Openness and Urban Air Pollution in China

Pei Li & Yong Tu

DRE, NUS

Types of major pollutants in the Air: system:

SO_2 : burning coal, fuel oil, gasoline

NO_2: motorized vehicles, industrial

PM_{10}: motorized vehicles, industrial, dust

Forms of pollutants measured:

Emission vs Emission Concentration

Air quality indicators in China

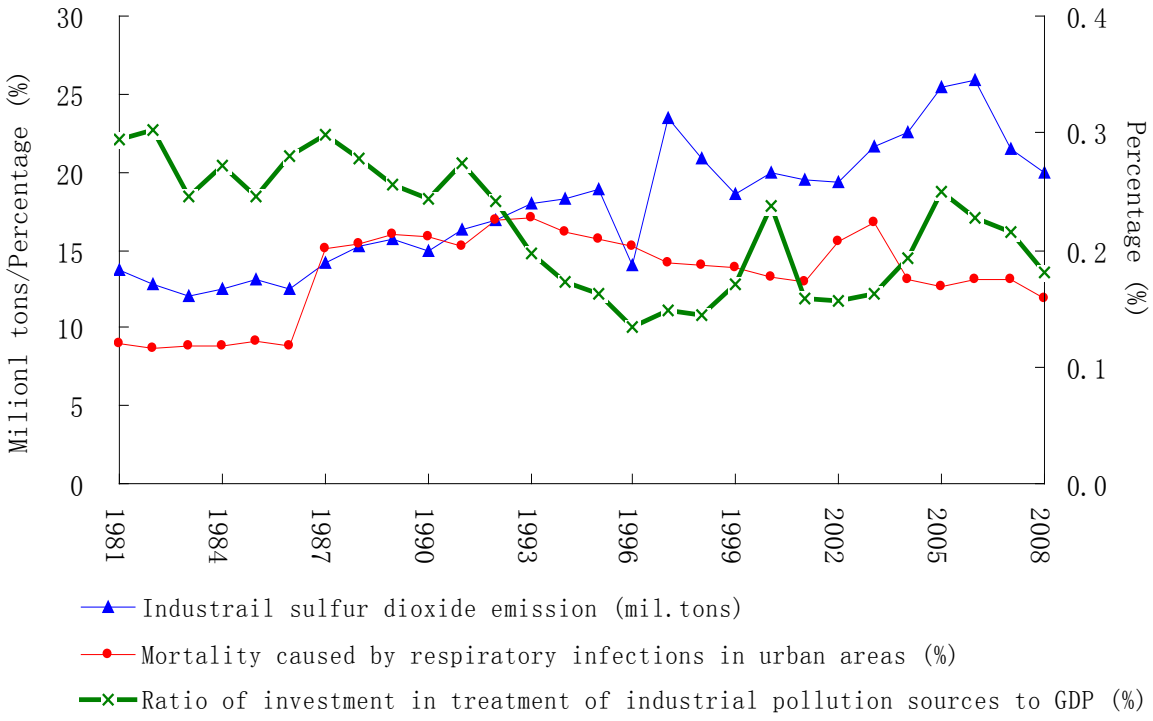


Figure 1. Industrial SO_2 emission, mortality and pollution abatement

Air quality indicators in China

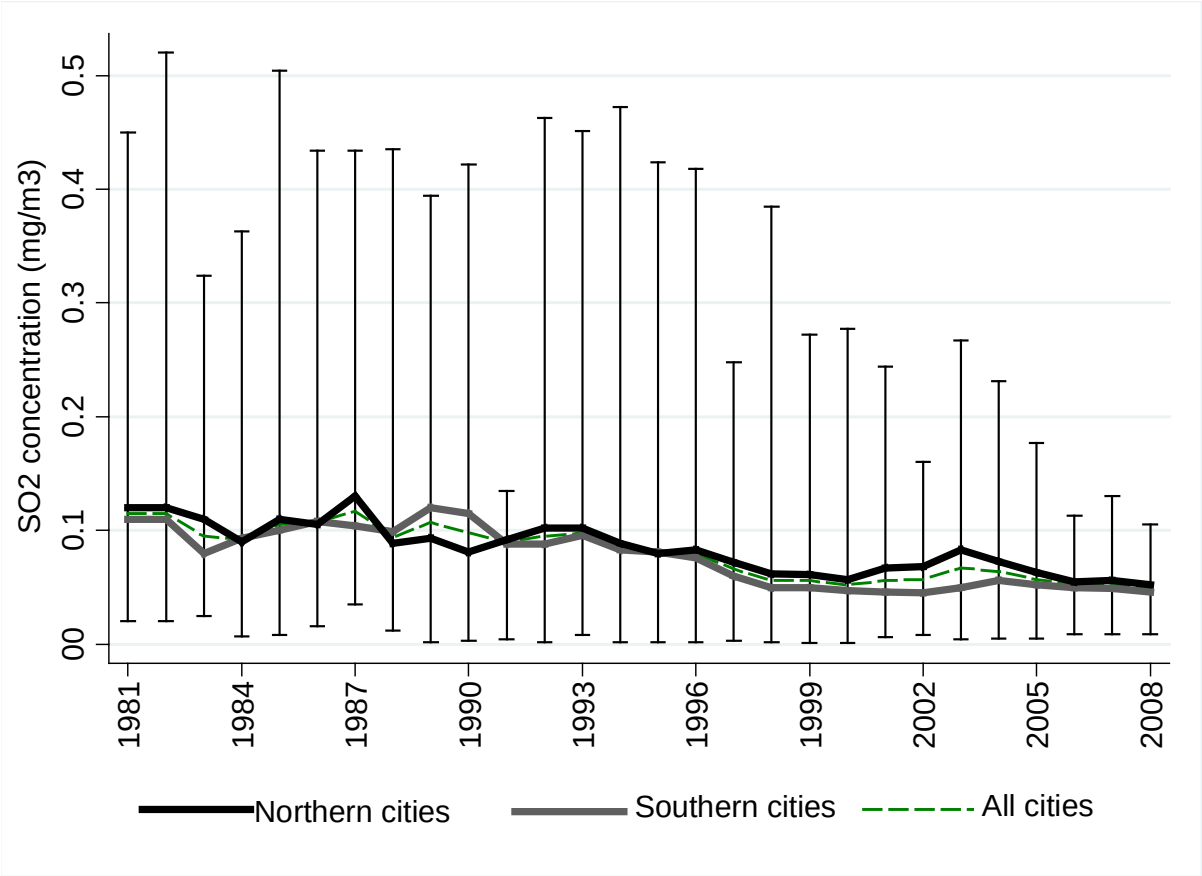
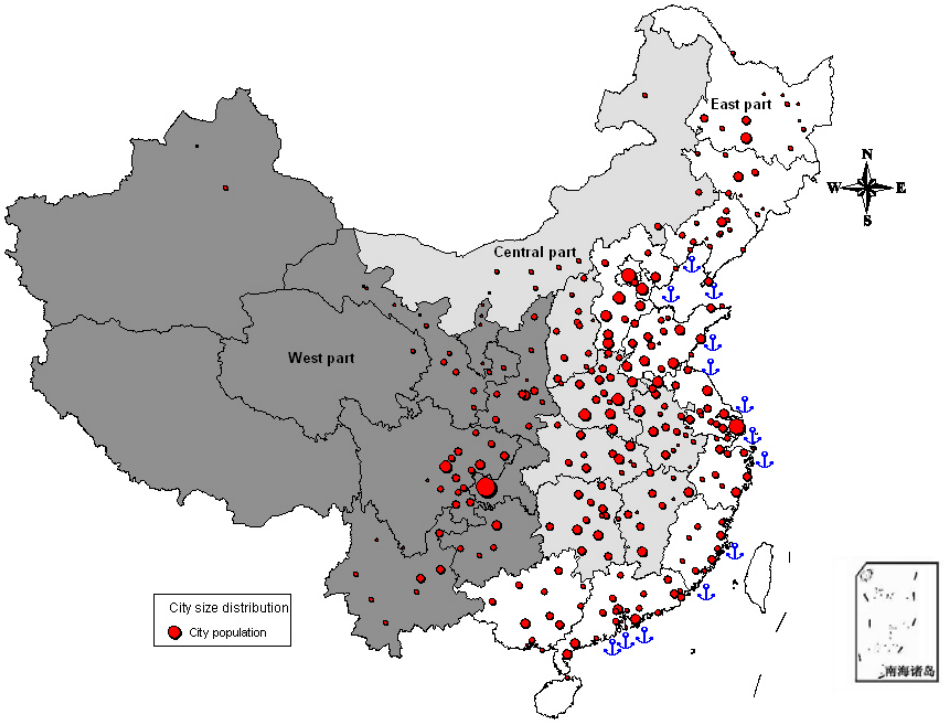


Figure 2. SO_2 concentration in China's most polluted cities

China urban growth



- Special economic zone in ShenZhen, Guang Dong 1980s
- Special economic zone, in PuDong, Shanghai 1990s
- Special economic zone, in BinHai new area, Tianjin 2005

Research questions

- How does the openness contribute to the urban air pollution?
- Is it possible that the continuous deterioration of urban air quality will be reversible in the course of China's further openness?
- If it is not, will it jeopardize the sustainable economic growth in China?

Literature tells us:

- Three important hypotheses:
  - Environment Kuznet Curve hypothesis theoretically predicts an inverted U shape relationship between income and pollution.
  - Pollution Heaven Hypothesis: predicts that an open economy with relatively weak environmental policy (typically low income) will specialize in dirty-industry production.
  - Factor Endowment Hypothesis (FEH) predicts that environmental policy has little effect on the trading pattern. Instead, factor endowments (Capital to labor ratio) or technology determine trading pattern. Capital-abundant economy (typically rich) tends to export capital-intensive dirty goods regardless of differences in environment policy.
- But the empirical results are contradicted.

Literature tells us:

- A pioneer paper:
- Grossman & Krueger (1991), one of the first papers tested EKC, empirically conclude that free trade is good for environment.

Literature tells us:

- ACT (2001):
  - Theoretically decomposes the impacts of international trade on pollution emission into scale effect, technique effect. composition effect and trade induced composition effect.
  - Empirically adopts SO_2 concentration, marginally concludes that free trade is good for environment.
- Three fallacies:
  1. The determinants of pollutant concentrations may not be the same as pollutant emissions.
  2. The evidence that free trade is good for reducing one particular pollutant does not infer that it is good for environment.
  3. Serious measurement (use of proxy) and multicollinearity problem in the empirical model may have led to wrong conclusion too.

Literature tells us:

- Some empirical papers support the identification of the first fallacy:
  - Cole and Elliot (2003) adopt the framework of ACT (2001) and find that the empirical results are sensitive to the choice of pollutants.
  - Managi et al (2009) argues whether trade has beneficial effect on the environment depending on the choices of pollutants and the country-specific characteristics.
  - The empirical evidences obtained from the cross country information provide very little knowledge and agreement on the nature of interactions between trade, growth and environment quality (Jayadevappa and Chhatre 2000; Copeland and Taylor 2004).

Literature tells us:

- Some empirical papers partially support the 2nd fallacy: Is trade good for environment?
  - Grossman & Krueger (1991): Yes
  - ACT (2001): Yes, but marginally
  - Cole & Elliot (2003) depends on the types of pollutants chosen.
  - He (2006) Yes, but small.
  - Shen (2008) Yes
- Different pollutants adopted and mixed uses of emission and concentration data.

Literature tells us:

- Some empirical papers partially support the 3rd fallacy under the ACT (2001) model:
  - He (2008) points out the problem of measurement inaccuracy when cross countries' data are used. Against China cross provinces' data, he concludes that the openness is unlikely to undermine China's sustainable development
  - Cole and Elliot (2003) and Shen (2008) partially correct the multicolinearity problem and finds that freer trade is good for environment.

Contributions of this paper

- This is the first paper to link international trade to city-level air pollution issue. The results have important implications for the policy makers who aim to prevent or reverse the environment degradation.

Contributions of this paper

- This is the first paper that systematically identifies the three fallacies, our empirical evidence supports the following hypotheses:
  - Different pollutants have different determinants, which explains why the empirical results are sensitive to the choice of pollutant.
  - International trade mainly impacts on environment through industrial pollutant emission.
  - Hence, it is not appropriate to conclude if free trade is good or bad for environment in general.

Contributions of this paper

- This is the first paper that systematically identifies the different measures of openness on environment. And the results are sensitive to how openness is measured.

Theoretical model

- We adjust ACT (2001)’s cross country international trade-environment model into a cross city international trade-environment model.

Model specification

$$p = \beta \cdot p^{w}$$

ß<1, the economy exports dirty good X;
ß>1, it imports X.

$$Z = e(\theta) \cdot x = e \cdot \varphi \cdot S$$

Z: pollution emission;

θ: pollution abatement

e: emission intensity

φ: share of dirty good output to total output

S: total output

Model specification

$$\hat{Z} = \hat{e} + \hat{\varphi} + \hat{S}$$

^: % change

The first item : technique effect

The second item: composition effect

The third item: scale effect

Note: international trade may lead to all three effect changes.

Model specification

- The demand for pollution is Z
- The supply for pollution(τ)is in effect given by government policy that sets the price for polluting
  - The government choose pollution abatement θ to minimize the total pollution emission; and all firms have zero economic profit with full employment condition
  - The composition of output is solved as

$$\hat{\varphi} = \varphi(k, \hat{p^N})$$

Where: $k = \frac{K}{L}$ Producer's net output price $\hat{p^N} = (\hat{\beta} + \hat{p^w})(1+\alpha) - \alpha\hat{\tau}$

Model specification

A general equilibrium condition gives rise to a reduced form of pollution emission specification:

$$\hat{Z} = \pi_1 \hat{S} + \pi_2 \hat{k} - \pi_3 \hat{I} + \pi_4 \hat{\beta} + \pi_5 \hat{p^w} - \pi_6 \hat{T}$$

All π are positive.

Scale effect: S
Technique effect:
Composition effect is decomposed into four parts:

1. Factor endowment effect: k (to test if FEH holds)
2. Trade-induced composition effect: ß
3. Impact of world price
4. Impact of “type of economic unit”, reflecting the government’s effort on green which effect can be combined with I.

Econometric implementation

$$Z_{i,t} = X'_{i,t}\alpha + Y'_{i,t}\gamma + \varepsilon_{i,t}$$

$$X'_{it}\alpha = \alpha_0 + \alpha_1 S_{i,t} + \alpha_2 k_{i,t} + \alpha_3 I_{i,t} + \alpha_4 \psi_{i,t}\beta_{i,t}$$

$$\psi_{i,t} = \psi_0 + \psi_1 REL\_k_{i,t} + \psi_2 REL\_k^2_{i,t} + \psi_3 REL\_I_{i,t} + \psi_4 REL\_I^2_{i,t} + \psi_5 REL\_k_{i,t} \times REL\_I_{i,t}$$

- Where, Y is other city specific factors

Data

Table 1. Main data sources

Code	Name of statistical yearbooks or databases	Issue time
1	*China Ports Yearbook*	2002-2009
2	*China Commercial Yearbook*	2005-2009
3	China Meteorological Database	2001-2008
4	*China Environmental Yearbook*	2001-2009
5	*China City statistical Yearbook*	2001-2009
6	*China Customs Statistical Yearbook*	2002-2009
7	*China Environmental Statistical Yearbook*	2001-2009
8	A collection of some Chinese cities' yearbooks	2001-2009
9	*China Urban Construction Statistical Yearbook*	2002-2009
10	*China Statistical Yearbook for Regional Economy*	2001-2009
11	A complete collection of provincial statistical yearbooks	2001-2009
12	A collection of some Chinese cities' statistical yearbooks	2001-2009
13	*China Special Economic Zone and Development Area Yearbook*	2002-2003
14	*Statistical Materials on the Population of Counties and Cities of the People's Republic of China*	2000-2008
15	A collection of some Chinese cities statistical communiqués on economic and social development	2001-2009

Notes: (1) See Zhou and Ma (2005) for a detailed description of scope and characteristics of the major sources of Chinese urban statistics. (2) The calibers of Chinese city-level data among different sources are not completely uniform.

Data

- Two panel datasets.

- The first one recorded industrial SO_2 emissions in all of the Chinese cities at prefecture level spanning the years 2001-2008.

- The second dataset is an unbalanced panel of 810 observations covering 112 national key environmental protection cities over the same period.

Measurement issues

- The air quality index does not only bundle both production-generated and consumption-generated pollution, but is also a function of geo-spatial factors and site-specific.

Table 2. Number of enterprises under national economic and environmental annual surveys

Year	Number of enterprises (unit)		Industrial output value (billion Yuan)		Ratio (%)	
	Total (A1)	Under environmental monitoring (A2)	Total (B1)	Under environmental monitoring (B2)	A2/A1	B2/B1
2001	171256	71425	9545	5382	41.71	56.39
2002	181557	70831	11078	6076	39.01	54.85
2003	196222	69904	14227	7093	35.62	49.85
2004	276474	70630	20172	8984	25.55	44.54
2005	271835	70612	25162	11209	25.98	44.55
2006	301961	76185	31659	14260	25.23	45.04
2007	336768	106457	40518	18332	31.61	45.24
2008	426113	110373	50745	22026	25.90	43.41

Note: Before 2007, industrial statistics have been collected from all state-owned industrial enterprises and other industrial enterprises with revenue from principal business over 5 million Yuan. For 2007, the scope of industrial statistics has been expanded to be all industrial enterprises with revenue from principal business over 5 million Yuan.

Source: *China Statistics Yearbook* 2002-2009 and *China Environment Yearbooks* 2002-2009

Measurement issues

- Household income vs. GDP per capita
- "*Shiqu (city district)*" *vs*. "*Diqu (urban area and rural counties*"
- Construction of physical capital stock data

  (Goldsmith 1951; Zhang 2008; Wu 2008)

$$K_{it} = K_{it-1} \times (1 - \delta_i) + I_{it}$$

- Inflation adjustment (CPI, fixed investment price index, GDP deflator, and so on).

Variable definition and descriptive statistics

Table 3. key variable description

Variable	Definition	Mean	Std dev	Minimum	Maximum
TECHNIQUE	One period lagged urban household disposable income (10,000 Yuan)	0.82	0.32	0.33	2.76
ECON_SCALE	City economic intensity calculated as units of GDP per sq.m (100 Yuan/m^2)	0.08	0.16	2×10^{-4}	2.62
KtoL	Captial-to-labor ratio (1,000 Yuan per person)	0.46	0.40	0.05	4.18
OPEN_TRADE	Trade intensity measured by ratio of imports plus exports to GDP	0.21	0.42	0.00	3.48
RINCOME	Urban household disposable income relative to the national average	1.00	0.33	0.13	3.70
RKtoL	Captial-to-labor ratio relative to the national average	1.00	0.82	0.16	11.37

Note: National averages are calculated as the average of all cities for whom data are reported in the year t.

Variable definition and descriptive statistics

Table 4. Control variable description

Variable	Definition	Mean	Std dev	Minimum	Maximum
DIRTY_SECTOR	Proportion of employed persons in "dirty sectors" to total employed persons (%)	34.34	13.40	5.21	78.17
TEMP_INDEX	Temperature index defined by $average_{temp}$ /(max_{temp}-min_{temp})	1.78	0.86	-0.08	4.77
COAL_DEPENDENCE	Ratio of net coal imports from other provinces and countries to total coal supply within the province which city i belongs to	0.16	1.14	-7.15	4.91
GROWTH_RATE	Real GDP per capita growth rate (%)	13.02	3.66	-7.80	37.00

Note: "Dirty sectors" include manufacturing industry, mining and quarrying industry, production and supply of electricity, gas and water industry.

Variable definition and descriptive statistics

Table 5. Description of other openness measurements

Variable	Definition	Mean	Std dev	Minimum	Maximum
OPEN_HARBOR	Harbor accessibility index defined by average weighted distance to the two closest harbors	3.50	3.98	0.02	27.31
OPEN_AIRPORT	Airport accessibility index defined by average weighted distance to the two closest international airport	38.01	32.95	0.35	228.00
OPEN_POLICY	Ratio of trade volumes in natin-level SEZs of city *i* to total trade volumes in city *i*	5.58	16.67	0.00	100.00
OPEN_FDI	Total inward FDI inflows (million $)	0.03	0.08	0.00	1.01
OPEN_FDI_RATIO	Ratio of Inward FDI to fixed investment	0.06	0.09	0.00	0.94
OPEN_HMT	Ratio of industrial output for firms funded by HMT to total industrial output	6.55	10.00	0.00	62.64
OPEN_FIND	Ratio of industrial output for firms funded by foreign countries to total industrial output	8.54	10.93	0.00	77.99
OPEN_TFIND	Sum of "*FENHMT*" and "*FENO*"	15.10	17.34	0.00	93.83
OPEN_FRIENDS	Total number of sister city relationships adopted	3.10	4.90	0.00	54.00
OPEN_TURISM	Ratio of foreign exchange earnings from tourism to GDP	0.65	1.72	0.00	28.93

Notes: (1) Weights for measuring variable *OPEN_HARBOR* and *OPEN_AIRPORT* are the harbors' annual container handling capacity and the airports' annual cargo handling capacity. (2) The distance is computed with the “Oblique Spherical Triangle Method” using the latitudes and longitudes of the cities and the harbors (Wei and Wu 2001).

Empirical results

Table 6. Antweiler *et al* . (2001) structural model: trade-environmental nexus request

Independent variable	Log (Industrial SO_2 emissions per capita)				Integrated air quality index		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Constant	1.936***	1.763***	1.303***	1.186***	2.399***	2.964***	2.345***
	(0.158)	(0.168)	(0.212)	(0.213)	(0.150)	(0.164)	(0.274)
TECHNIQUE	0.880***	1.084***	1.145***	1.249***	-0.841**	-1.455***	-1.312***
	(0.238)	(0.248)	(0.310)	(0.307)	(0.374)	(0.341)	(0.390)
$TECHNIQUE^2$	-0.210***	-0.243***	-0.256***	-0.291***	0.233**	0.436***	0.401***
	(0.057)	(0.061)	(0.085)	(0.081)	(0.117)	(0.112)	(0.135)
ECON_SCALE	-0.890***	-0.763***	-1.041***		4.261***	3.955***	3.069***
	(0.135)	(0.092)	(0.118)		(0.433)	(0.571)	(0.588)
$ECON\_SCALE^2$	0.184***	0.314***	0.367***		-1.135***	-1.075***	-0.898***
	(0.053)	(0.056)	(0.067)		(0.151)	(0.168)	(0.178)
KtoL	0.030***	0.032***	0.019***	0.026***	-0.061	-0.086	-0.113*
	(0.005)	(0.006)	(0.007)	(0.006)	(0.041)	(0.053)	(0.061)
$KtoL^2$	0.001***	0.001***	0.001***	0.001***	0.002***	0.002***	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
$KtoL \times TECHNIQUE$	-0.035***	-0.042***	-0.027***	-0.041***	0.003	0.022	0.059**
	(0.002)	(0.004)	(0.004)	(0.004)	(0.010)	(0.023)	(0.028)
Trade intensity and interaction terms	No	Yes	Yes	Yes	No	Yes	Yes
Control variables	No	No	Yes	Yes	No	No	Yes
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....

Note : *, **, and *** stand for Statistically significance level at 10%, 5%, and 1% respectively.

Empirical results

Table 6. Antweiler *et al* . (2001) structural model: trade-environmental nexus request (continued)

Independent variable	Log (Industrial SO_2 emissions per capita)				Integrated air quality index		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
…….	…….	…….	…….	…….	…….	…….	…….
…….	…….	…….	…….	…….	…….	…….	…….
OPEN_TRADE		0.525***	0.577***	0.546***		-0.182	-0.049
		(0.063)	(0.065)	(0.064)		(0.279)	(0.261)
OPEN_TRADE × *RKtoL*		-0.031	-0.068	-0.056		-0.607***	-0.769***
		(0.085)	(0.088)	(0.084)		(0.215)	(0.229)
OPEN_TRADE × *RKtoL* ^{2}		-0.007	0.008	0.001		0.113*	0.160***
		(0.010)	(0.011)	(0.100)		(0.040)	(0.043)
OPEN_TRADE × *RINCOME*		-0.608***	-0.615***	-0.556***		0.476***	0.501***
		(0.118)	(0.110)	(0.095)		(0.148)	(0.128)
OPEN_TRADE × *RINCOME* ^{2}		0.103***	0.106***	0.096***		-0.175***	-0.168***
		(0.034)	(0.033)	(0.029)		(0.035)	(0.033)
OPEN_TRADE × *RKtoL* × *RINCOME*		0.072*	0.055	0.048		0.124***	-0.071
		(0.039)	(0.037)	(0.031)		(0.042)	(0.053)
Trade intensity and interaction terms	No	Yes	Yes	Yes	No	Yes	Yes
Control variables	No	No	Yes	Yes	No	No	Yes
…….	…….	…….	…….	…….	…….	…….	…….
…….	…….	…….	…….	…….	…….	…….	…….

Note : *, **, and *** stand for Statistically significance level at 10%, 5%, and 1% respectively.

Empirical results

Table A. Capital-to-labor ratio across different industries

Industry	K/L (10,000 Yuan per person)	
	Year of 2004	Year of 2008
Light industry	17.54	24.03
Heavy industry	31.91	50.03
Mining and quarrying	19.55	77.84
Manufacturing	22.46	33.77
Production and supply of gas, electricity and water	119.01	184.24
Information transmission, computer services and software	125.43	109.56
Real estate	178.93	266.81
Leasing and business services	193.54	282.20
Scientific research, technical service and geologic prospecting	44.25	119.43
Management of water conservancy, environment and public facility	108.85	112.00

Data sources: *China Economic Census Yearbook 2004* and *China Economic Census Yearbook 2008*.

Empirical results

Table 6. Antweiler *et al* . (2001) structural model: trade-environmental nexus request (continued)

Independent variable	Log (Industrial SO_2 emissions per capita)				Integrated air quality index		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
……	……	……	……	……	……	……	……
……	……	……	……	……	……	……	……
COAL_DEPENDENCE			-0.052***	-0.048***			-0.128*
			(0.014)	(0.015)			(0.069)
DIRTY_SECTOR			0.005***	0.004***			0.014***
			(0.001)	(0.001)			(0.003)
GROWTH_RATE			0.007***	0.007***			0.026***
			(0.002)	(0.002)			(0.008)
TEMPERATURE_INDEX			0.106***	0.110***			-0.148***
			(0.037)	(0.038)			(0.030)
Within R-squared	0.256	0.260	0.272	0.269	0.311	0.320	0.344
F test	13642.67***	211.25***	383.59***	419.13***	1555.21***	4078.84***	401.87***
Hausman test	55.18***	59.24***	170.81***	119.85***	36.19***	35.56**	28.03*
Frees test	41.14***	40.07***	35.62***	36.34***	12.82***	12.62***	11.08***
Wooldridge test	48.89***	49.63***	49.27***	49.68***	73.53***	73.94***	77.75***
Wald test for heteroskedasticity	9.9×10^4***	9.6×10^4***	9.1×10^4***	8.9×10^4***	9.5×10^3***	1.3×10^4***	8.6×10^3***
Wald test for year dummies	9.3×10^4***	1.7×10^6***	1.6×10^6***	4.0×10^5***	2.7×10^4***	1.2×10^5***	1.7×10^3***
City dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2288	2288	2288	2288	810	810	810
Cities	286	286	286	286	112	112	112

Note : *, **, and *** stand for Statistically significance level at 10%, 5%, and 1% respectively.

Conclusion 1

- The overall picture corresponds to the situation that the unbridled economic growth driven by the openness in China has moved the Chinese closer to industrial smokestacks and increased the number of people exposed to polluted urban air.

Conclusion 2

- There is no single link between economic growth, trade and pollution that fits all pollutants for all places and times.

Empirical results

Table 7. ACT (2001) structural model: alternative specifications (dependent variable: logarithmic industrial SO_2 emission per capita)

Independent variable	Geography and policy			FDI		HMT and foreign funded enterprises			Culture	
	Harbor	Airport	Trade policy	Real value	Ratio	All	H-M-T	Foreign	Sister cities	Foreign turism
……	……	……	……	……	……	……	……	……	……	……
……	……	……	……	……	……	……	……	……	……	……
OPEN_HARBOR	0.010***									
	(0.006)									
OPEN_AIRPORT		-0.001**								
		(0.000)								
OPEN_POLICY			0.001							
			(0.001)							
OPEN_FDI				0.034						
				(0.061)						
OPEN_FDI_RATIO					0.425					
					(0.279)					
OPEN_TFIND						-0.004***				
						(0.002)				
OPEN_HMT							-0.011**			
							(0.005)			
OPEN_FIND								0.001		
								(0.002)		
OPEN_FRIENDS									-0.040***	
									(0.005)	
OPEN_TURISM										-0.005
										(0.012)
Within R-squared	0.270	0.268	0.268	0.267	0.270	0.269	0.273	0.267	0.274	0.268
F test	117.12***	141.67***	887.06***	589.43***	852.34***	798.88***	310.46***	233.41***	551.40***	449.96***
……	……	……	……	……	……	……	……	……	……	……
……	……	……	……	……	……	……	……	……	……	……

Note: *, **, and *** stand for Statistically significance level at 10%, 5%, and 1% respectively.

Empirical results

Table 8. ACT (2001) structural model: alternative specifications (dependent variable: integrated air quality index)

Independent variable	Geography and policy			FDI		HMT and foreign funded enterprises			Culture	
	Harbor	Airport	Trade policy	Real value	Ratio	All	H-M-T	Foreign	Sister cities	Foreign turism
…….	…….	…….	…….	…….	…….	…….	…….	…….	…….	…….
…….	…….	…….	…….	…….	…….	…….	…….	…….	…….	…….
OPEN_HARBOR	0.017									
	(0.020)									
OPEN_AIRPORT		0.005*								
		(0.002)								
OPEN_POLICY			0.002							
			(0.002)							
OPEN_FDI				-0.331						
				(0.387)						
OPEN_FDI_RATIO					-1.151***					
					(0.258)					
OPEN_TFIND						0.007*				
						(0.004)				
OPEN_HMT							-0.0002			
							(0.004)			
OPEN_FIND								0.010*		
								(0.006)		
OPEN_FRIENDS									0.033***	
									(0.011)	
OPEN_TURISM										-0.001
										(0.011)
Within R-squared	0.333	0.338	0.331	0.331	0.335	0.332	0.331	0.333	0.334	0.331
F test	800.64***	1312.77	632.58***	1553.70***	430.67***	499.85***	2234.96***	438.12***	574.27***	504.27***
…….	…….	…….	…….	…….	…….	…….	…….	…….	…….	…….
…….	…….	…….	…….	…….	…….	…….	…….	…….	…….	…….

Note: *, **, and *** stand for Statistically significance level at 10%, 5%, and 1% respectively.

Conclusion 3

- Our refinements to the measure of openness appear to substantially weaken the robustness of the link between openness and pollution. In fact, the impact of openness on environment is sensitive to how is measured.

The elasticities of pollution emission to economic indicators by type of cities

Table 4. Scale, technique, composition and trade intensity elasticities of industrial SO_2 emission per capita

City group	Scale and technique	Composition	Trade intensity
Middle	0.348	-0.037	0.019
Income top 10%	-0.771	-0.341	-0.074
Income bottom 10%	0.520	0.004	0.015
Population top 10%	0.244	-0.080	0.011
Population bottom 10%	0.214	0.026	0.030
Captial cities	-0.055	-0.058	0.007
key environmental protection cities	0.177	-0.057	0.015

Note: elasticities are evaluated at the subsample means.

Conclusion 4

- It seems possible that the continuous deterioration of urban air quality will be reversible in the course of China’s further openness.

Conclusion 5

- It also suggests that the *latecomers* have a strong desire for economic growth at the cost of the environment in order to catch up with their counterparts.

An important implication

- If one considers the effects of economic growth and trade on the environment, one should realize that it needs to be explained in multidimensional ways.

Further research

- One shortcoming of our paper is time-period and pollutants considered for analysis, cost and ease of environmental cleanup.

- The second potential problem relates to the question of causality between the determinants and structural dynamic model is recommended to accurately capture the impact of trade on environment.

- The environmental performance of cities is dependent on the characteristics of neighboring cities.