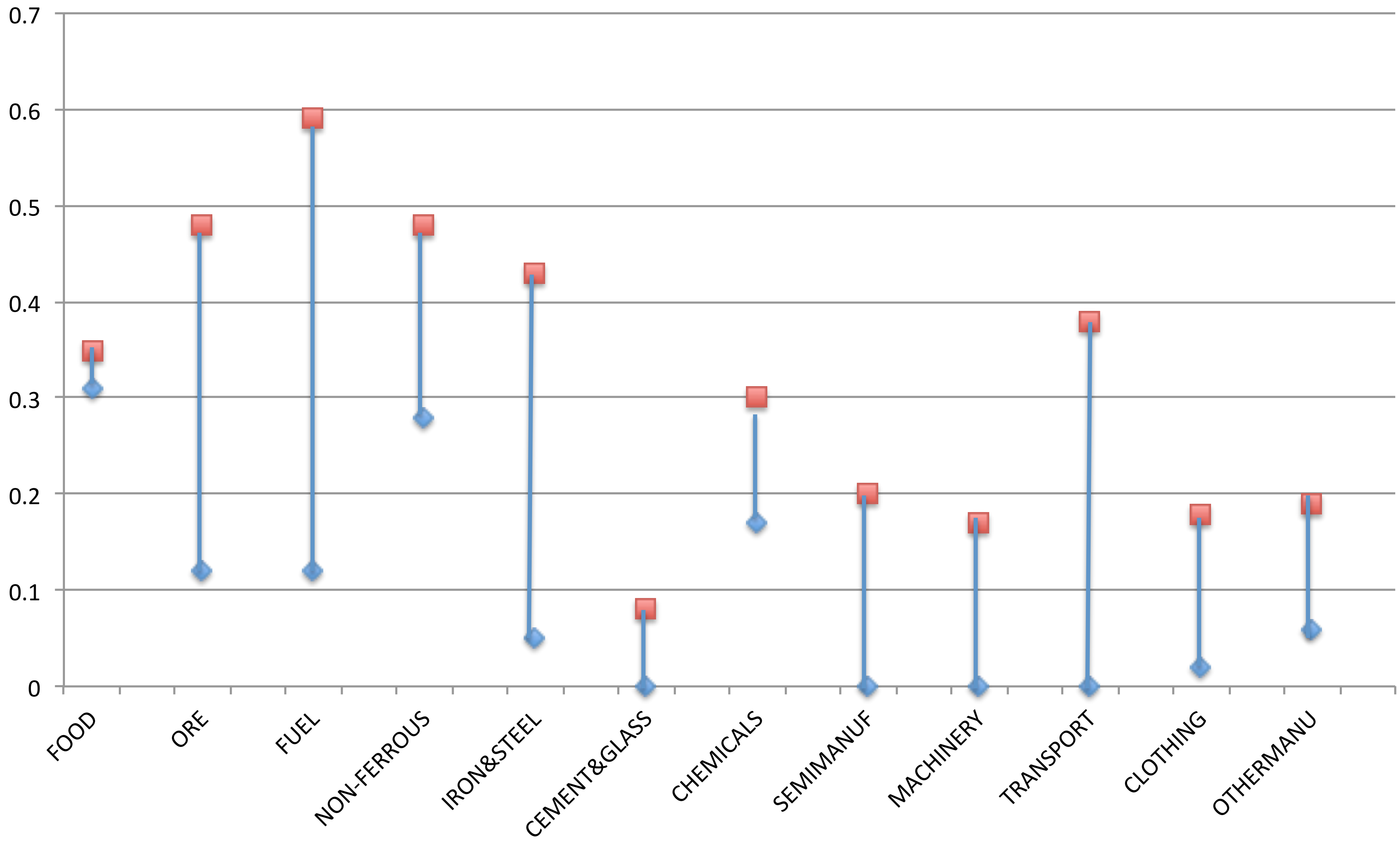
$$
\begin{aligned}
lnX_{ijt}^{s} \quad = \quad & \beta_0 + \beta_1 epgap_{ijt} + \beta_2 gdpsum_{ijt} + \beta_3 lngdpsim_{)ijt} + \beta_4 lrfac_{ijt} + \\
& \phi SGROUP + \sum_{k=1}^{n=12} \gamma_k (SGROUP * epgap_{ijt}) + \\
& \sum_{p=1}^{n} \lambda_p lnX_{ij(t-p)}^{s} + \alpha_t + \omega_{ij}^{s} + \varepsilon_{ijt}
\end{aligned}
$$

- SGROUPS: food; ore; fuel; raw material; non-ferrous metals; iron & steel; cement & glass; chemicals; semi-manufacturing; machinery; transport equipment; other manufacturing

Estimation results 2. Sectors interacted with EPGAP

	(1) OLS	(2) Poisson	(3) ppml	(4) Arellano-Bond GMM
EPGAP*FOOD	0.33***	0.31***	0.35***	0.11
	(0.02)	(0.02)		
EPGAP* ORE	0.12***	0.48***	0.43	0.11
	(0.05)	(0.05)		
EPGAP*FUEL	0.52***	0.59***	0.26	0.12*
	(0.06)	(0.05)		
EPGAP*NON-FERROUS	0.38***	0.28***	0.48*	0.88
	(0.06)	(0.04)		
EPGAP*IRON&STEEL	0.05***	0.43***	0.35	0.17**
	(0.06)	(0.03)		
EPGAP*CEMENT&GLASS	-0.08*	-0.06	0.00***	0.08***
	(0.04)	(0.03)		
EPGAP*CHEMICALS	0.30***	0.26***	0.17***	0.21**
	(0.02)	(0.02)		
EPGAP*SEMIMANUF	-0.00*	-0.05**	0.07***	0.2***
	(0.02)	(0.02)		
EPGAP*MACHINERY	0.17***	-0.07	0.00***	0.05***
	(0.02)	(0.02)		
EPGAP*TRANSPORT	0.38***	0.10***	-0.05***	0.1***
	(0.04)	(0.03)		
EPGAP*CLOTHING	0.10***	-0.01	0.18**	0.02*
	(0.03)	(0.03)		
EPGAP*OTHERMANU	0.19***	0.10***	0.06***	0.15***
	(0.02)	(0.02)		
EPGAP*RAW MATERIAL	-0.20**	-0.03	0.44	-0.11
	(0.02)	(0.03)		
AR(1)				-77.16 (0.00)
AR(2)				0.15 (0.877)
Country-Pair, sector effects	Yes	Yes	Yes	Yes
Country-specific effects	No	No	No	No
Year effects	Yes	Yes	Yes	Yes
N	741387	724192	741387	401828

Semi elasticities by sector group



Robustness checks

- Dropping and including outliers
- Using other energy price series instead of electricity price
- Alternative measures of electricity price gap (pi-pj)/(pi+pj)
- Including importer-time and exporter-time fixed effects
- Alternative measure of the dependent variable – weight of trade, rather than value

Illustration – US exports to Spain

- Between 2001 and 2008
  - Spain's industrial electricity price increased 0.041 to 0.125 $US/ kWh
  - US prices increased from 0.05 to 0.068 $US/ kWh
  - The logged ratio of electricity prices increased from -0.198 to 0.61=0.81%, or roughly 1%.
  - At the same time, US exports increased by 270% in value.
  - Our estimates predict only 0.2%

Comments welcome

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Conclusions

- Semi-elasticities

- Energy price differences have a higher impact on trade for energy intensive sectors.

My PhD
"The role of trade in decarbonising global supply chains"

- Paper 1. Measuring embodied emissions in international trade: A quantitative review of the literature
- Paper 2. Embodied carbon flows in trade: A study drawing on bilateral trade data
- Paper 3. Near-term trade impacts of asymmetric climate change mitigation policies
- Paper 4. (Sector case study)

Final steps

- Over-estimation due to selection issue (20% zeros in dependent variable)
  - Zero inflated models (negative binomial and poisson)
  - But need to control for FE -> computational issues
  - ->Blundell pre sample mean scaling estimator

- Write up!

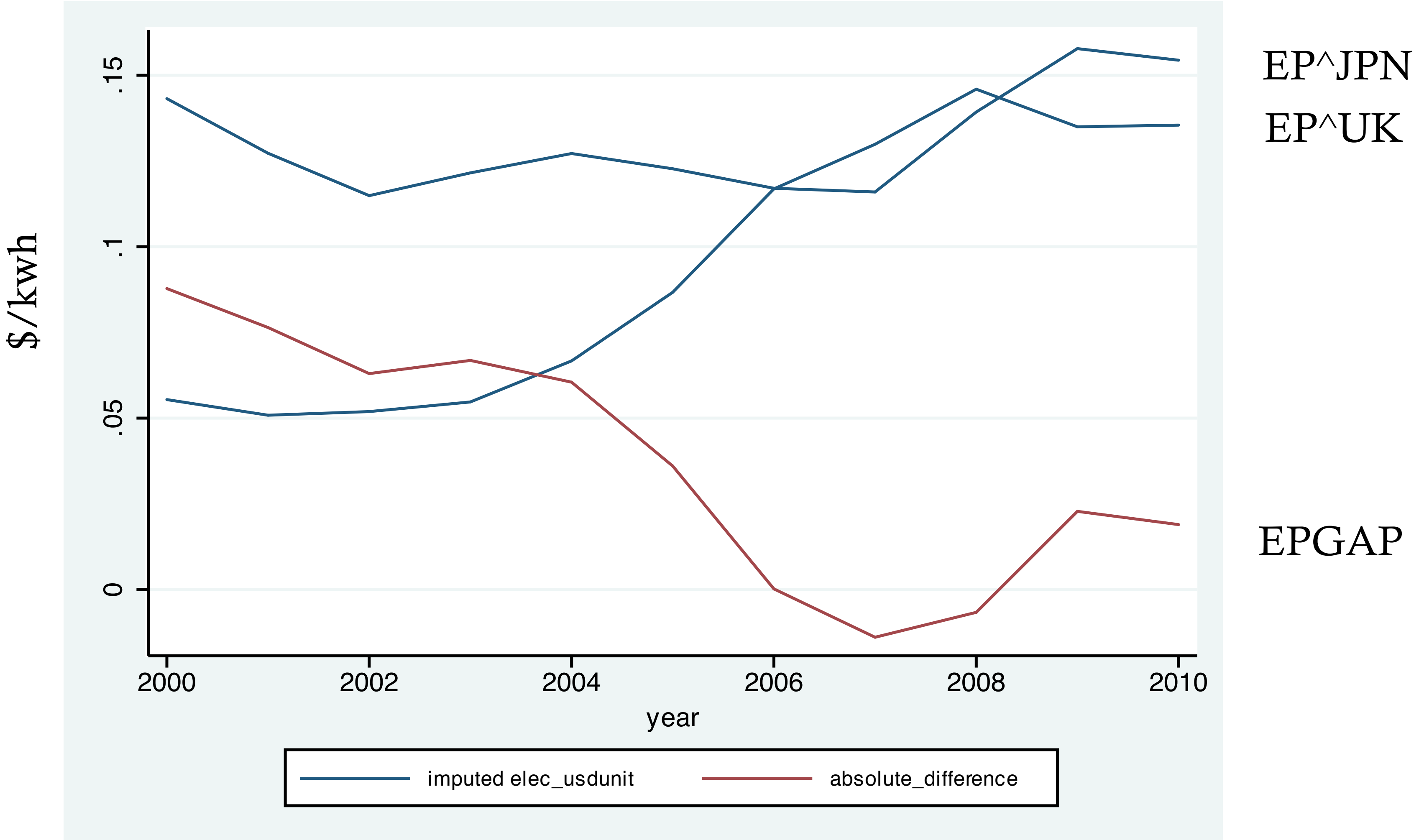
Relevant literature (1)
Empirical literature on near-term trade impacts of asymmetric environmental regulation

- Challenging to evaluate empirically due to:
  - Many factors mitigate/dominate the effect of environmental regulation (e.g. transport costs, labour costs, resource availability, exchange rate risk etc.).
  - Poor indicators of policy stringency
    - Abatement cost (PACE) e.g. Levinson and Taylor (2008), but endogeneity problem.
    - Kyoto protocol (Achiele and Felbermayr 2010)

Relevant literature (2)
Trade impacts of climate policies

- Carbon leakage studies using CGE models (Gerlagh and Kuik 2007, Babiker 2005 etc)
  - A wide range of results (5-130%)
- Partial equilibrium models (e.g. Demailly and Quirion 2008)
  - Steel 10-30% and Cement 5-10% (assuming 20EUR/tCO2)
- Literature has identified a handful of sectors where a high carbon prices could affect them. (Hourcade et al 2008, Oeko 2009)
- Econometric studies:
  - Kyoto Protocol Annex B vs non Annex B. e.g. Achiele and Felbermayr (2010)
  - Industrial energy prices e.g. Aldy and Pizer (2011).

Industrial electricity price gap
In the case of Japan's imports fro UK



Key contributions of this paper

- Empirically analyses carbon leakage effect by using a novel approach - using energy prices to proxy the impact of carbon prices
- Large dataset.
- Estimations by sector.
- Looks at dynamic structure.