Environmental Regulation and Competitiveness:

Evidence from Trade and Production in the Manufacturing Sector

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Overview

- The negative impact of trade liberalization on the environment has been debated since the early 1970s.
- The the pollution haven hypothesis (PHH) conjectures that polluting production would relocate from countries with stricter environmental regulations to the countries with laxer environmental regulations when trade barriers fall.
- Our work studies the PHH in the framework of international trade theory, i.e. whether environmental stringency could be one of the determinants to the comparative advantage of pollution-intensive production and reflected in trade flows and production data.
- Antweiler et al. (2001) and Copeland and Taylor (2003) present a unified framework where the comparative advantage arguments of the standard H-O models and PHH are nested.
- Another characteristic of our study is to examine the relation between the competitiveness and innovative ability in environment-related technology.

Data & Model

- **Variable Definition and Basic Statistics**

Variable	Definition	Mean	Std. Dev.	Min	Max
EXPO	the share of export value of most polluting industries in total manufacturing sector	.3925809	.2040125	.068757	.983137
IMPO	the share of import value of most polluting industries in total manufacturing sector	.3155105	.0616035	.184484	.5427012
KL	national capital-labor ratio (thousand USD per labor)	4.094973	4.046694	.1444192	22.41048
I	one period lag GDP per ca. (thousand USD per ca)	7.823799	8.435482	.2244799	41.96765
INNOV	accumulated patent stock of environment-related technologies with 5% obsolescence rate divided by GDP. (stock per hundred million USD)	.0409288	.0701496	0	.3886603
O	total import and export / GDP (%)	50.53803	27.37972	12.34638	217.5709
RKL	national capital-labor ratio / world average	1.726891	1.593264	.0637095	7.872415
RI	one period lag GDP per ca. / world average	1.473513	1.444486	.0428457	5.883289
RINNOV	INNOV / world average	.9772369	1.568904	0	7.07915

- **Summary of pollution intensity classification by sector**

Summary of pollution intensity classification by sector

	Category 1 Most Polluting Sector	Category 2 Moderately Polluting Sector	Category 1 Least Polluting Sector
Definition	ToxTot>= 1500 pnds/USD million	500 pnds/ USD million <ToxTot<= 1500 pnds/USD million	ToxTot<= 500 pnds/USD million
Sectors (ISIC)	industrial chemicals (351) non-ferrous metals (372) iron and steel (371) leather products (323) pulp and paper (341) petroleum refineries (353) other chemicals (352) plastic products (356) fabricated metal products (381) furniture, except metal (332)	pottery, china, earthenware (361) electrical machinery (383) rubber products (355) other non-metallic mineral products (369) textiles (321) transport equipment (384) other manufactured products (390) misc. petroleum and coal products (354) non-electrical machinery (382)	professional and scientific equipment(385) footwear, except rubber or plastic(324) printing and publishing (342) wood products, except furniture (331) glass and products (362) tobacco (314) food products (311) beverages (313) wearing apparel, except footwear (322)

Empirical Results

Two-way error component regression model for impacts on the most polluting industries

Dependant Variable Independent Variables	Export	Import	Net Export	Production 1	Production 2
KL	7.178833 (1.18)	-41.15054*** (-3.01)	48.32937*** (3.55)	1.632692 (0.13)	-13.42918 (-0.72)
KL^2	-69.64392 (-0.13)	4641.425*** (3.77)	-4711.069*** (-3.83)	-3491.075*** (-3.04)	-2467.842 (-1.46)
I	.0107085** (1.98)	.1240081*** (10.27)	-.1132996*** (-9.42)	-.0807508*** (-7.18)	-.0720673*** (-4.36)
I^2	.0005184 (1.56)	.0016066** (2.16)	-.0010882 (-1.47)	-.0011934* (-1.72)	-.0010867 (-1.07)
INNOV	.0850222 (0.09)	-10.83923*** (-5.26)	10.92425*** (5.31)	7.640318*** (3.98)	7.683283*** (2.72)
$INNOV^2$	-.0311653 (-0.01)	18.60079 (1.64)	-18.63195 (-1.65)	-17.52904* (-1.66)	-21.30884 (-1.37)
KL*I	-2.363924* (-1.93)	-12.92851*** (-4.73)	10.56459*** (3.88)	9.046464*** (3.55)	8.125956** (2.17)
KL*INNOV	634.2819** (2.23)	2552.455*** (4.01)	-1918.173*** (-3.02)	-1260.109** (-2.12)	-991.2286 (-1.14)
I*INNOV	-.2209403** (-2.44)	-.690391*** (-3.40)	.4694507** (2.32)	.3060344 (1.62)	.2167942 (0.78)
O	.0030573*** (7.07)	.0048026*** (4.97)	-.0017453* (-1.81)	-.0032065*** (-3.56)	-.004557*** (-3.44)
O*KL	-.2850594*** (-2.69)	.4247693* (1.79)	-.7098287*** (-3.01)	-.2573644 (-1.17)	.042128 (0.13)
$O*KL^2$	11.27421 (1.15)	-63.05691*** (-2.87)	74.33112*** (3.40)	67.15107*** (3.28)	44.64979 (1.49)
O*I	-.0001247 (-1.20)	-.0015493*** (-6.68)	.0014246*** (6.16)	.0006212*** (2.87)	.0003774 (1.19)
$O*I^2$	-5.76e-06 (-0.97)	-.0000363*** (-2.73)	.0000306** (2.30)	.0000353*** (2.85)	.000033* (1.81)
O* INNOV	.0120505 (0.80)	.1598111*** (4.73)	-.1477607*** (-4.39)	-.1156094*** (-3.67)	-.1080243** (-2.34)
$O*INNOV^2$	-.0345758 (-0.49)	-.3061928* (-1.94)	.271617* (1.73)	.2601995* (1.77)	.2933339 (1.36)
O*KL*I	.0305747 (1.56)	.1926762*** (4.40)	-.1621014*** (-3.71)	-.1412948*** (-3.46)	-.1203218** (-2.01)
O*KL* INNOV	-8.414629** (-1.99)	-36.70326*** (-3.88)	28.28863*** (3.00)	18.17175** (2.06)	13.77936 (1.06)
O*I* INNOV	.0032669** (2.38)	.0110435*** (3.60)	-.0077766** (-2.54)	-.0045072 (-1.58)	-.002884 (-0.69)
Number of countries	35				
Observations	349				
R- Squared (within)	0.6034	0.3715	0.3685	0.4429	0.3756

*, **, *** indicate significant at the 10%, 5%, and 1%.
Export = export value divided by output value of polluting industries.
Import = import value divided by output value of polluting industries.
Production 1 = logarithm of output value of the most polluting industries divided by the output value of the whole manufacturing industry.
Production 2 = logarithm of value added of the most polluting industries divided by the value added of the whole manufacturing industry.

Specifications to the Empirical Results

• Specifications:

1) The positive coefficient of capital-labor ratio (KL) is consistent with the argument that pollution-intensive production tends to be capital-intensive. Country's capital abundance contributes comparative advantage to pollution-intentive industries. Therefore, through the incresing trade openness, countries with higher levels of KL ratio would specialize in pollution-intensive production and export more pollution-intentive commodities.

2) The negative coefficient of environmental stringency measurement (I) indicates that country's environmental stringency would raise the production cost of pollution-intensive industries. However, such comparative disadvantage is not demonstrated through trade openness.

3) The positive coefficient of innovative ability (INNOV) suggests that country's innovative ability in environment-related technology positively relates to the competitiveness of polltuion-intensive production.

• Total Trade Induced Effect =

$$\gamma_0 O_{it} + \gamma_1 O_{it} KL_{it} + \gamma_2 O_{it} (KL_{it})^2 + \gamma_3 O_{it} I_{it} + \gamma_4 O_{it} (I_{it})^2 + \gamma_5 O_{it} INNOV_{it} + \gamma_6 O_{it} (INNOV_{it})^2 + \gamma_7 O_{it} KL_{it} I_{it} + \gamma_8 O_{it} KL_{it} INNOV_{it} + \gamma_9 O_{it} I_{it} INNOV_{it}$$

Conclusion

1) **Capital abundance generates comparative advantage to polluting production. We identify that the endowment effect did influence the composition change in manufacturing sector**

2) **Although the empirical results suggest that environmental regulation stringency (proxied by GDP per ca.) has negatively direct effect on polluting production and its net export, we do not find this negative impact induced through trade openness.**

3) **Country's innovative ability in environment-related technology creates comparative advantage to the polluting production has an important implication to policy suggestion --- governments have a better option other than environmental regulation itself for the purpose of pollution control.**