Does climate change policy pose a risk to competitiveness? Global firm level evidence

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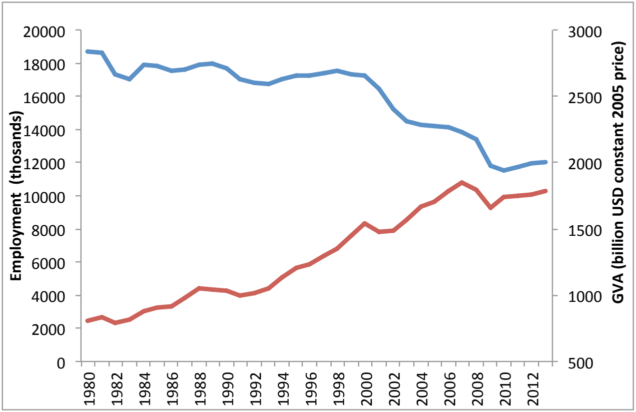
Falling manufacturing employment in OECD countries

- US manufacturing jobs declined 54% from 19million in 1980 to 12million in 2013, while output rose by 55%.



- Similarly manufacturing jobs declined 20% in the UK and 11% in Japan from 2004-2014.

Why is falling manufacturing employment a problem?

- Important implications for the quality of life for the middle class.
- Offers less educated workers relatively well paying jobs (Neal, 1995).
- Attracting and retaining manufacturing jobs is important for vibrancy of local economy (Greenstone et al 2010).

$\rightarrow$ Active research on the role of government regulations and local factor prices in attracting or deflecting manufacturing employment e.g. trade policies, pro/anti union policies and energy or environmental regulations.

Environmental policies & jobs - Theoretical predictions are undetermined

- Theoretical predictions:
  - $\searrow$ employment, Pollution haven effects (Baumol and Oates 1988, Taylor and Copeland 2004)
  - $\nearrow$ employment, Porter hypothesis (Porter 1991)
- Employment effects are structural:
  - Labour substitution between declining (polluting) and expanding (clean) sectors (Brahmbhatt 2014).
  - Net effect depends on the relative labour intensity of polluting and clean industries (Fankhauser and Stern, 2008).

$\rightarrow$ Effect of this substitution on net employment at the economy level is a priori undetermined.

Environmental policies & jobs - Heterogeneous empirical predictions from negative to positive

- Negative effect of CAAAs on manufacturing jobs
  - Kahn (1997) 1980s Amendments → 10% lower growth rates in counties with stringent air pollution regulations
  - Greenstone (2002) 1970s Amendments → loss of 590,000 jobs (3.4% of US manufacturing jobs and 0.5% of total US employment).
  - Walker (2011, 2013) 1990s Amendments → 15% decline in manufacturing employment over 10 years, but not permanent due to migration.
- No effect / positive effect
  - Morgenstern et al (2002) variation in pollution abatement operating costs → No negative effects, some positive.
  - Belova et al. (2013) PACE → no employment effect.
  - Berman and Bui (2001) LA stringent air pollution regulation → No negative effects, some positive.
  - Ferris et al. (2014) SO_2 cap and trade 1990s → Evidence of relocating employees between regulated and unregulated plants.

Energy prices & manufacturing jobs - small negative effects found in national level studies

- Kahn & Mansur (2013) US, sectors. Employment elasticity to energy price ranges from -1.65 (primary metals) to - 0.17, average -0.2.
- Aldy & Pizer (2012) US, sectors. Employment faces about a -0.2 elasticity in the face of higher energy prices.
  - 15USD/tCO2 (8% increase in electricity prices) $\searrow$ employment by 1.6%.
- Dechênes (2012) US, states. -0.16 to -0.10
- Cox et al (2014) Germany, sectors. - 0.069 to -0.06

$\rightarrow$ Current literature estimates suggest an employment-energy price elasticity of around -0.2%.

This paper's contribution

- Does the employment effect hold internationally, where reallocation barriers are higher?
  - We use a *global* firm level dataset, and examine cross-country employment effects from variation in industrial energy prices across 42 countries.
  - More relevant for climate policy.
- What is the most extreme employment response observed to date?
  - Develop the Worst case scenario estimator using genetic algorithm.
  - Move away from obtaining average effects for each sector, and try to assess the most negative impact.
  - Aid policy makers in assessing the expected impacts ambitious climate policies.

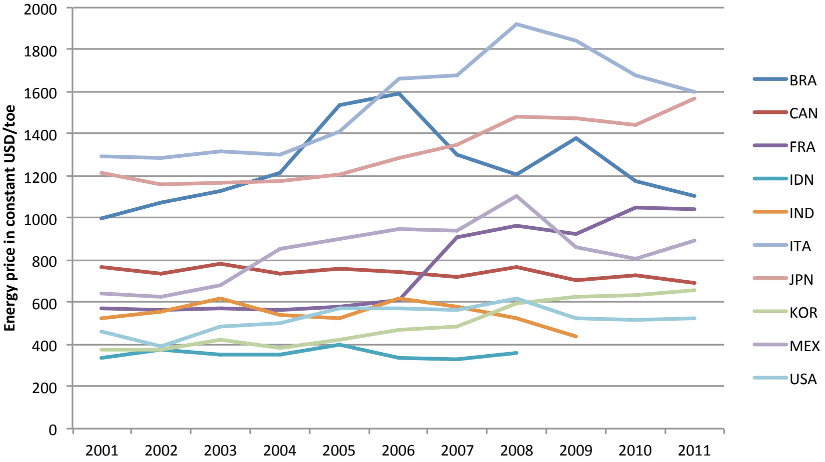
Data

- Firm level employment data and turnover from OBRIS maintained by Bureau Van Dijk
  - 800,000 firms in 42 countries, 1995-2010
  - 8 manufacturing sectors
- Energy prices (including taxes) by sector, country and year data from Sato et al (2015)
  - Fixed-weight energy Price Index (FEPI) constructed by combining:
  - Industrial energy price by fuel type (at the country level) from the IEA Energy End-Use Prices database
  - Fuel use data by sector and country from IEA World Energy Balances

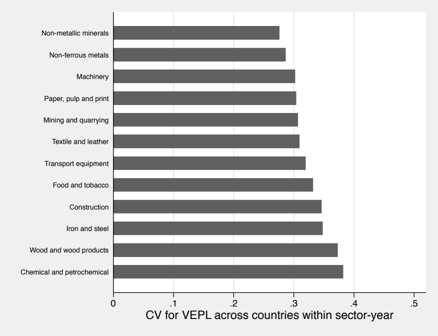
$$FEPI_{ist} = \sum_j \frac{F_{is}^j}{\sum_j F_{is}^j} \cdot log(P_{it}^j) = \sum_j w_{is}^j \cdot log(P_{it}^j) \tag{1}$$

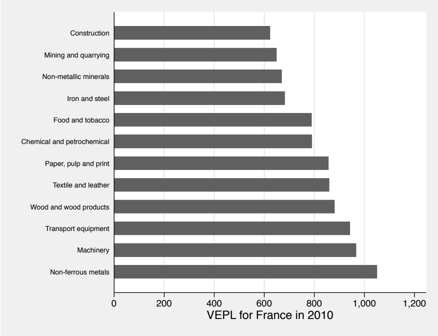
- Other data: Wage data from UNIDO INDSTATS2 and national statistical offices.

Industrial energy prices (including tax) vary across countries (average across sectors) and time



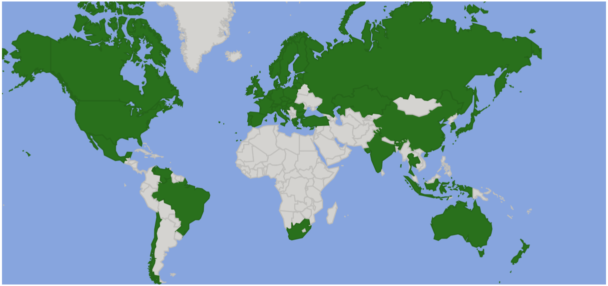
Industrial energy prices (including tax) vary across sectors (global and France)





Coverage

- 42 countries



- 8 NACE 2igit manufacturing sectors:
  17. Paper and paper; 19. Coke and refined petroleum; 20. Chemicals; 21. Pharmaceuticals; 22. Rubber and plastic; 23. Non-metallic minerals; 24. Iron & steel ; 28. Machinery and equipment

Worst Case Scenario Estimator (1)

- Competitiveness impacts occur from *relative* energy prices.
- If prices increased for everyone, there should be no effect
- Estimating equation in differences:

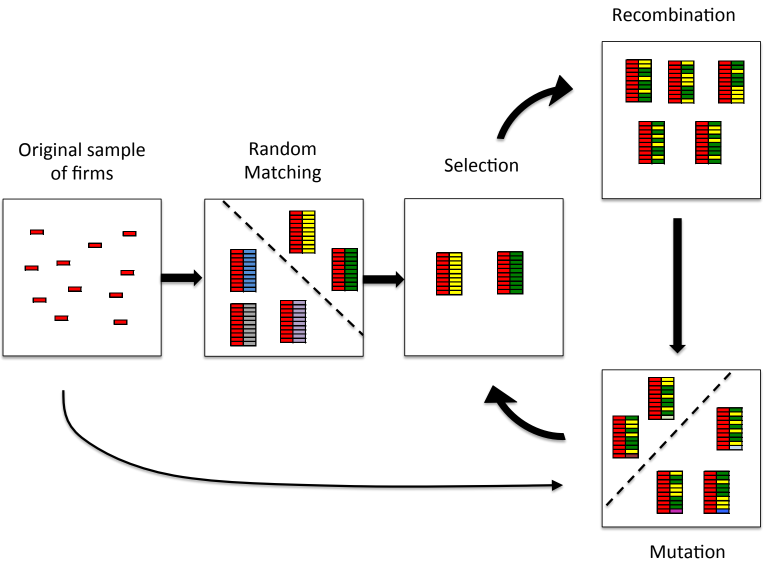
$$y_{it} - y_{j(i)t} = \beta_{ps(i)} \left(p_{it-1} - p_{j(i)t-1} \right) + \beta_{ws(i)} \left(w_{it-1} - w_{j(i)t-1} \right) + \epsilon_{it} - \epsilon_{jt} \quad (2)$$

- Both price and wage coefficients $\beta_{ps(i)}$ and $\beta_{ws(i)}$ vary at the sectoral level s.
- If the *control* firm $j(i)$ is a true competitor, we expect $\beta_{ps(i)}$ to be more pronounced.

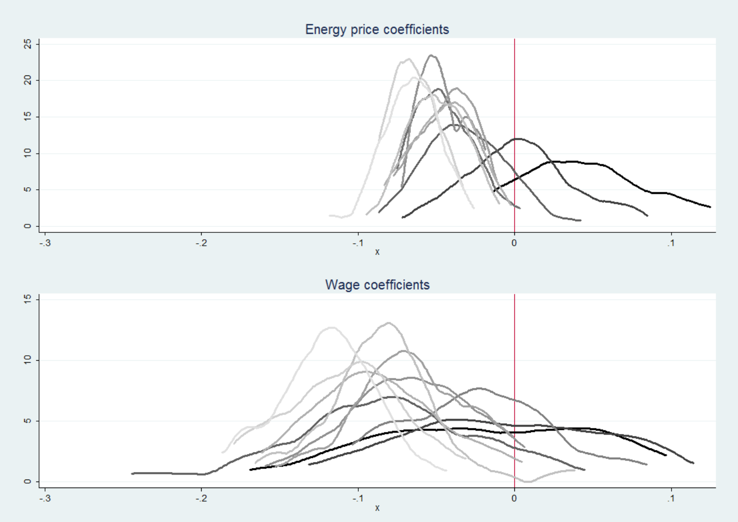
Worst Case Scenario Estimator (2)

- Problem: true competitors are unknown.
- Options1. Consider all possible combinations of firms and pick the "worst" matching for each firm
  $\rightarrow$ Computationally infeasible at usual sample sizes.
- Option 2: Restrict sample to firms more likely to be competing for the same market.
  $\rightarrow$ Little is available to guide our choice of $j(i)$
- Option 3: Randomised search strategy using genetic algorithm.
  $\rightarrow$ The worst case scenario estimator.

Genetic Algorithm to find the true competitor



Results (1) - Worst case scenario in the paper and paper products sector, -0.12 for G=10



Results (2) by sector - Worst case across all sectors smaller than -0.4, most are smaller than -0.2.

		All firms		EU firms		EU vs NON-EU	
NACE	Sector	Mean	Min	Mean	Min	Mean	Min
				G = 1			
17	Paper and paper products	0.034	-0.033	-0.024	-0.096	0.139	0.056
19	Coke and refined petroleum products	0.033	-0.160	0.098	-0.187	0.023	0.170
20	Chemicals and Chemical products	0.068	0.009	0.020	-0.059	0.035	0.045
21	Pharmaceutical	0.047	-0.085	0.046	-0.142	-0.011	0.101
22	Rubber and Plastic	0.085	0.043	0.065	-0.002	0.006	0.069
23	Non-metallic minerals	0.045	-0.015	0.073	-0.013	0.097	0.045
24	Basic Iron and steel	-0.007	-0.101	0.037	-0.074	-0.011	0.042
28	Machinery	0.029	-0.059	0.040	-0.056	0.027	0.069
		G=10		G=9		G=4	
17	Paper and paper products	-0.048	-0.084	-0.047	-0.087	0.077	-0.006
19	Coke and refined petroleum products	-0.274	-0.359	-0.224	-0.326	-0.147	-0.332
20	Chemicals and Chemical products	-0.003	-0.043	-0.052	-0.090	-0.062	-0.103
21	Pharmaceutical	-0.090	-0.135	-0.099	-0.192	-0.097	-0.171
22	Rubber and Plastic	-0.006	-0.051	-0.019	-0.054	-0.141	-0.182
23	Non-metallic minerals	-0.016	-0.044	0.009	-0.037	0.022	-0.038
24	Basic Iron and steel	-0.141	-0.185	-0.060	-0.102	-0.081	-0.139
28	Machinery	-0.032	-0.053	-0.057	-0.093	-0.026	-0.088

Results (3) Subsidiaries of multinational companies are associated with greater employment effects.

		MNE	
NACE	Sector	Mean	Min
		G=1	
17	Paper and paper products	-0.283	-0.519
19	Coke and refined petroleum products	-0.084	-0.340
20	Chemicals and Chemical products	0.190	-0.051
21	Pharmaceutical	-0.255	-0.481
22	Rubber and Plastic	0.061	-0.185
23	Non-metallic minerals	0.033	-0.219
24	Basic Iron and steel	-0.270	-0.951
28	Machinery	0.008	-0.254
		G=31	
17	Paper and paper products	-0.799	-0.947
19	Coke and refined petroleum products	-0.403	-0.542
20	Chemicals and Chemical products	-0.141	-0.262
21	Pharmaceutical	-0.470	-0.610
22	Rubber and Plastic	-0.284	-0.405
23	Non-metallic minerals	-0.240	-0.478
24	Basic Iron and steel	-1.322	-1.811
28	Machinery	-0.299	-0.414

A "Worst case scenario" from a 30EUR/tCO2 price gap between EU steel companies and ROW

- Assume a 30EUR/tCO2 translates to an 15 - 20% increase in energy prices in Europe
- Worst case scenario:
  - Steel sector's most negative energy price elasticity $\approx$ -0.08 (EU vs non-EU)
    $\rightarrow$ -1.6 to -1.2% impact on employment.

Summary and some policy implications

- In all 8 sectors, the energy price elasticity of employment is less than -0.4, and in all but Refining are below -0.2 in the worst case scenario.
- This elasticity is comparable to the *average* effects found in national level studies, suggesting employment effects are smaller across international borders.
- Sectors most at risk are Refining, Iron and steel and Rubber and Plastic.
- More employment response to energy price differences between sister firms.
- These effects tend to be smaller than the impact of relative real wages.
  $\rightarrow$ Impact of increased energy prices might be compensated by decrease in relative wages if the revenues from energy taxation are recycled to lower income tax.

Thank you!

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