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# *Environmental regulation and revealed comparative advantages in Europe*


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# Presentation outline

- Motivations and literature review
- How to measure the stringency of environmental regulation
- Empirical strategy
- Main findings
- Conclusions

# Motivations 1/2

• Environmental quality matters to the world economy. Climate policies major issue in the policy agenda (G8, G20).

• If a "healthier natural environment" is a normal good, demand for it tends to be higher in richer countries ➔ impose more stringent environmental regulations compared to poorer countries (so called *"environmental Kutznets curve" hypothesis*; Copeland and Taylor, 2003).

• Concern: if the cost burden is significant enough it might hurt the international competitiveness of domestic firms operating in more polluting sectors compared to firms located in countries with weaker environmental standards.

# Motivations 2/2

- The relocation of more polluting industries to poorer countries due to gaps in environmental standards is known as the *pollution haven effect*, whereby the scale and the composition of output change across countries (Copeland and Taylor, 2003).

- The existence and the magnitude of such an effect depends on:

(a) whether environmental regulations impose substantial additional costs on polluting industries;

(b) whether, absent other compensative policies, regulation differentials are large enough to impact on industry location, output composition and trade

# Literature review 1/2

- The empirical literature searching for *pollution haven effects* has mainly looked at the effects of environmental regulation on **plant location** and **FDI flows** (Dean et al., 2005 and Zhang and Fu, 2008, for China and, among others, Keller and Levinson, 2002, for the US).

- Results, in particular for the US, point to a weak relationship between plant location decisions, or FDI flows, and environmental regulation.

# Literature review 2/2

- Studies that look at trade flows and changes in comparative advantages find mixed evidence of *pollution haven effects* (Grether and de Melo (2004), for a set of 52 countries; Cole et al. (2005), for the US; Malatau et al. (2004), for Germany, Netherlands and the US; Levinson and Taylor (2008) for US vs. Mexico and Canada).

- In general: results are very sensitive to the choice of countries, to the empirical specification and to the definition of environmental regulation.

# What I do

- I analyze the impact of the environmental regulation on EU-China trade structure: the dependent variable is an index of bilateral RCA.

- I consider 14 EU countries (EU14) and look at whether the changes of their RCAs with respect to China have been affected by environmental regulation in the last decade, when China surged as world's top exporter and EU committed to the most stringent environmental regulation.

# What's new

- It is the first attempt to relate the bilateral trade between several EU countries and China to environmental regulation
- I suggest a new strategy to look at the relationship between trade and environmental regulation to overcome the endogeneity problems associated with the available measures of environmental regulation, such as pollution abatement and control expenditures (PACE).

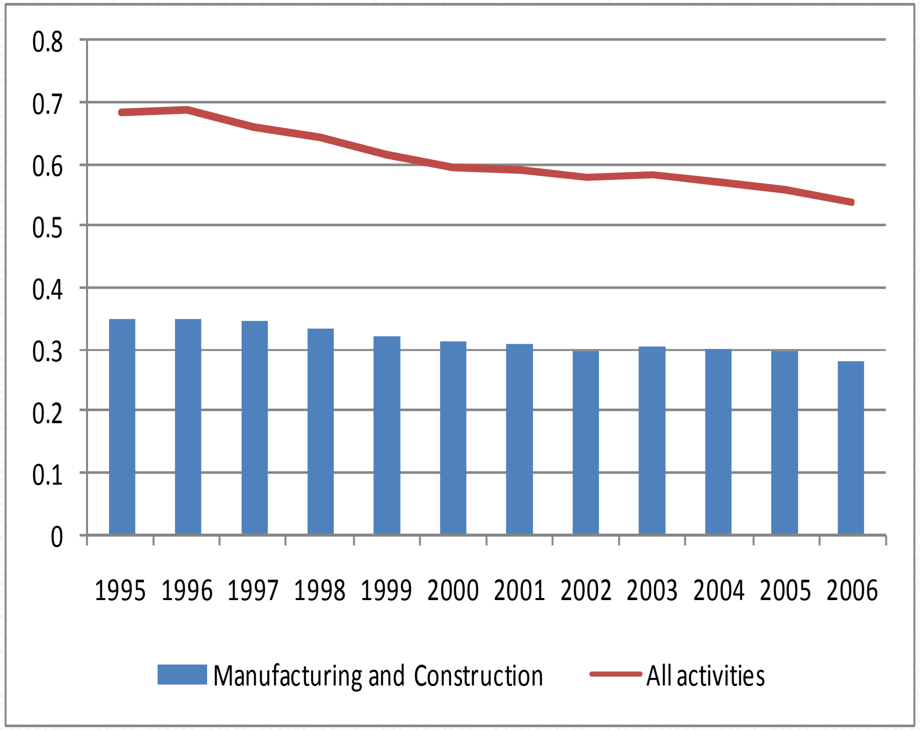
# Main results

- On average the EU countries considered have kept or improved their comparative advantages with respect to China in both water-polluting industries (such as paper and agro-based industries) and air-polluting industries (such as basic metals and chemicals);

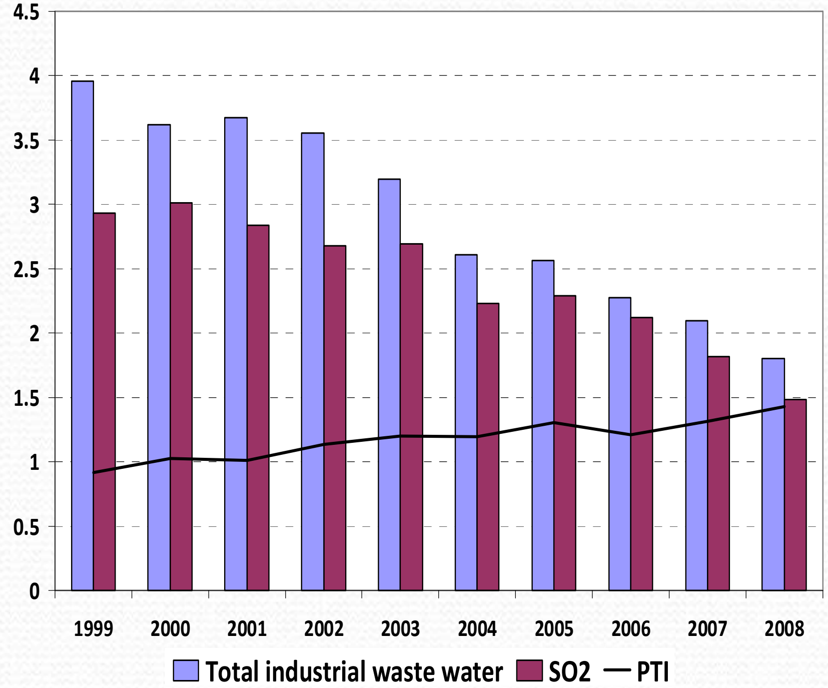
- On average our EU14 countries have lost competitiveness in cleaner and more internationally-mobile industries (such as communication equipment and office and computing machinery), presumably in response to unfavourable unit-labour-cost differentials and higher capital accumulation in China.

# Pollution in Europe and China

**EU15: Green house gas emission intensity**




**China: Investment in pollution treatment (% of GDP); Waste water discharges and SO2 intensities in industry**



# How to measure the stringency of environmental regulation 1/2

- Stringency of environmental regulation should be reflected into pollution abatement and control (PAC) costs. We would like to observe such costs (expenditures or investments) by industries, countries and time.

- Unfortunately such information is not available for a sufficient number of countries and time length; comparison among countries for which data are available must be taken with great caution, definitions differ from country to country (Pasurka 2008).

# How to measure the stringency of environmental regulation 2/2

- Available data (OECD and Euro Stat) on PAC expenditures refers to macro-industrial branches, therefore they are endogenous to output mix changes within the branch (Levinson and Taylor, 2008).

- If we could observe in each country polluting emissions per unit of output by highly disaggregated industrial sectors over time, we could evaluate the effectiveness of environmental regulation. Unfortunately there are no time series of emissions per unit of output by disaggregated industrial sectors and by country readily available.

# A possible solution to overcome data shortages

- We have emissions per unit of output for 18 manufacturing branches in China (water polluting emissions (COD) and air polluting emissions($SO_2$)) and in some EU countries (GWP per unit of output) (table)

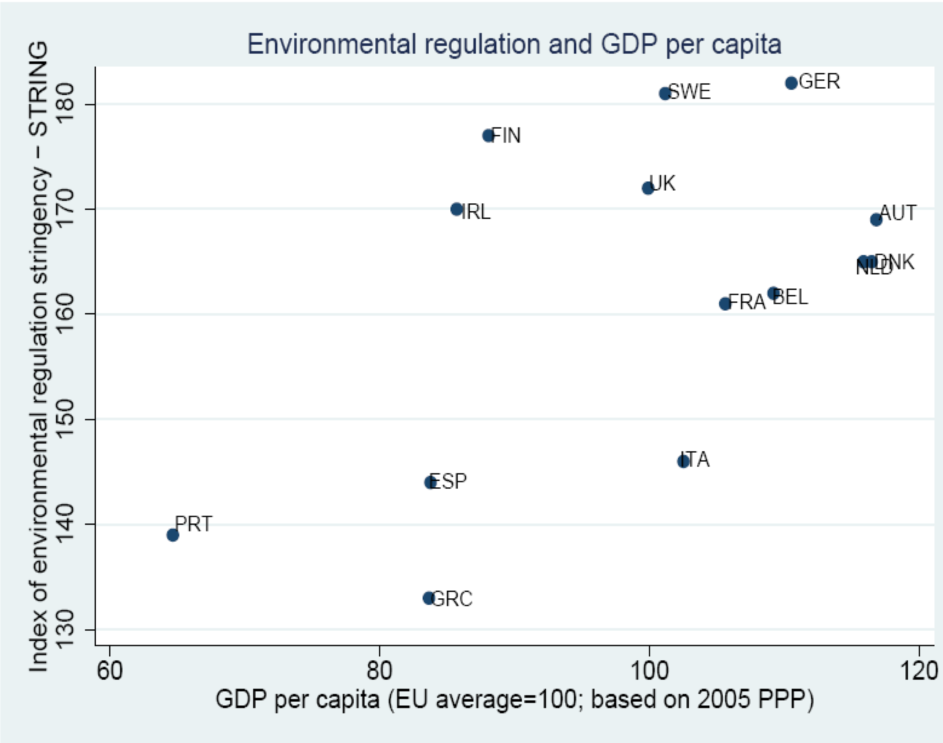
- We have Proxies of ennvironmental regulation for 14 EU countries (Eliste and Fredricson index (STRING); index GDP per capita (GDPPC) and index of Green House Gas Emissions per unit of output (GHGE); figure)

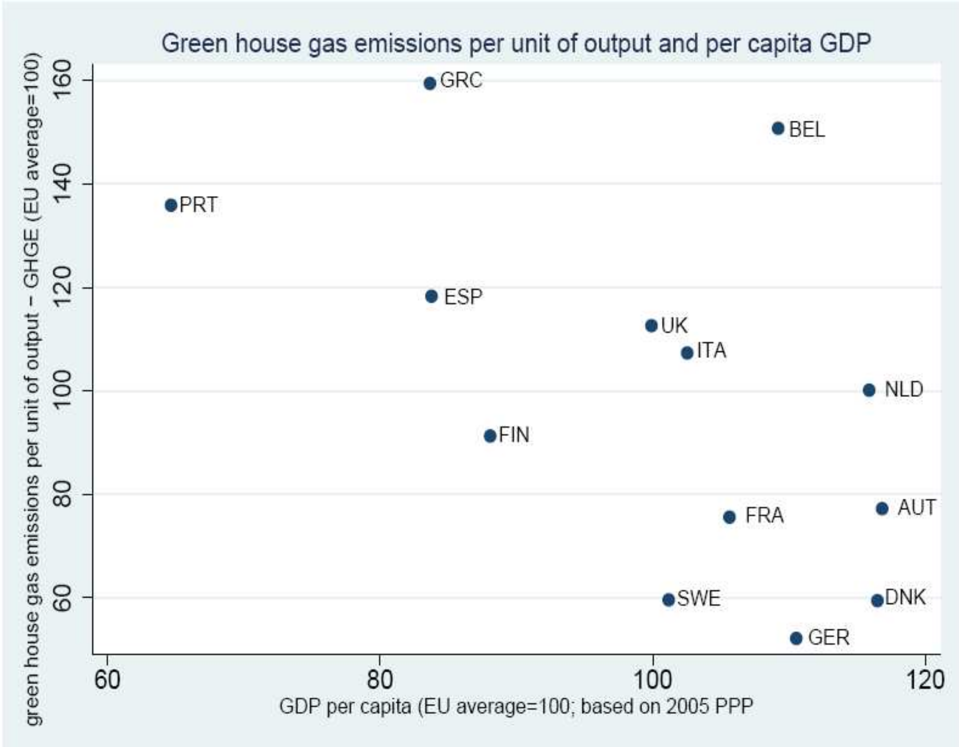
- We can use all the available *industry* and *country* information to get a variable that varies by industry and country (Rajan and Zingales (1998)): interact pollution intensities by industry with proxies of environmental stringency by country.

# COD, SO2 and GWP emissions per unit of output and RCA changes by industry (back)

| Sectors | (1) COD emissions per unit of output in China (2004) | (2) SO2 emissions per unit of output in China (2004) | (3) GWP emissions per unit of output in Italy (2000) | (4) COD rank | (5) SO2 rank | (6) GWP rank | (7) EU14 Average RCA changes (1996-2006) |
|---|---|---|---|---|---|---|---|
| **Resource-based (RB) industries** | | | | | | | |
| Coke and Petroleum | 0.08 | 0.85 | 5.11 | 10 | 6 | 3 | -0.01 |
| Pulp, paper, paper products, printing and publishing | 5.21 | 1.41 | 1.46 | 1 | 2 | 5 | 0.01 |
| Food products, beverages and tobacco | 1.16 | 0.44 | 0.34 | 2 | 8 | 8 | 0.16 |
| Wood | 0.92 | 1.15 | 0.33 | 3 | 4 | 9 | -0.15 |
| **Non-resource-based (NRB) industries** | | | | | | | |
| Non-metallic minerals | 0.14 | 4.26 | 9.76 | 6 | 1 | 1 | -0.18 |
| Basic metals | 0.12 | 1.26 | 5.96 | 7 | 3 | 2 | 0.99 |
| Chemicals | 0.67 | 1.13 | 1.80 | 4 | 5 | 4 | 0.39 |
| Rubber and Plastics | 0.10 | 0.26 | 0.49 | 9 | 11 | 6 | 0.55 |
| Motor vehicles | 0.06 | 0.06 | 0.44 | 12 | 15 | 7 | 1.58 |
| Textiles, textile products, leather and footwear | 0.66 | 0.54 | 0.31 | 5 | 7 | 10 | 2.05 |
| Fabricated metals | 0.08 | 0.32 | 0.30 | 11 | 9 | 11 | -0.19 |
| Machinery | 0.05 | 0.18 | 0.23 | 14 | 12 | 12 | -0.02 |
| Transport equipment | 0.06 | 0.06 | 0.22 | 13 | 16 | 13 | -0.42 |
| Furniture and Other Mfg. | 0.12 | 0.28 | 0.20 | 8 | 10 | 14 | 1.10 |
| Medical, Precision and Optical Instruments | 0.05 | 0.08 | 0.19 | 15 | 14 | 15 | 1.01 |
| Electrical Machinery | 0.02 | 0.16 | 0.16 | 18 | 13 | 16 | 0.62 |
| Communications Equipment | 0.03 | 0.03 | 0.16 | 17 | 18 | 17 | -5.10 |
| Office and Computing Machinery | 0.03 | 0.03 | 0.06 | 16 | 17 | 18 | -2.40 |

# Proxies of environmental regulation in Europe (back)



# Regressions

$$\Delta RCA_{ij(2006-1999)} = \alpha_j + \alpha_i + \beta_1 RVASH_{ij(1995)} + \beta_2 ULC_{ij(1995)} + \beta_3 SO2_j * string_i + \beta_4 COD_j * string_i + \varepsilon_{ij}.$$

$$\Delta RCA_{ij(2006-1999)} = \alpha_j + \alpha_i + \beta_1 RVASH_{ij(1995)} + \beta_2 ULC_{ij(1995)} + \beta_3 GWP_j * string_i + \varepsilon_{ij}$$

$\beta_1<0$ (>0); $\beta_2<0$;
$\beta_3$ and $\beta_4<0$ : more stringent environmental regulations worsen RCAs with respect to China in polluting industries (the sign should be positive when the stringency variable is proxied by GHGE).

$$RCA_{ij} = \left[ \frac{X_{ij} - M_{ij}}{X_{ij} + M_{ij}} - \frac{\sum_{j=1}^{18} X_{ij} - \sum_{j=1}^{18} M_{ij}}{\sum_{j=1}^{18} X_{ij} + \sum_{j=1}^{18} M_{ij}} \right] * \frac{X_{ij} + M_{ij}}{\sum_{j=1}^{18} X_{ij} + \sum_{j=1}^{18} M_{ij}} * 100$$

# Data source

- Trade data, classified by 2-digit NACE-ISIC rev. 3 nomenclature, are from the OCSE-STAN Bilateral Trade database.
- Data on value added and labour compensations are from the EUKLEMS database, classified by 2-digit NACE –ISIC rev.3 nomenclature.
- Data on $SO_{2j}$ and $COD_j$ emissions (kilos per thousand of 1995 Yuan in 2004), classified by 2-digit ISIC rev.3 nomenclature, are from Dean and Lovely (2008).
- Industry-level data on "Global warming potential" are from Moll et al (2007). The variable *STRING* is from Eliste and Fredricson (2002). Greenhouse gas emissions in manufacturing and construction and value added for EU14 are from Euro Stat. Per capita GDP at 1995 prices and 2005 purchasing power parities are from the World Bank.

$$(2)\ \Delta RCA^{C}_{ij(2006-1999)} = \alpha_j + \alpha_i + \beta_1 RVASH_{ij(1995)} + \beta_2 ULC_{ij(1995)} + \beta_3 SO2_j * string_i + \beta_4 COD_j * string_i + \varepsilon_{ij}$$

| **Variable** | (1) STRING | | (2) PCGDP | | (3) GHGE | |
|---|---|---|---|---|---|---|
| $RVASH_{ij(1995)}$ | -1.18*** | | -1.21*** | | -0.74** | |
| $ULC_{ij(1995)}$ | -4.34* | | -4.41* | | -3.94* | |
| $SO2_j * string_i$ | 1.58* | | 1.04 | | -0.77** | |
| $COD_j * string_i$ | 0.69 | | -0.1 | | -0.23 | |
| **R-squared** | 0.25 | | 0.24 | | 0.27 | |
| $RVASH_{ij(1995)} * RB$ | -0.88 | -1.12* | -0.92 | -0.99* | -1.04* | -1.24** |
| $RVASH_{ij(1995)} * NRB$ | -1.23** | -1.27*** | -1.31*** | -1.32*** | -0.24 | -0.16 |
| $ULC_{ij(1995)} * RB$ | -1.63* | -1.60* | -1.39 | -1.38* | -1.61 | -1.36 |
| $ULC_{ij(1995)} * NRB$ | -6.16** | -6.03** | -6.40** | -6.54** | -5.61** | -5.44** |
| $(SO2_j * string_i) * RB$ | 0.70 | | -1.95 | | -0.46 | |
| $(SO2_j * string_i) * NRB$ | 1.62* | | 1.04 | | -0.89*** | |
| $(COD_j * string_i) * RB$ | | 0.92 | | -0.12 | | -0.42 |
| $(COD_j * string_i) * NRB$ | | 27.19*** | | 25.38*** | | -12.93*** |
| **Adj R-squared** | 0.26 | 0.30 | 0.26 | 0.29 | 0.29 | 0.34 |
| **Observations** | 248 | 248 | 248 | 248 | 231 | 231 |

$$(3)\,\Delta RCA^{C}_{ij(2006-1999)} = \alpha_j + \alpha_i + \beta_1 RVASH_{ij(1995)} + \beta_2 ULC_{ij(1995)} + \beta_3 GWP_j * string_i + \varepsilon_{ij}$$

| **Variable** | (1) STRING | (2) PCGDP | (3) GHGE |
|---|---|---|---|
| $RVASH_{ij(1995)}$ | -1.18*** | -1.22*** | -0.75** |
| $ULC_{ij(1995)}$ | -4.37** | -4.45** | -4.07* |
| $GWP_j * string_i$ | 4.47* | 3.31 | -2.23** |
| **R-squared** | 0.24 | 0.24 | 0.27 |
| $RVASH_{ij(1995)} * RB$ | -0.93 | -0.87 | -1.10* |
| $RVASH_{ij(1995)} * NRB$ | -1.27*** | -1.31*** | -0.32 |
| $ULC_{ij(1995)} * RB$ | -1.50* | -1.26 | -1.22 |
| $ULC_{ij(1995)} * NRB$ | -6.27** | -6.36** | -5.78** |
| $(GWP_j * string_i) * RB$ | -6.03 | -9.04 | 2.78 |
| $(GWP_j * string_i) * NRB$ | 5.39** | 3.44 | -2.70*** |
| **Adj R-squared** | 0.26 | 0.25 | 0.29 |
| **Observations** | 248 | 248 | 231 |

# Conclusion 1/2

- Controlling for unit labour costs, endowment-convergence effects and the degree of international mobility, there is no evidence that environmental regulation in Europe has negatively affected the structure of bilateral trade with China in a predictable way.

- Indeed EU14 seem to have kept or improved comparative advantages in most polluting industries and lost competitiveness in more clean and mobile industries.

- This conclusion holds true when different definitions of pollution-intensity and environmental regulation are considered.

# Conclusion 2/2

- For the more mobile industries traditional factors still play a dominant role in shaping international competitiveness of European industries.

- Such results may reflect, on the one hand, the fact that the additional costs eventually imposed by environmental regulation in Europe are compensated by the savings due to higher energy and eco-efficiency standards (Vollebergh, 2007, and Moll et al., 2007), and, on the other hand, the fact that environmental regulation in China might have become more stringent. Our findings seem in line with those recently reported by the OECD/IEA (2008).

THANK YOU
FOR
YOUR ATTENTION