Examining the Effect of International Trade on the Environment Within and Across Sectors: Theory and Evidence

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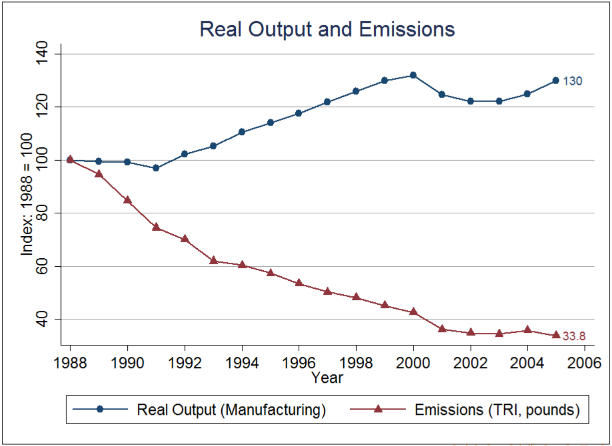
Sources of Pollution Variation

Research Question:

What role do changing trade regulations play in determining environmental outcomes?



Recent Inquiry

- **Trade Policy: Across Sector**: Lower trade barriers induce environmental effects according to comparative advantage
    - Antweiler, Copeland, and Taylor (AER, 2001) lay out and estimate a cross-country Hecksher-Ohlin (2x2x2) model
    - Comparative advantage in dirty production can be off-set by strong environmental policy response
- **Trade Policy: Within Sector**: Lower trade barriers induce productivity gains (within sectors) that lower per-unit emissions
    - Holladay (Forthcoming, 2015); Kreikemeier and Richter (RIE, 2013); Cui et. al. (2012)
- **Environmental Policy:** Strong environmental policy response has caused the cleanup
    - Shapiro and Walker (2015)

Current Contribution

- Related work (LaPlue 2015) established that emissions do vary significantly both within and across sectors (69% and 23%, respectively) and developed a theoretical framework combining:
  - Cross-sector Comparative Advantage
  - Within-sector productivity gains
  - Endogenous response to environmental policy
- The current paper extends the theoretical framework and predictions to the data to answer:
  - Does US manufacturing data support the theoretical framework?
  - How does trade liberalization affect our environment within and across sectors?
    - Do these channels conflict? And, if so, which dominates?

Basic Results from Theory

- **Across Sector:** lower trade barriers will induce increases in emissions demand when country holds a comparative advantage (CA) in capital intense, dirty production
  - This can be counteracted by increased environmental stringency
- **Within Sector:** lower trade barriers induce endogenous productivity gains in each sector that reduce emissions intensity and emissions demand
- **Combined:** Under costly trade, CA and trade-induced productivity gains interact to effect national emissions (and should not be treated separately)
  - Productivity gains and corresponding reductions in emission intensity are, alone, unlikely to outweigh a country's CA

From Theoretical Framework to Estimating Equation

- Equilibrium aggregate emissions demand, from profit maximization:

$$Z_s = Q_s \times \left(\frac{\left(\frac{\nu_s}{t_s}\frac{\alpha_s}{1-\alpha_s}\right)^{\sigma(1-\alpha_s)-1} \cdot \left(\left(\frac{L_s}{K_s}\frac{\beta_s}{1-\beta_s}\right)^{\beta_s}\right)^{\sigma(1-\alpha_s)}}{\left(\zeta_s \cdot \left(\left(\frac{L_s}{K_s}\frac{\beta_s}{1-\beta_s}\right)\cdot \bar{K} - \bar{L}\right)\right)} \right)^{\frac{1}{\sigma-1}} \times \frac{(f_s + \chi_s f_{sx})^{\frac{1}{\sigma-1}}\frac{c\cdot\sigma}{\gamma}}{\tilde{\varphi}_s} \times \psi_s$$

- Translates into the following log-linear specification:

$$\ln(Z_s) \approx \beta_0 + \beta_1 \ln(Q_s) + \beta_2 \ln(t_s) + \beta_3 \ln\left(\frac{L_s}{K_s}\right) + \beta_4 \ln(\chi_s) + \beta_5 \ln(\tilde{\varphi}_s) + \beta_6 \ln(\psi_s)$$

where $\psi_1 \equiv \left[1 + \frac{\chi_1^F M_1^F \tau_1^{1-\sigma} \cdot \left(p_1^F(\tilde{\varphi}_{1x}^F)\right)^{1-\sigma}}{M_1^H \left(p_1^H(\tilde{\varphi}_1^H)\right)^{1-\sigma}}\right]^{1/(1-\sigma)}$

The Data: 1990 - 2005

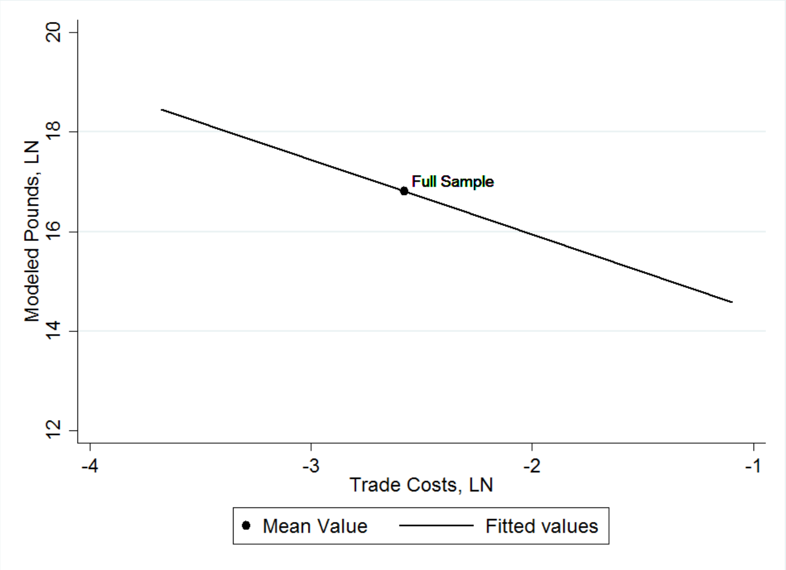
- Emissions (pounds)
  - EPA / RSEI (plant level)
- Capital, Labor, Real Output, TFP
  - US Census / NBER (Becker et. al. 2013)
- Trade costs, imports, exports
  - (Schott 2008, update)
- Environmental costs (Measure 1: share of plant level output in a sector subject to "Non-Attainment" regulations) and industry share of firms exporting
  - Merged: NETS sample (provided by Dun and Bradstreet) and EPA non-attainment records

Results

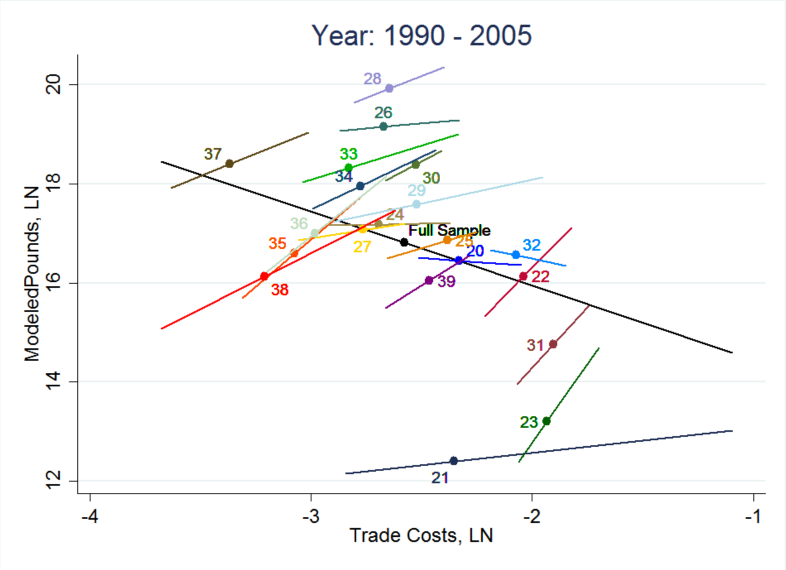
	(1)	(2)
Real Output, LN	0.58***	0.50***
	(0.10)	(0.05)
KL-Ratio, LN	1.90***	1.34***
	(0.18)	(0.12)
Trade Costs, LN	-0.41***	0.30***
	(0.12)	(0.08)
Non-Attainment Share, LN	-0.51***	-0.39***
	(0.15)	(0.10)
χ (Export Share, LN)	1.11***	0.92***
	(0.13)	(0.15)
TFP, LN	-1.55***	-0.81***
	(0.17)	(0.13)
Constant	12.61***	11.03***
	(0.96)	(0.60)
Observations	5,462	5,462
R^2	0.40	0.64
SIC2 FE	NO	YES
Year FE	YES	YES

Dependent Variable: Modeled Pounds, LN | | Robust standard errors in parentheses | | *** p<0.01, ** p<0.05, * p<0.1

Trade Costs and Emissions



Within vs Across



Results 2 (Trade Interaction)

	(1)	(2)
Real Output, LN	1.10***	0.86***
KL-Ratio (K/L), LN	-0.42*	0.59***
Trade Costs, LN	-0.79***	0.13
Non-Attainment Share (Non), LN	1.53***	0.87***
χ (Export Share), LN	1.34***	0.98***
TFP, LN	4.21***	1.76
Trade#(K/L)	-1.02***	-0.55***
Trade#(K/L)^2	-0.21***	-0.15***
Trade#Non	0.58***	0.47***
Trade#Non^2	0.02	0.03*
Trade#TFP	2.11***	1.19***
Trade#TFP^2	1.51***	0.99***
Trade#(K/L)#Non	-0.0381	-0.02
Trade#(K/L)#TFP	0.55***	0.48***
Trade#Non#TFP	-0.09	-0.12
Observations	5,430	5,430
R^2	0.451	0.633
SIC2 FE	NO	YES
Year FE	YES	YES

Dependent Variable: Modeled Pounds, LN | | Robust standard errors in parentheses | | *** p<0.01, ** p<0.05, * p<0.1

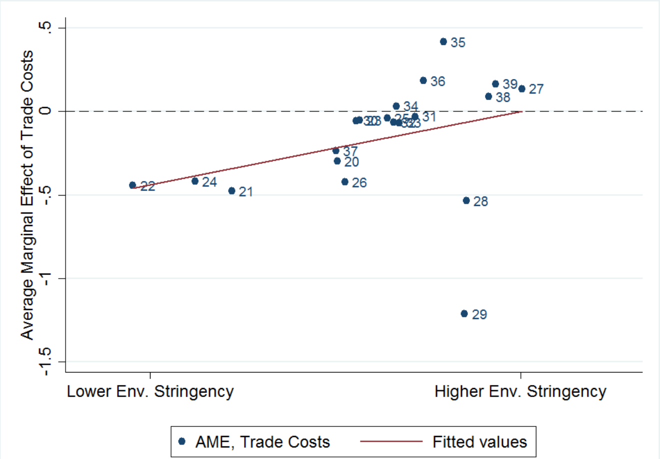
Results 2 – Marginal Effects

	(1)	(2)
Real Output,LN	1.10***	0.86***
	(0.05)	(0.04)
KL-Ratio,LN	0.63***	0.78***
	(0.09)	(0.09)
Trade Costs,LN	-0.17*	0.27***
	(0.10)	(0.10)
Non-Attainment Share	-0.31*	-0.50***
	(0.17)	(0.13)
χ (Export Share),LN	1.34***	0.98***
	(0.12)	(0.14)
TFP,LN	-0.0412	-0.0691
	(0.12)	(0.14)
Observations	5,430	5,430
SIC2 FE	NO	YES
Year FE	YES	YES

Dependent Variable: Modeled Pounds, LN | | Robust standard errors in parentheses | | *** p<0.01, ** p<0.05, * p<0.1

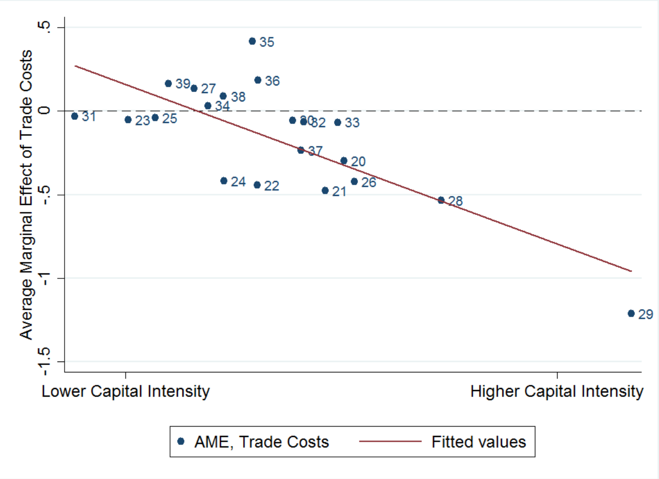
Trade Liberalization and Environmental Stringency

- Theory: Trade liberalization lowers emissions more (or raises emissions less) in sectors facing more stringent environmental regulation.



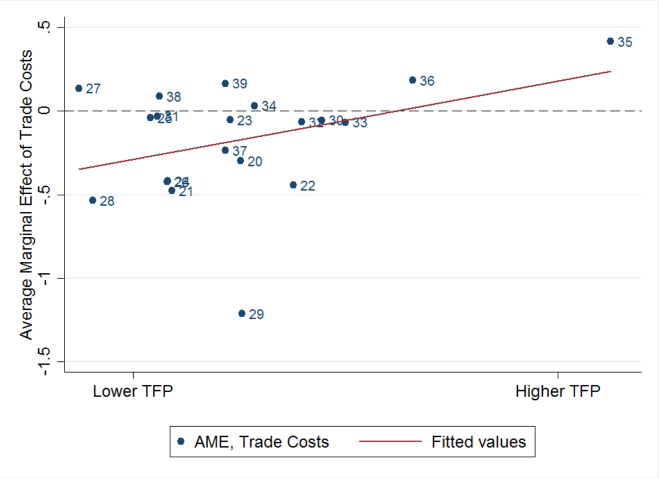
Trade Liberalization and Capital Intensity

- Theory: Trade liberalization raises emissions more (or lowers emissions less) in capital-intense sectors.



Trade Liberalization and Productivity

- Theory: Trade liberalization lowers emissions more (or raises emissions less) in sectors with higher productivity.



Conclusion: Insights from Combined Framework

1. Cross-Sector Comparative Advantage and Within-Sector Reallocation interact in important ways to determine aggregate environmental outcomes.
   - Implication: future work in this area must take this interaction into consideration when evaluating (or designing) policy
2. In the case of US manufacturing, recent, simultaneous, changes to *both* trade and environmental policy have been instrumental in driving observed emissions outcomes.

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Thank You

Policy Remarks: Trade vs. Environmental Policy

- Across Sectors

	β	s.d.	Standardized Effect
Trade	-0.17	0.75	-0.13
Environmental Policy	-0.31	0.49	**-0.15**

- Within Sectors

	β	s.d.	Standardized Effect
Trade	0.27	0.75	0.21
Environmental Policy	-0.50	0.49	**-0.25**

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Trade	0.27	0.75	0.21
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TFP of Omitted Sectors: 3571 (Computers) and 3674 (Semi-Conductors)

Results