

Blue Skies in Urban China?

Matthew E. Kahn

UCLA and NBER and IZA

Institute of the Environment

Department of Economic

Department of Public Policy

Anderson School of Management

UCLA Law School

Introduction

- Applied environmental and urban economics research on non-market quality of life
- All of my China research is joint with Professor Siqi Zheng of Tsinghua University
- A Preview of Our 2016 Princeton University Press book

Outline for Today

- (1) general concept of environmental economics
- (2) United States experience with environmental regulations
- (3) My own research in China.

Three Big Ideas in Environmental Economics

- Idea #1: We all want clean air, clean water, safe food and physical safety
- BUT, we cannot purchase these at Starbucks!
- Our exposure to pollution is a function of choices by households, governments and firms
- The Tianjin Disaster as a salient example

Finishing Idea #1

- There is no “free lunch”
- China’s wonderful economic growth has been fueled by coal consumption
- Coal is cheap
- BUT, coal is dirty
- As China grows richer, a rising demand for “blue skies”
- Government officials will have an incentive to “go green”

Idea #2: Industrial Composition Matters

- San Francisco versus Pittsburgh: A Tale of Two Cities
- San Francisco as a “green city”
- Pittsburgh and steel as its “golden goose” in the 1950s versus Pittsburgh today
- Lessons for China?

Idea #3 Dynamic Incentives

- Polluting industries do incur costs as they try to reduce their pollution
- They have incentives to overstate their costs of compliance because “nice regulators” will ease off and not enforce
- Heterogeneity --- new firms who do not exist yet will figure out ways to adapt and thrive in the face of the “new rules of the game”

Pollution Permit Markets

- If the polluter must pay a fee that reflects the social damage from pollution, then this provides an incentive for the polluter to reduce its pollution and to seek “greener” production methods.

An Algebra Example

- Suppose that a factory is located in a city where 500 people live.
- Suppose that each unit of steel produced by the factory creates 2 units of pollution
- Suppose that each unit of pollution causes each person to be sick for .5 more days per year
- Suppose that each person is willing to pay \$20 to not be sick for a day.
- Total \$ damage caused per one unit of steel produce = $500 * 2 * .5 * 20 = \$10,000$

The United States Experience

- Clean Air Act
- Superfund Regulation
- Intended and unintended consequences
- “One Size Fits All”
- Field Experiments and humility

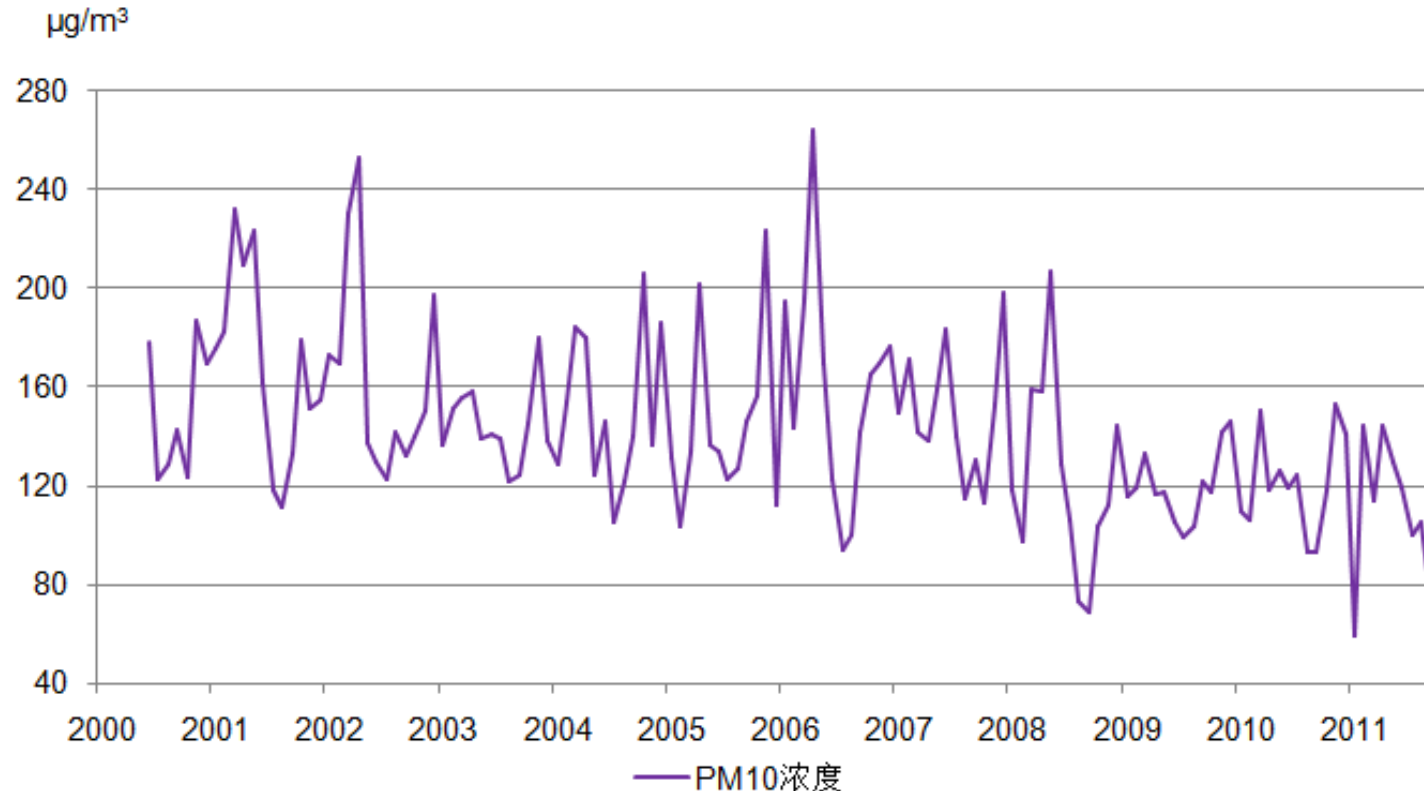
A “Cloudy Day” in Beijing



China's Local Pollution Challenge

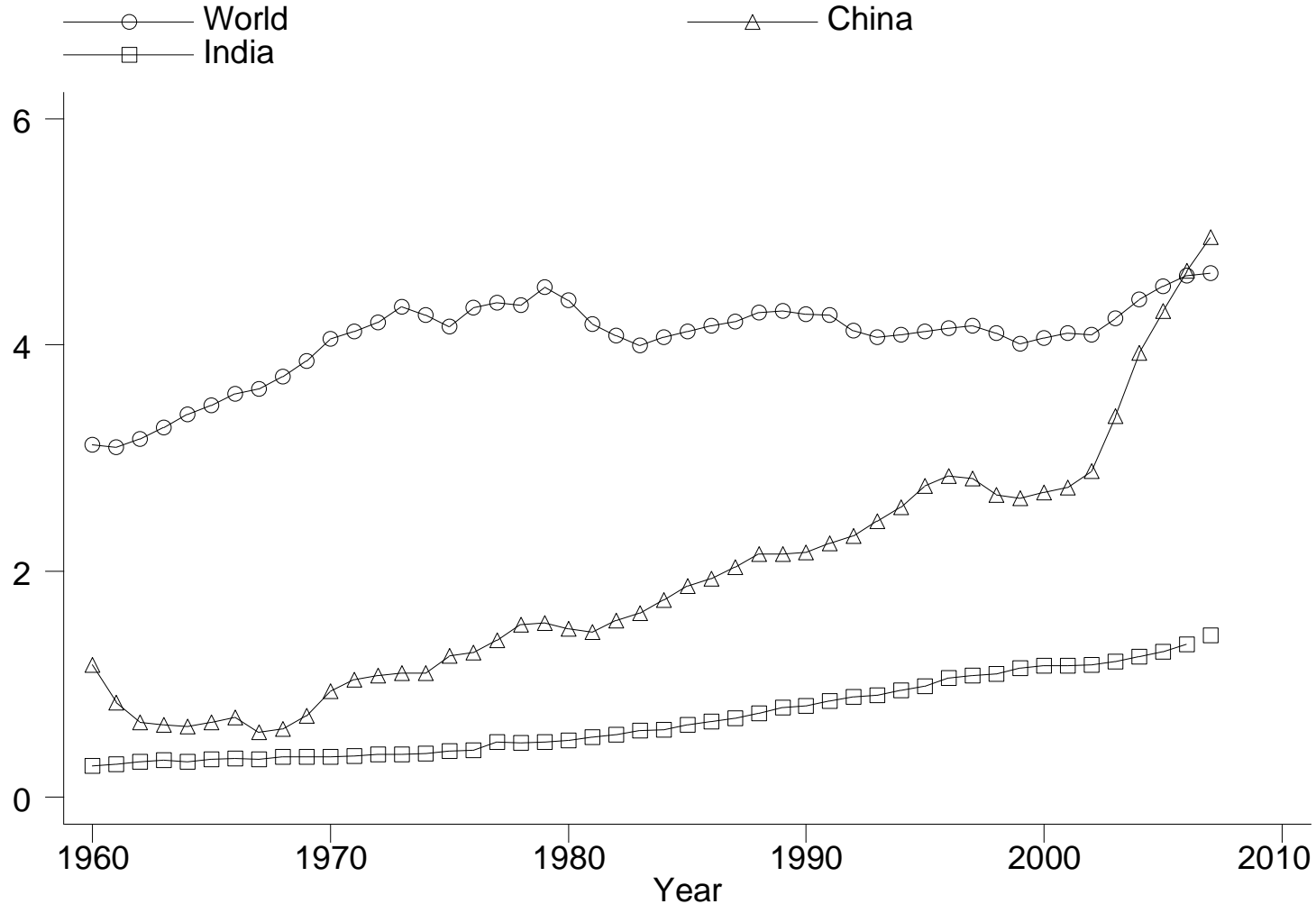
- Based on an ambient particulate concentration criteria of PM_{10} , twelve of the twenty most polluted cities in the world are located in China

PM₁₀ concentration in Beijing



Although air quality is improving, PM₁₀ concentration is still at a high level.

The Global Challenge of Climate Change



Time Trends in Per-Capita Carbon Dioxide Emissions

How Much is the Standard of Living Rising in Urban China?

- 8% annual GDP Growth
- But, an old research line dating back to Nordhaus and Tobin 1972 says that pollution damage should be deducted from GNP (capital stock depreciation)

Easterlin 2012 PNAS --- Unhappy in Urban China!

- Survey Chinese households
- “There is no evidence of an increase in life satisfaction of the magnitude that might have been expected to result from the fourfold improvement in the level of per capita consumption that has occurred. “

Our Urban China Research Agenda

- Measuring the rising demand for “blue skies” among Chinese urbanites
- Urban growth’s implications for household carbon production
- The political economy of implementing and enforcing pollution mitigation policies
- Infrastructure investment in subways and bullet trains → quality of life impacts

Major Urban Polluting Sectors

- Major Sectors
- 1. Transportation
- 2. Industry
- 3. Coal for power generation and winter heating
- For each; engineering challenges and introducing incentives to cost-effectively reduce emissions

Energy consumption and pollution



Transportation

- The demand for cars --- Income elasticity of 1
- New car emissions control
- Emissions = miles driven * Emissions per mile
- Issues of refining gasoline and the lottery versus auction on access to plate and other daily car driving restrictions (Sun et. al. 2013)
- U.S case suggests possible future progress

Shifting Geography of Industrial Production

- Rising land prices in major cities
- Improvements in road networks
- Rising wages
- Rising environmental regulation in the big cities
- Prediction that major cities will continue to deindustrialize like U.S cities (i.e Pittsburgh)
- Producer City to Consumer City transition

Electric Power

- Coal is dirty and 80% of China's power generated by coal
- Winter heat generated using coal
- The U.S natural gas transition, could it happen in China?
- Co-benefits of a coal to natural gas and renewables transition
- RPS in California and ideas as public goods

Globalized Trade in Renewable Power Equipment (Sawnhey and Kahn 2013)

Table 2. Country Shares in US Imports (by real value) of High-Tech Core Wind and Solar Equipment, 1989 and 2010**

<i>Country</i>	<i>Blades</i>		<i>Wind Turbines</i>		<i>Hub& Drive</i>		<i>Solar Modules</i>		<i>Solar Cells</i>	
	<u>1989</u>	<u>2010</u>	<u>1996*</u>	<u>2010</u>	<u>1995*</u>	<u>2010</u>	<u>1989</u>	<u>2010</u>	<u>1989</u>	<u>2010</u>
Australia	0.23	0.02	0.00	0.00	0.00	0.51	1.17	0.01	22.29	0.05
Brazil	0.27	24.31	0.00	0.05	10.19	1.76	0.00	0.00	5.30	0.00
Canada	13.06	5.33	0.20	0.69	12.35	10.31	0.16	0.09	0.48	0.07
China	0.97	7.22	0.04	0.39	0.12	12.70	0.04	43.72	0.00	13.75
Denmark	1.13	10.72	95.37	45.92	2.02	1.94	0.00	0.00	0.19	0.00
France	1.29	1.30	0.00	0.01	4.83	0.73	0.00	0.01	0.19	0.04
Germany	31.29	14.37	0.43	7.55	19.48	9.51	0.88	1.87	5.13	24.14
Hong Kong	0.01	0.04	0.00	0.00	0.00	0.02	1.62	0.15	0.29	0.01
India	0.00	9.74	0.00	10.04	0.52	1.13	0.79	0.95	0.00	0.72
Indonesia	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
Italy	2.77	0.61	0.00	2.48	2.58	1.02	0.01	0.02	0.10	0.07
Japan	10.45	3.59	0.23	17.29	18.01	9.64	53.59	10.99	25.14	2.08
Korea, South	0.10	1.37	0.00	0.23	0.45	2.38	0.00	0.42	0.00	2.25

The Basis for Our “Blue Skies” Optimism

- Richer, educated people demand “Blue Skies”
- City quality of life evolves over time
(examples of NYC, Chicago, London)
- The rise of consumer cities and the recognition of the central role of human capital as the “golden goose” of urban economic growth
(Glaeser 2011, Moretti 2012)

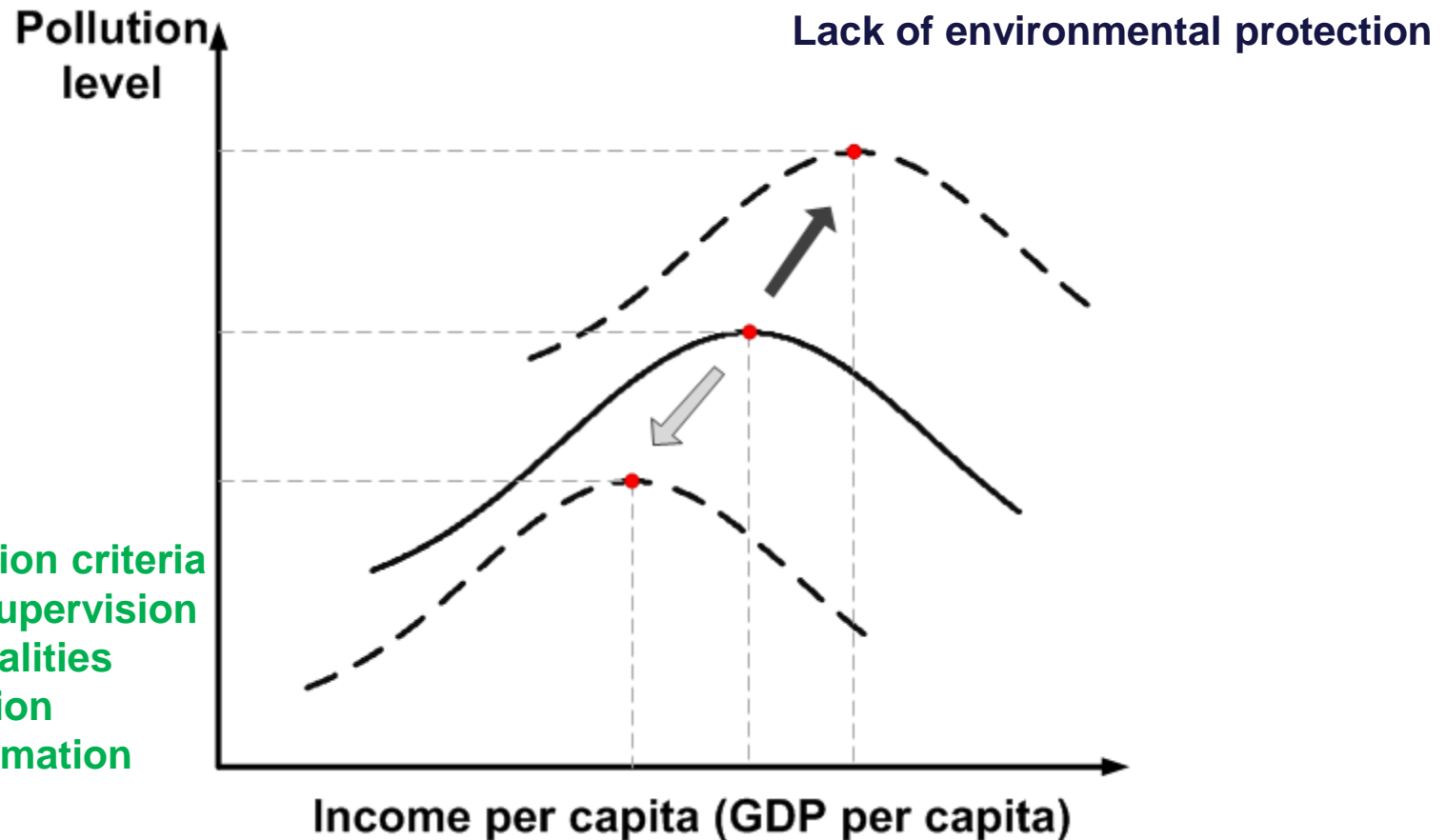
China's Demand for "Green Cities"

- 4-2-1 Demography
- Becker's quality vs. quantity of children
- Low pollution is an investment fostering child development (Janet Currie, Jim Heckman, Mark Rosenzweig)

More on Demand for Non-Market Quality of Life

- Richer people demand less risk in their life
(Costa and Kahn)
- Tiebout and “Voting with your feet” as China relaxes its hukou domestic passport system

A Shifting Environmental Kuznets Curve(EKC)



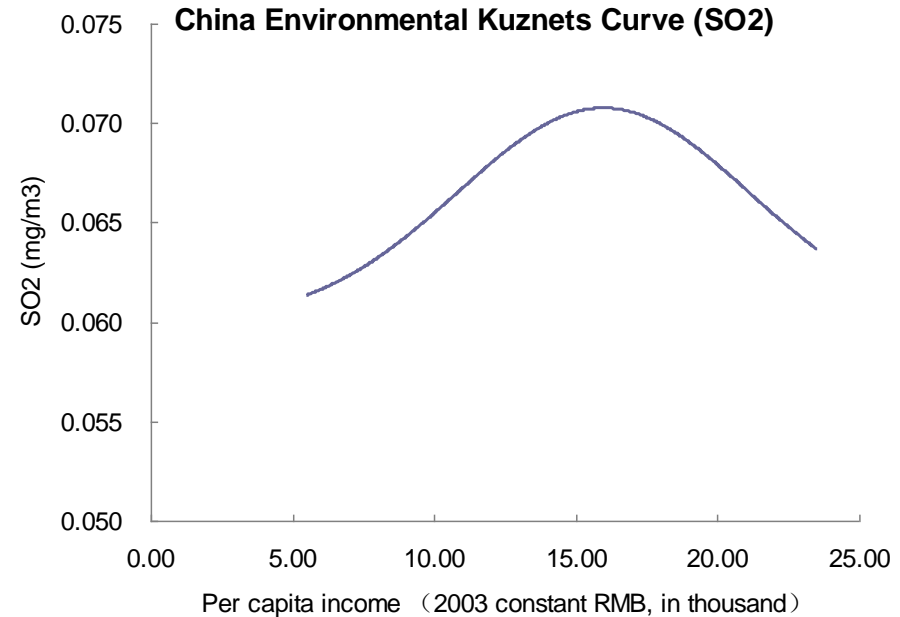
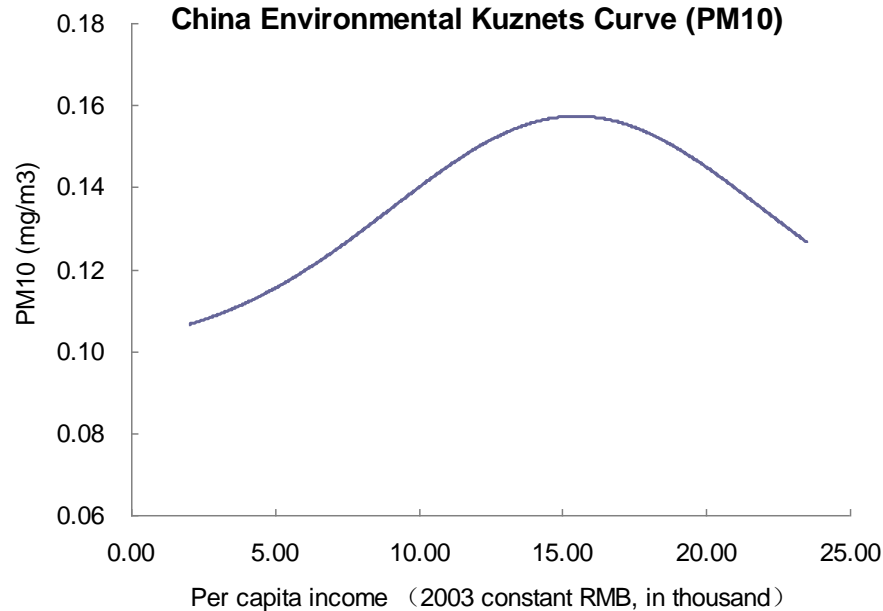
Towards a System of Open Cities in China: Home Prices, FDI flows and Air Quality in 35 Major Cities

By Siqi Zheng, Matthew E. Kahn and Hongyu Liu

Regional Science and Urban Economics. 40, 2010: 1-10.

- In this paper we document a EKC in a cross-section of Chinese cities

PM₁₀ and SO₂ Environmental Kuznets Curves for Chinese cities



- Turning point: 16,000 RMB (2,000 USD)
- In 2006, 8 cities passed this turning point

Our Main Demand Side Papers

- **Rising green demand**

- Zheng and Kahn. 2008. *Journal of Urban Economics*
- Zheng, Kahn and Liu. 2010. *Regional Science and Urban Economics*
- Zheng, Cao, Kahn and Sun. 2013. *Journal of Real Estate Finance and Economics*.
- Zheng, Wu, Kahn and Deng, 2012, *European Economic Review*

- **Political Economy and Blue Skies:** the “Sandwich” structure

- Zheng, Kahn, Sun and Luo. NBER working paper w18872

Empirical Evidence on Demand for Non-Market Local Public Goods

- Within Beijing, real estate hedonic pricing (Zheng and Kahn 2008 JUE).
- Compensating differentials estimates
- All else equal apartments closer to public transit, closer to green space, in lower air pollution parts of the city sell for a price premium
- GIS geo-coded real estate analysis

Land and Residential Property Markets in a Booming Economy: New Evidence from Beijing

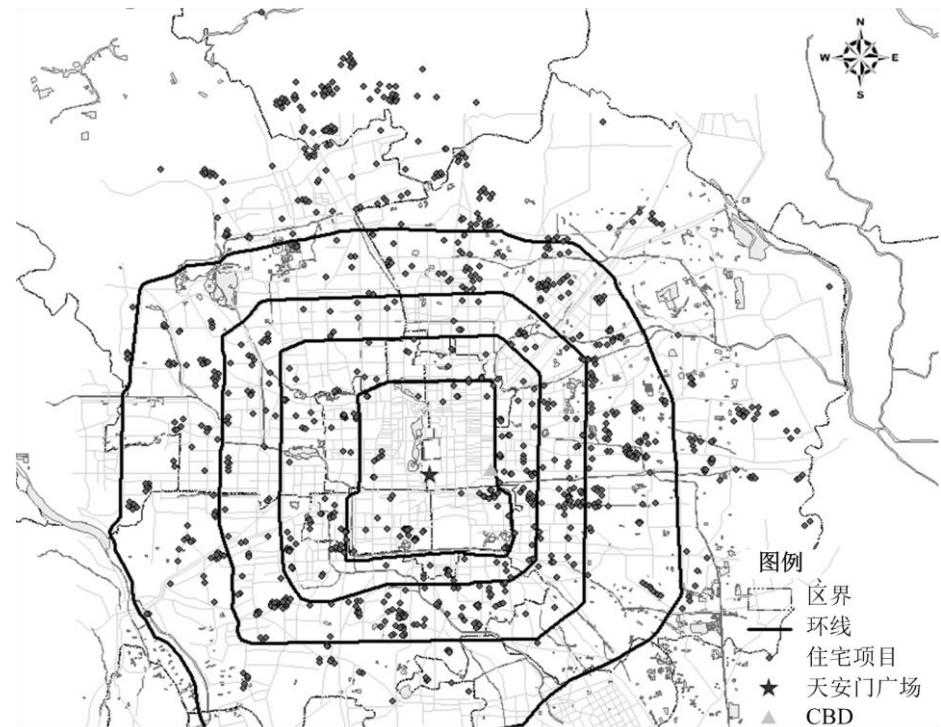
By Siqi Zheng and Matthew E. Kahn

Journal of Urban Economics, 63, 2008: 743-757.

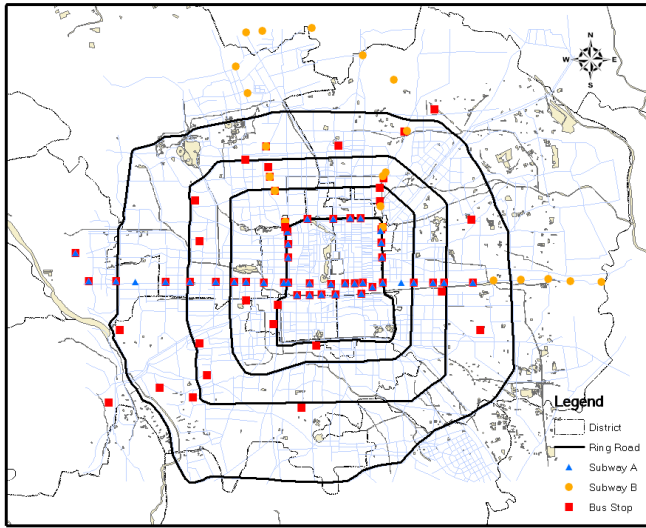
Home Price = f (physical characters, distance to CBD, distance to infrastructures)

Empirical analysis (Hedonic model)

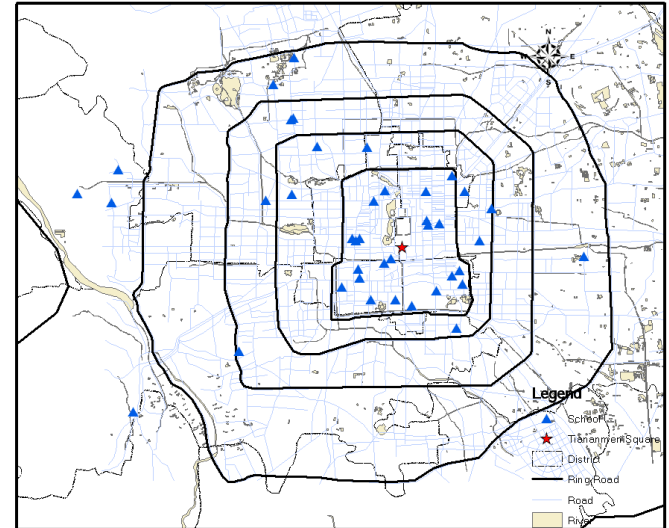
$$\log(P) = c_0 + c_1 * X_1 + c_2 * X_2 + c_3 * X_3$$



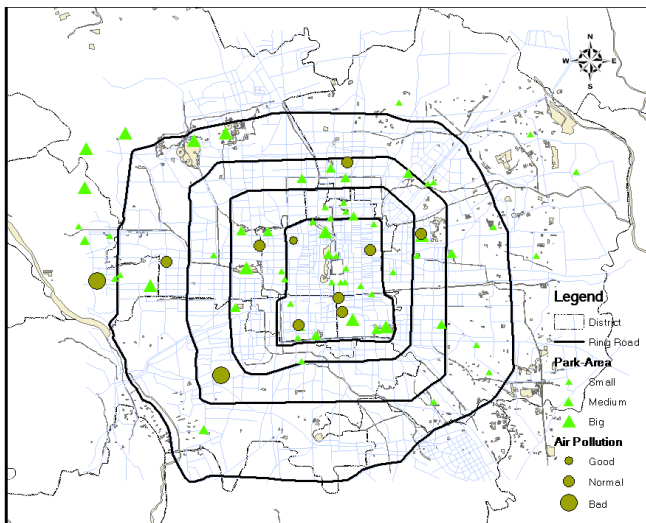
New-built commodity residential projects
in Beijing
(2004-2005)



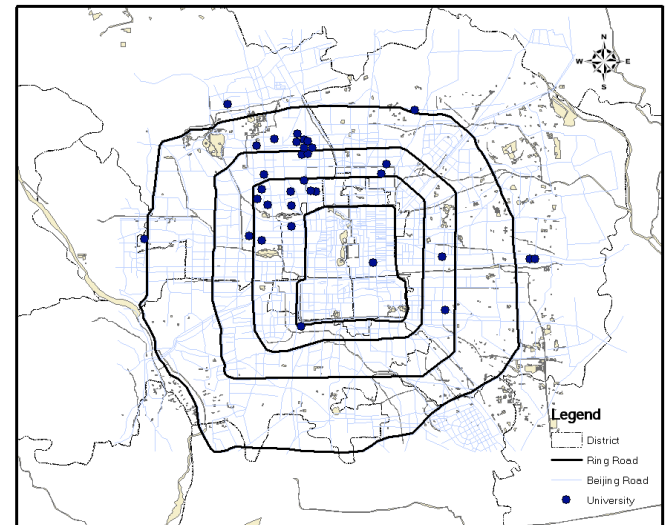
Bus stops and subway stations



Primary and middle schools



Parks and air quality



Key universities

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	8.491*** (110.15)	8.805*** (127.39)	9.843*** (19.95)	10.046*** (30.13)	10.252*** (43.60)	8.945*** (19.12)
Distance to city center	-0.019*** (-7.67)	-0.011*** (-4.81)	-0.008*** (-4.01)	-0.007*** (-3.55)	-0.007*** (-3.82)	-0.007*** (-3.98)
Area	0.003*** (4.46)	0.003*** (4.78)	0.002*** (3.74)	0.002*** (2.67)	0.002** (2.65)	0.002** (2.52)
Area ²	-2.09×10 ⁻⁶ *** (-1.03)	-1.24×10 ⁻⁶ *** (-0.72)	2.53×10 ⁻⁷ (0.10)	4.40×10 ⁻⁷ *** (0.18)	1.60×10 ⁻⁷ (0.06)	8.93×10 ⁻⁷ (0.38)
Size of project	-0.164*** (-4.32)	-0.132*** (-4.07)	-0.131*** (-3.36)	-0.110*** (-3.64)	-0.115*** (-3.56)	-0.100*** (-3.63)
Size of project ²	0.025** (2.15)	0.022** (2.27)	0.022*** (4.40)	0.018*** (4.16)	0.020*** (4.76)	0.017*** (3.75)
State-owned real estate developer(0/1)	-0.091** (-3.64)	-0.077** (-3.64)	-0.100*** (-3.46)	-0.098*** (-3.21)	-0.100** (-2.87)	-0.087** (-2.88)
Log(distance to the nearest old subway stations)		-0.161*** (-14.25)	-0.113** (-3.25)	-0.089** (-2.70)	-0.082** (-2.54)	-0.108*** (-3.80)
Log(distance to the nearest new subway stations)		-0.038*** (-3.43)	-0.014 (-0.90)	-0.014 (-0.67)	0.021 (0.84)	0.023 (1.11)
Log(distance to the nearest bus stop)		-0.079*** (-5.21)	-0.074** (-2.43)	-0.074* (-2.13)	-0.051* (-1.94)	-0.035 (-1.01)

	(1)	(2)	(3)	(4)	(5)	(6)
Log(distance to the nearest park)			-0.104***	-0.086**	-0.041	-0.057*
			(-3.46)	(-2.51)	(-1.57)	(-2.06)
Air quality index(PM ₁₀)			-0.0041**	-0.0049***	-0.006***	-0.005***
			(-2.44)	(-4.40)	(-6.93)	(-5.85)
Log(distance to the nearest key high middle school)				-0.065**	-0.066**	-0.054**
				(-2.56)	(-2.87)	(-2.45)
High-crime-rate area (0/1)				-0.024	-0.055	-0.051
				(-0.64)	(-1.19)	(-1.55)
Log(distance to the nearest key universities)					-0.104***	
					(-3.68)	
Key universities within 3km (0/1)						0.106***
						(3.60)
admission score line of the nearest key university in 2005						0.002***
						(3.28)
Adjusted R ²	0.356	0.533	0.569	0.578	0.597	0.601
Observations	900	900	900	900	900	900

- 1 mg/m³ increase in PM₁₀ reduces home prices by 0.4 - 0.6%
- Chay and Greenstone (1998): 0.7-1.5%

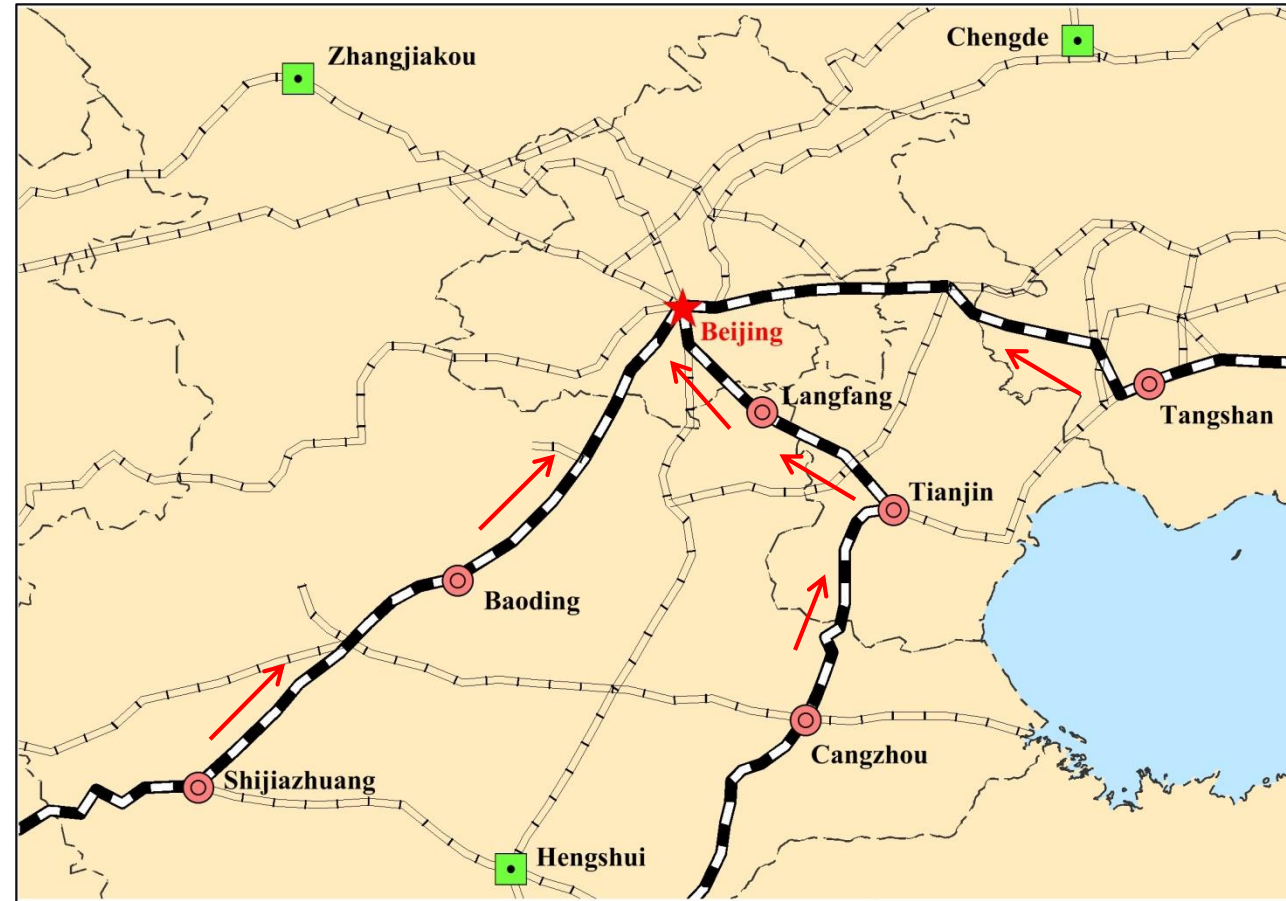
Greater Beijing Area

commute time change
between **Beijing** and
some nearby cities (minute)

	2006	2010
Langfang	45~60	20
Tianjin	90~120	30
Baoding	90~120	58
Cangzhou	160~180	90
Shijiazhuang	180	120
Hengshui	180	
Zhangjiakou	240	
Chengde	300	

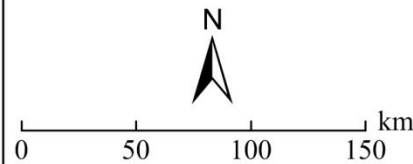
located in "sweet spot"

not located in "sweet spot"



Legend

- ★ central city
- ⊙ bullet train station
- conventional train station
- bullet train line
- +— conventional train line
- province



Yangtze River Delta

commute time change
between **Shanghai** and
some nearby cities (minute)

	2006	2010
Suzhou	60~90	30
Hangzhou	120~150	50
Nanjing	180~240	100
Shaoxing	150~180	110
Hefei	360~450	180
Huzhou	—	—
Yangzhou	300	300
Wuhu	420	420
Nantong	500	500

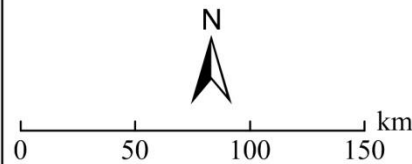
located in "sweet spot"

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Legend

- ★ central city
- bullet train station
- conventional train station
- bullet train line
- conventional train line
- province



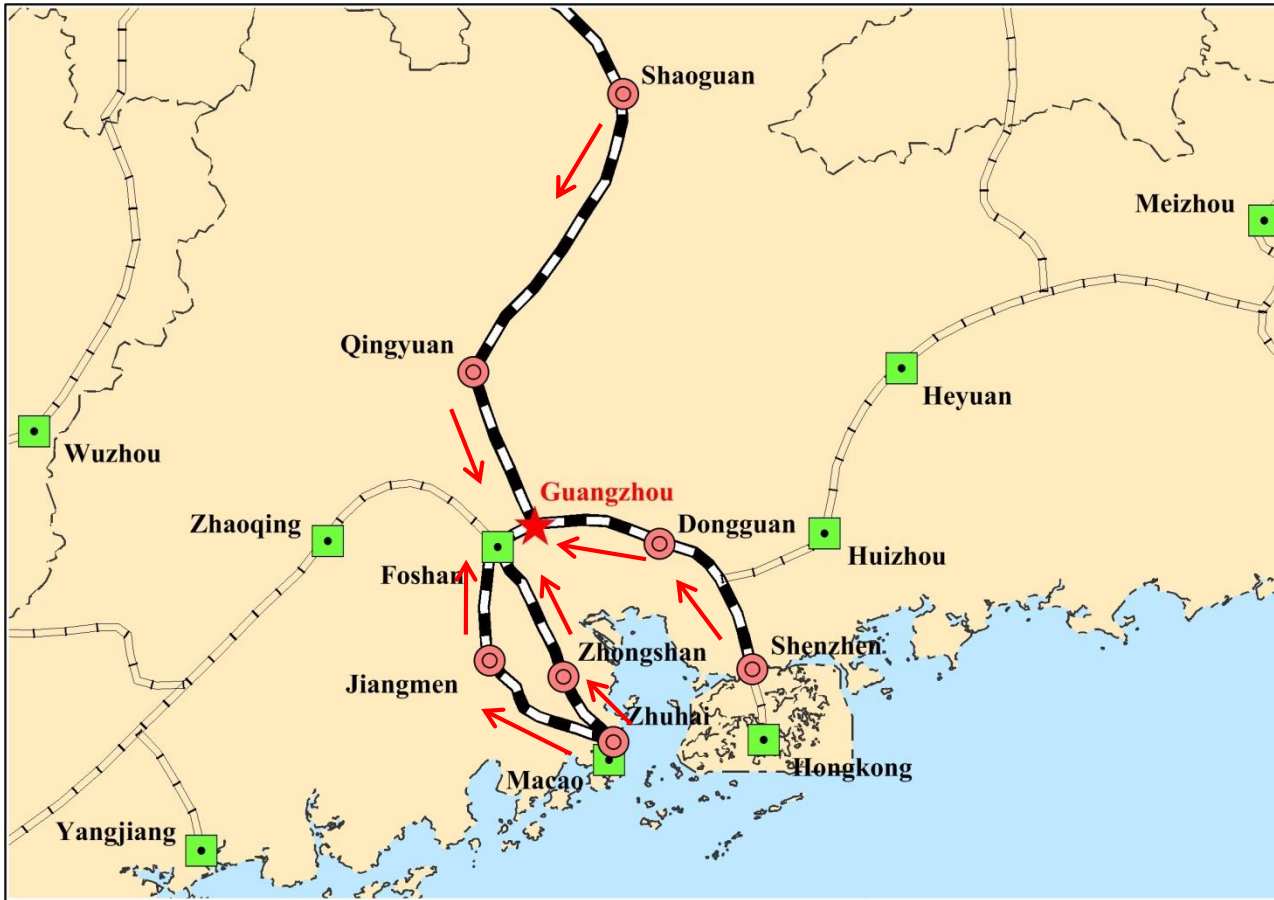
Pearl River Delta

commute time change
between **Guangzhou** and
some nearby cities (minute)

	2006	2010
Qingyuan	50~60	23
Dongguan	60	30
Jiangmen	—	45
Shaoguan	240~280	46
Shenzhen	120	60
Foshan	30	
Zhaoqing	100~150	
Huizhou	120	
Hong Kong	120	

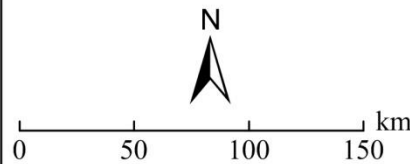
located in "sweet spot"

not located in "sweet spot"



Legend

- ★ central city
- bullet train station
- conventional train station
- bullet train line
- conventional train line
- province



Bullet Train Paper Findings

- A city's home price is an increasing function of local market potential
- Since bullet train connection increases a city's market potential, those close but not very close cities connected by the BT to the superstar cities experience price appreciation

Government Policy

- 1. Investment in transportation infrastructure within and across cities
- 2. incentivize local government to “go green”

Incentivizing China's Urban Mayors to Mitigate Pollution Externalities: The Role of the Central Government and Public Environmentalism

Siqi Zheng, *Tsinghua University*

Matthew E. Kahn, *UCLA and NBER*

Weizeng Sun, *Tsinghua University*

Danglun Luo, *Sun Yat-Sen University*

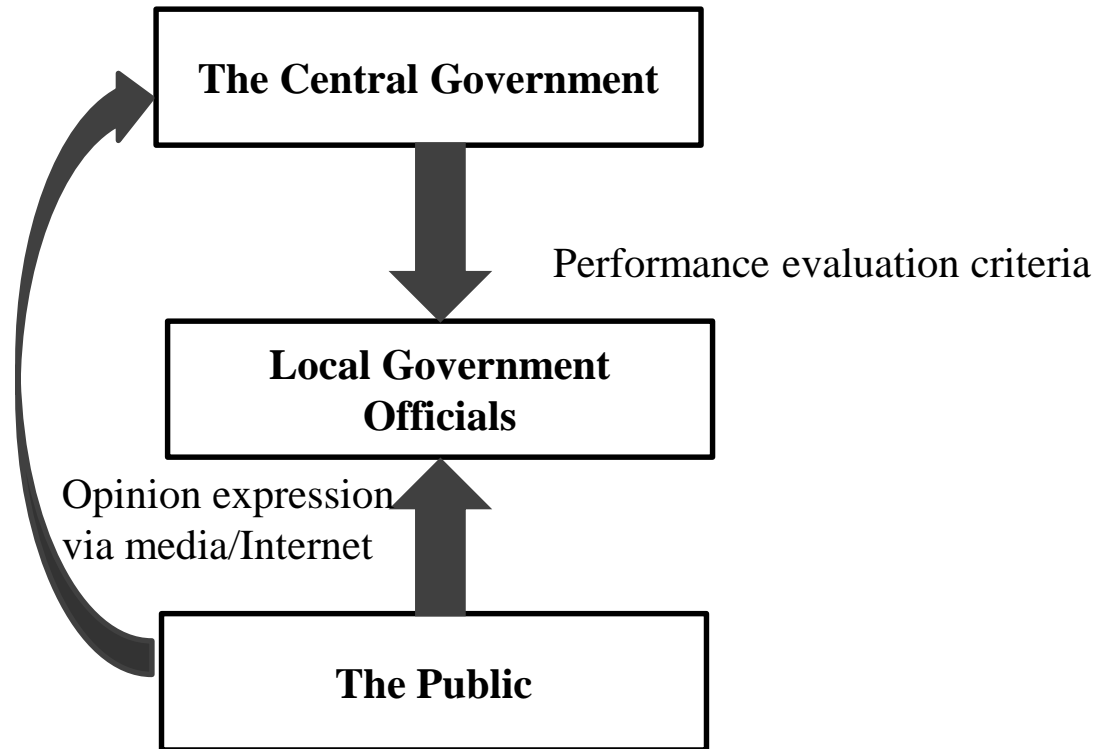
March 2013

Incentives for Government Officials to “Go Green”?

- Even though the people do not vote, will the local government supply public goods they desire?
- The Old Regime standards evaluated urban mayors based on GDP growth and social stability
- Pollution criteria have been introduced into the promotion criteria --- Why? Are these real?
- Principal/agent problem and the “golden goose”

The “Sandwich” Story

The Fundamental Principal-agent Problem



Information Encourages Accountability

- Urbanites in China know more about their exposure to pollution than in the past
- Microblogs are a key source of information and the media writes about these issues
- Many Chinese urbanites have traveled abroad
- The PM 2.5 Controversies and measurement at the U.S Embassy

PM2.5 Debate in October 2011 in Beijing and Data Monopoly Smashed



Date	U.S. Embassy (PM _{2.5})	MEP, China (PM ₁₀)
10-24	● Moderate	● Excellent
10-23	● Very Unhealthy	● Light Pollution
10-22	● Hazardous	● Slightly Polluted
10-21	● Hazardous	● Slightly Polluted
10-20	● Hazardous	● Light Pollution
10-19	● Very Unhealthy	● Good
10-18	● Unhealthy	● Good

Source: Los Angeles Times

Old Regime (Prior to the 2000s)

- China's central government focused on GDP growth
- No competitive election. The upper-level government determines the promotion of lower-level officials.
- The State set up pure output-based (GDP) promotion criteria for local officials. Mayors had little incentive to address pollution issues with their growth focus
 - Li and Zhou (2005, JPE) – Booming economy caused promotion (1979-1995)
 - Chen et. al. (2005) – High relative GDP growth caused promotion (1979-2002)
- The media was just the “mouth” of government.
- Weak public participation and weak civil society

New Regime (the 21st Century) – The State

- President Jintao Hu – “Scientific Outlook on Development (*ke xue fa zhan guan*)”—2002
- The Tenth Five-Year Plan (2001-2005)
 - Major water and air pollutants to decrease by 10 percent over the five-year period. (Facts: chemical oxygen demand (COD): only decreased by 2%; SO₂: increased by 27%)
- The Eleventh Five-Year Plan (2006-2010)
 - Major pollutants such as COD and SO₂ to decrease by 10 percent each year from the 2005 level; (Facts: COD: 12.45%; SO₂ emission: 14.29%; big improve in air quality)
 - Energy consumption per unit of GDP to decline by about 20% from the 2005 level. (Fact: 19.06%)
- The Twelfth Five-Year Plan (2011-2015) – higher targets

New Regime (the 21st Century) – The State

- The State has included more “greenness” (Energy/environment) indicators into the promotion evaluation criteria
 - Public talks by central government officials since 2005-2006
 - Landry (2008) discusses the composition of promotion criteria
 - Economic development, human capital, quality of life, key infrastructure and environmental protection (30%)

Motivations behind the Central Government's Green Push

- First, the national government may be responding to the rising “green” demand of the urban middle class.
- Second, domestic energy security concerns have risen on the central government's agenda as a result of electricity shortages and rapidly rising energy consumption.
- Third, the central government believes that the rest of the world is embracing the low-carbon energy agenda has created a market imperative for China to become a technological and economic leader in this nascent field (Boyd 2012).

Motivations behind the Central Government's Green Push (con't)

- The last explanation is that the central government seeks "legitimacy" with the Chinese people and also in the international arena, and making a commitment to pursuing environmental goals is one way to credibly signal to both domestic constituents and international actors that China is an international leader and that the Communist Party leadership cares about its own people (Wang 2012).

New Regime (21st Century) – The Public

- Urban households care more about quality of life
 - Kenkel, Lillard and Liu (2009) – the drop of smoking rates since 1990 in China.
 - 33% price premium for imported baby milk after the tainted baby milk scandal in 2008.
 - Revealed preference evidences: Zheng and Kahn (2008, 2010, 2012), Zheng, Fu and Liu (2009), WTP for QOL sharply rose after 2000s



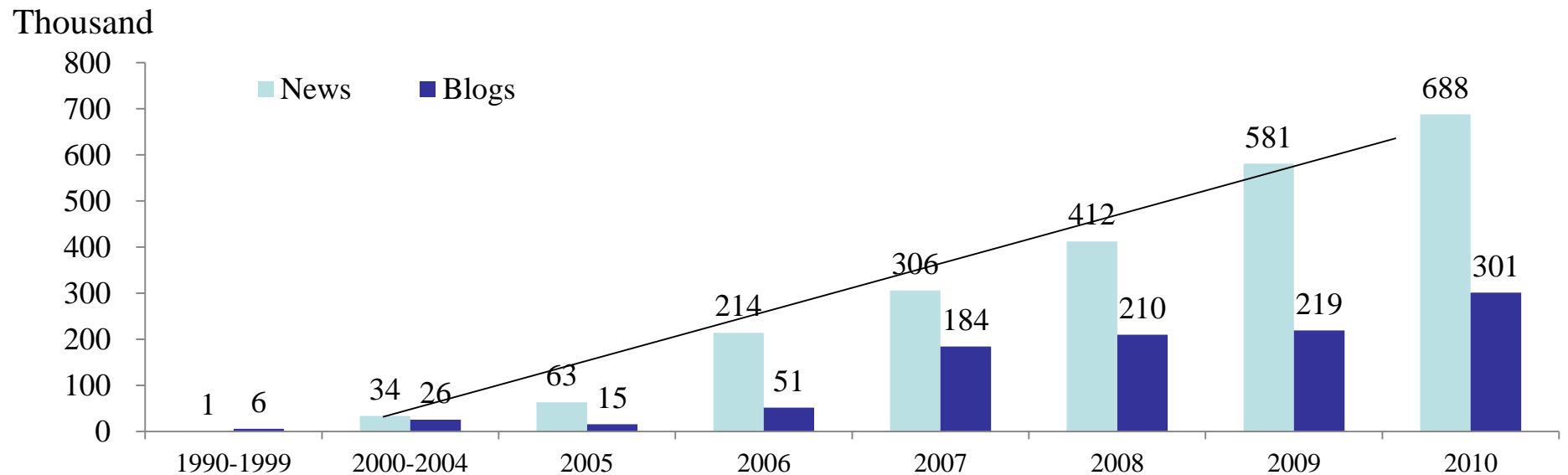
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10-21	● Hazardous	● Slightly Polluted
10-20	● Hazardous	● Light Pollution
10-19	● Very Unhealthy	● Good
10-18	● Unhealthy	● Good

Source: Los Angeles Times

New Regime (21st Century) – The Public

- No competitive election, but greater information transparency
 - Rising demand for information and political accountability

Num. of News and Blogs about Environment in Google



Main Hypotheses

- H1: Local officials are more likely to be promoted if their city experiences environmental progress. (?)
- H2: Those regions (province/city) facing stronger demand for environmental quality and with higher media openness have higher public concern intensity. (?)
- H3: The attributes of the local leaders are associated with environmental outcomes. Cities with higher educated leaders experience greater energy and environmental progress. (?)
- H4: Cities facing more pressure from the public will engage in greater energy conservation and environmental protection. (?)

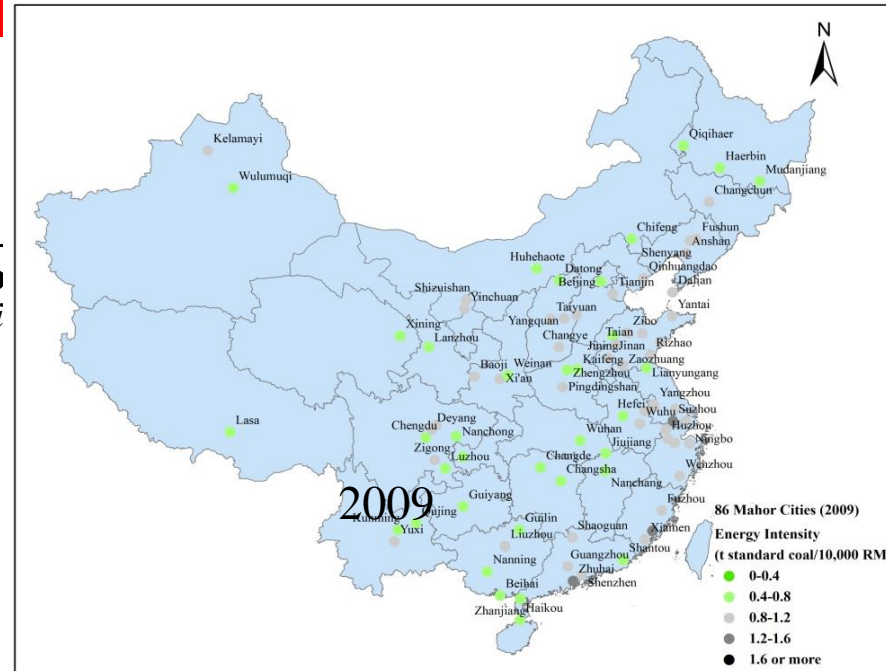
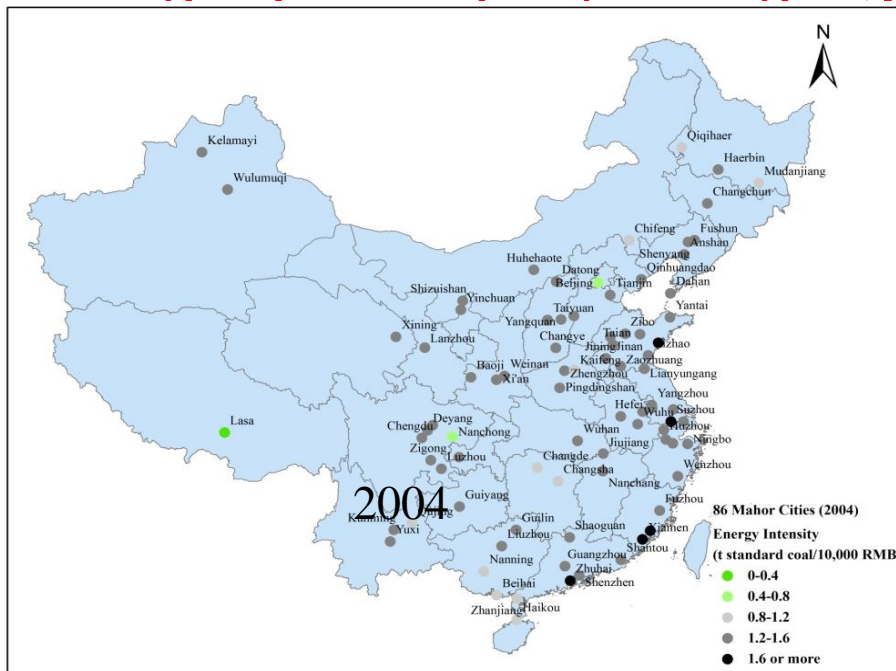
Local Officials' Promotion Criteria

- Whether energy conservation and pollution reduction indicators are reflected in city mayors' promotion criteria?

$$\begin{aligned} Promotion_{it} = & \beta_0 + \beta_1 \cdot GDP_Growth_{it} + \beta_2 \cdot \mathbf{GREEN}_{it} + \beta_3 \cdot \mathbf{Z}_{it} \\ & + \textit{City fixed effects} + \textit{Year fixed effects} + \delta_{it} \end{aligned}$$

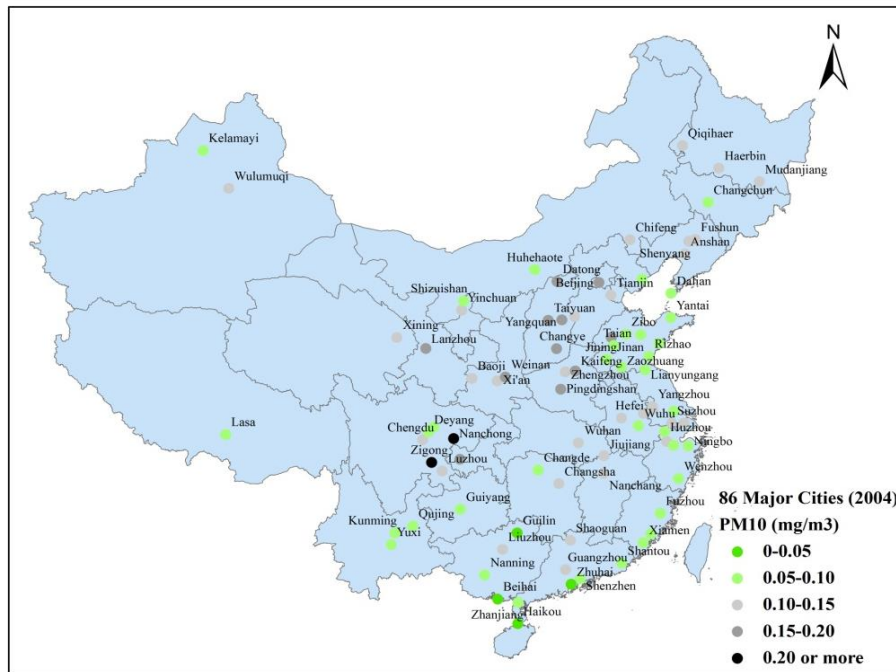
Green Indicators-*EI*

- *EI* (Energy intensity): energy consumption per GDP dollar – “Yearbook” numbers
 - (t standard coal per 10,000 RMB)

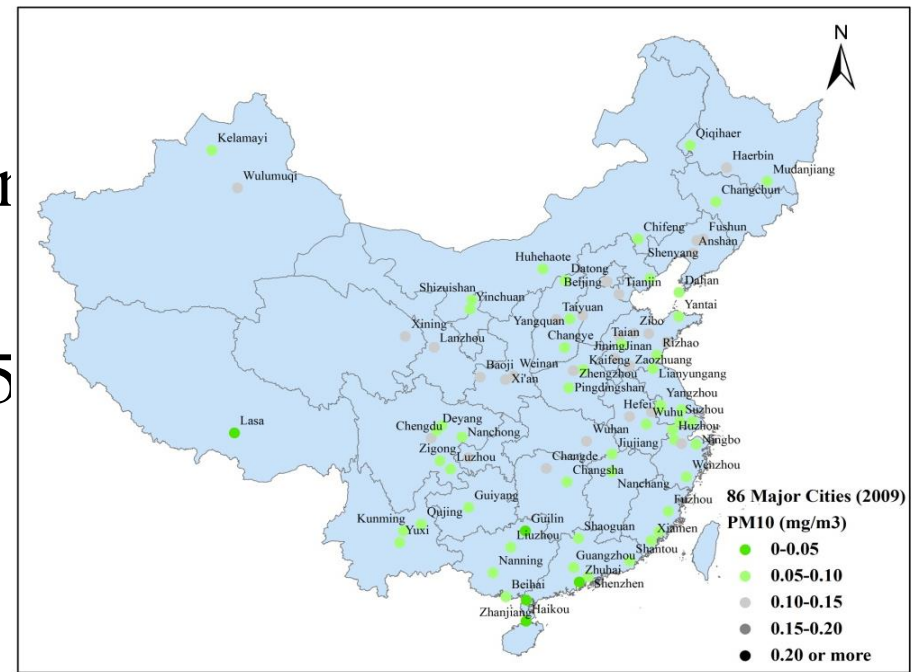


Green Indicators-*Air Pollution*

- Annual expenditure on waste gas treatment facilities per GDP (*FACILITY_EXP*)
- PM10 (mg/m^3) –“objective” pollution



2004



2009

Mayor Promotion Regressions Using Data from 2004-2009 for 86 Cities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>GDP_GROWTH_M</i>	3.710*** (4.61)	3.673*** (4.61)	3.657*** (4.59)	3.745*** (4.62)	3.738*** (4.64)	3.741*** (4.66)	3.720*** (4.64)
<i>PM10_DECLINE</i>		0.319* (1.67)				0.333* (1.75)	
<i>PM10_{p75}_DECLINE</i>			0.358** (2.10)				0.361** (2.11)
<i>EI_DECLINE</i>				0.312* (1.70)		0.331* (1.82)	0.335* (1.84)
<i>FACILITY_EXP(lag1)</i>					0.952*** (2.83)	1.009*** (3.01)	0.983*** (2.93)
<i>AGE_MAYOR</i>	0.0188** (2.11)	0.0180** (2.00)	0.0176** (1.97)	0.0185** (2.08)	0.0184** (2.08)	0.0170* (1.92)	0.0167* (1.89)
<i>MASTER_MAYOR</i>	0.0643 (0.91)	0.0578 (0.82)	0.0519 (0.74)	0.0606 (0.86)	0.0661 (0.94)	0.0561 (0.81)	0.0499 (0.72)
<i>TERM_MAYOR</i>	0.466*** (2.69)	0.477*** (2.76)	0.491*** (2.89)	0.456*** (2.60)	0.472*** (2.74)	0.477*** (2.74)	0.492*** (2.87)
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	422	422	422	422	422	422	422
Pseudo R ²	0.227	0.232	0.234	0.230	0.235	0.245	0.247
chi2	87.34	88.08	90.85	87.06	92.39	93.80	96.28
Joint F test for <i>PM10_DECLINE</i> (<i>PM10_{p75}_DECLINE</i>), <i>EI_DECLINE</i> and <i>FACILITY_EXP(lag1)</i>						14.88*** (0.0019)	15.87*** (0.0012)

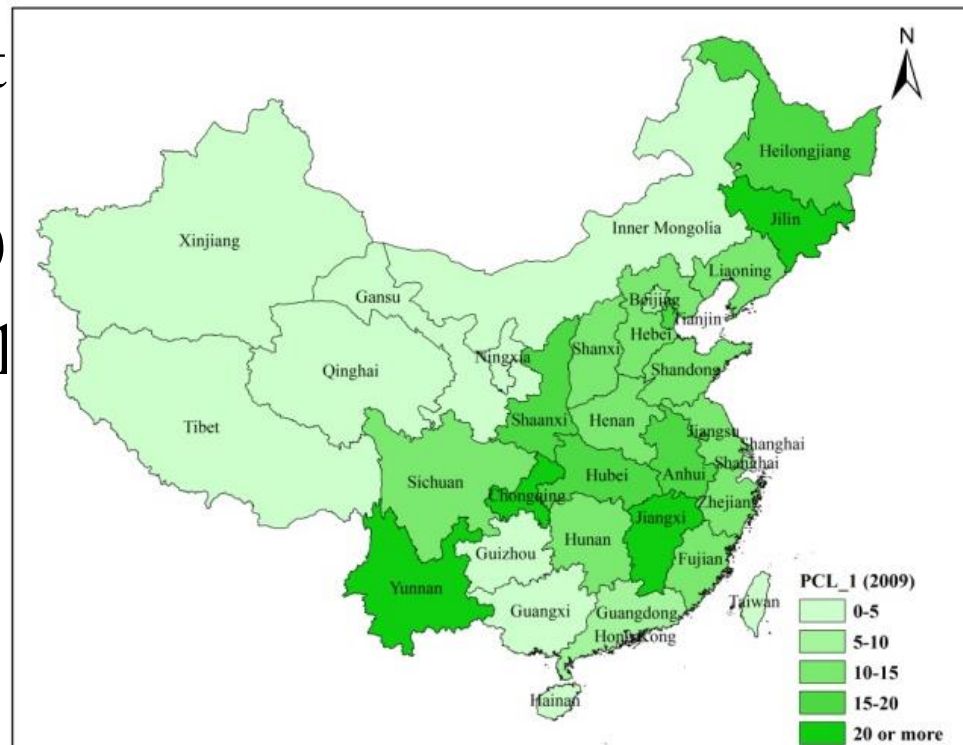
Public Concern Intensity over Pollution

- Public opinion (Google index)
 - Dasgupta and Wheeler (1997): The number of public's complaint letters
 - Google Insights Index
 - Google Search Index

Public Concern Intensity over Pollution

- Google Insights Index
 - Compiled by Google Insights, which measures the internet search intensity of a specific keyword

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The Spatial and Temporal Variations

$$\log(PCI_{it}) = \alpha_0 + \alpha_1 \cdot \log(DIS_HK_i) + \alpha_2 \cdot \log(INTERNET_{it}) + \alpha_3 \cdot \log(GDPPC_{it}) + \alpha_4 \cdot EDU_{it} + \alpha_5 \cdot ACC_NUM_{it} + \alpha_6 \cdot \log(POP) + \text{region fixed effects} + \text{year fixed effects} + \varepsilon_{it}$$

Dependent Variables	log(PCI_1)	log(PCI_2)
	(1)	(2)
log(<i>D_HK</i>)	-1.417*** (-3.46)	-0.500*** (-5.05)
log(<i>INTERNET</i>)	1.118* (1.90)	0.241* (1.84)
log(<i>PM10</i>)	1.632* (1.74)	0.524** (2.07)
log(<i>GDPPC</i>)	3.254*** (4.91)	0.0516 (0.35)
log(<i>POP</i>)	-2.804*** (-4.47)	0.538*** (4.85)
<i>EDU</i>	0.961 (1.33)	0.265*** (3.13)
Constant	3.292 (0.40)	6.056*** (2.80)
East/west/central region dummies	Yes	Yes
Year fixed effects	Yes	Yes
Standard errors clustered	By province	By city
Observations	180	498
<i>R</i> ²	0.505	0.492

Discussion

- Our optimistic view about the rise of China's "Blue Skies" hinges on:
 - Rising middle class demand for quality of life.
 - Increased information transparency (civil society and a media) that encourages the accountability of governments and firms.
 - The inclusion of sustainability into local politicians' performance criteria.
 - Technology transfer and endogenous innovation