Trade and Climate Change:
Chinese Facts and Its Implication 1978-2009

The 13th SUIBE-KAS WTO Forum

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Topics

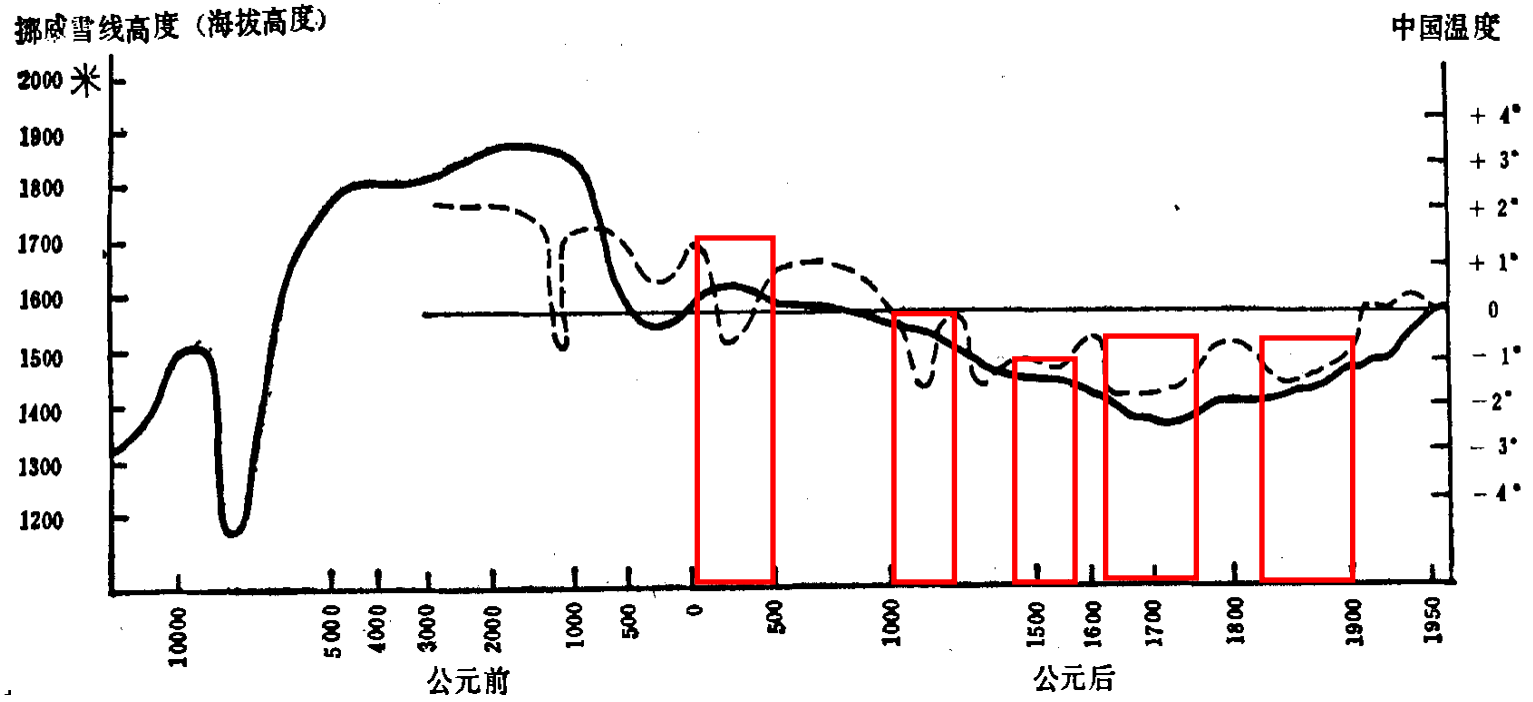
- What is the theory?
- What is the facts in China 1978-2009?
- What is the implications?

What is the theory?

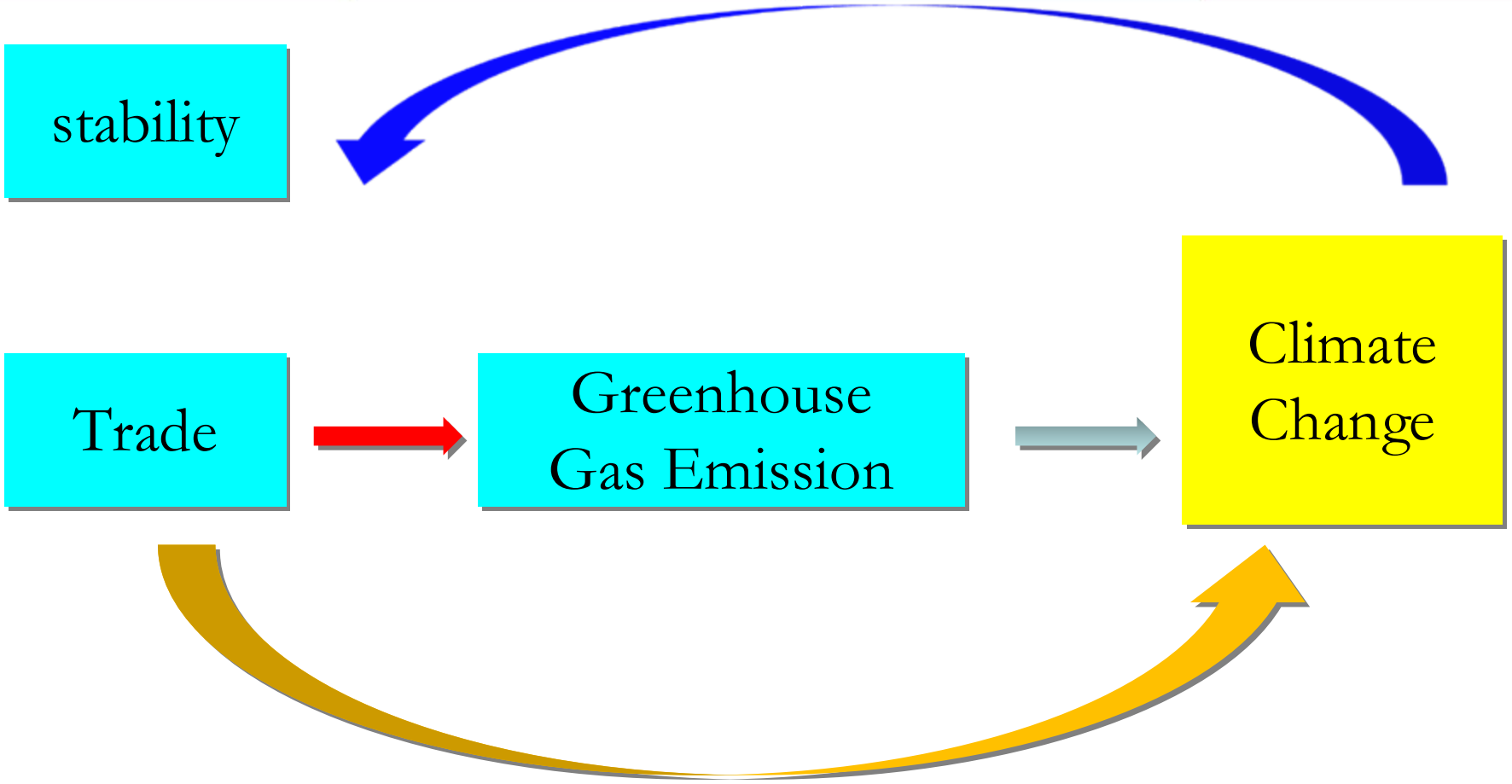
- Theory in Chinese and European history
  - Climate change was one of the biggest shocks on dynastic collapse , Song Dynasty in China, Yuan, Maya
  - Huntngton (1915), Montesquieu (1750) , Marshall (1890), Dell, Jones and Olken (2008) etc.
- Nowadays Theory about Climate change
  - **Pollution heaven hypothesis** (Grossman, 1995; Copeland and Taylor(2003)，等)
  - **Environmental Kuznets Curve** (McCarney and Adamowicz(2005)

Chinese historical facts

- Average temperature change in past 5000years

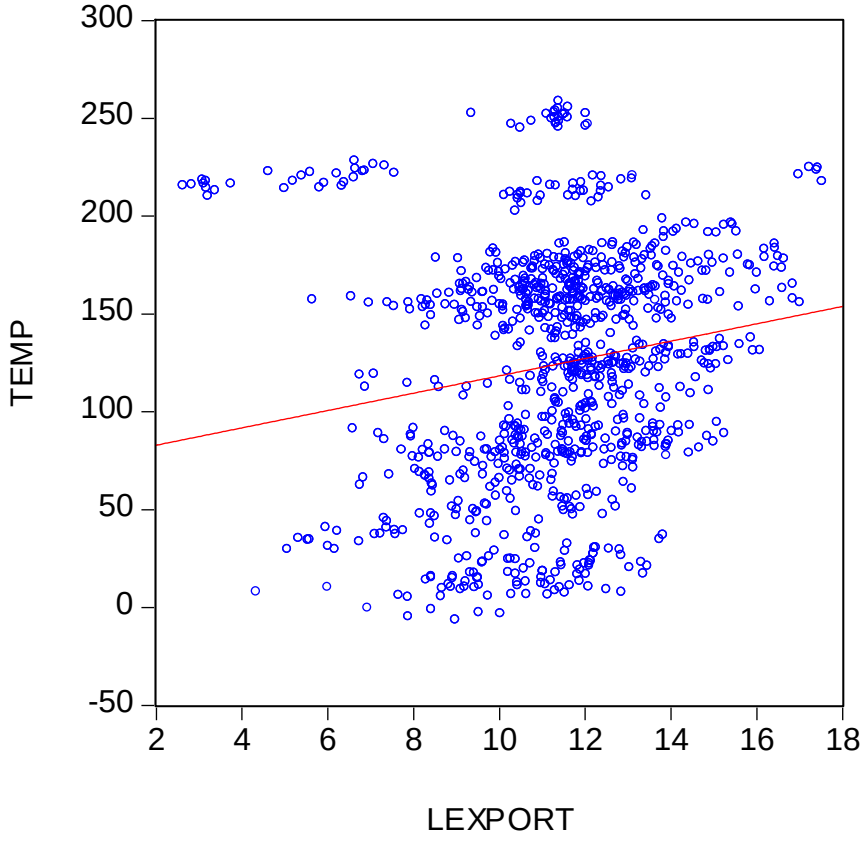


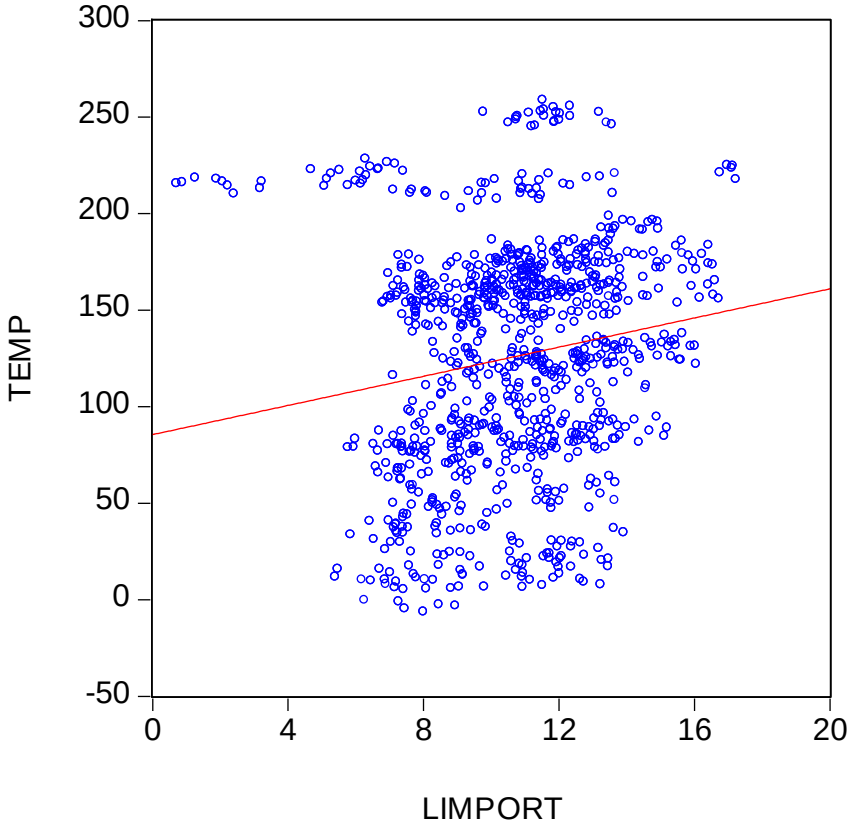
Mechanisms



National Facts during 1978-2009

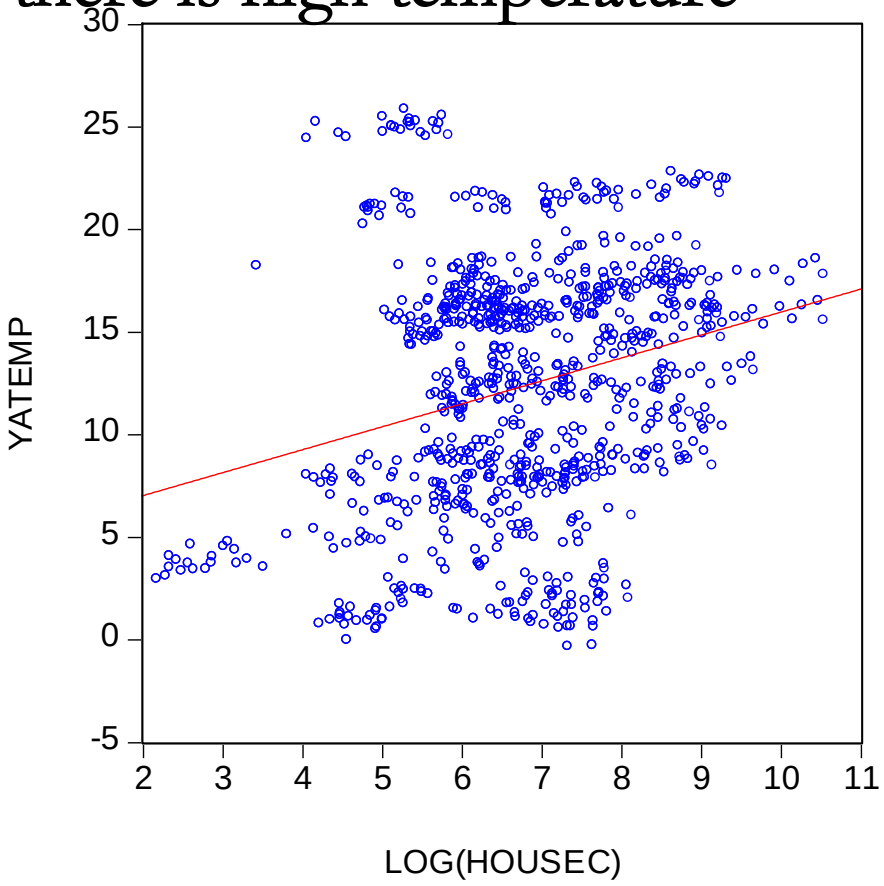
Where there is more trade, there is high temperature

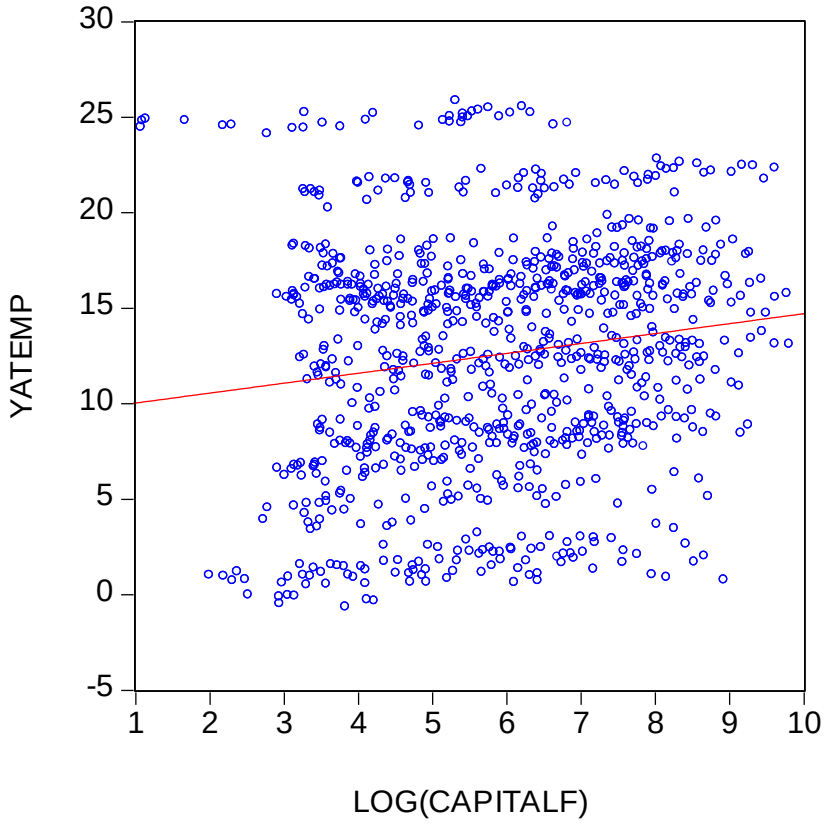




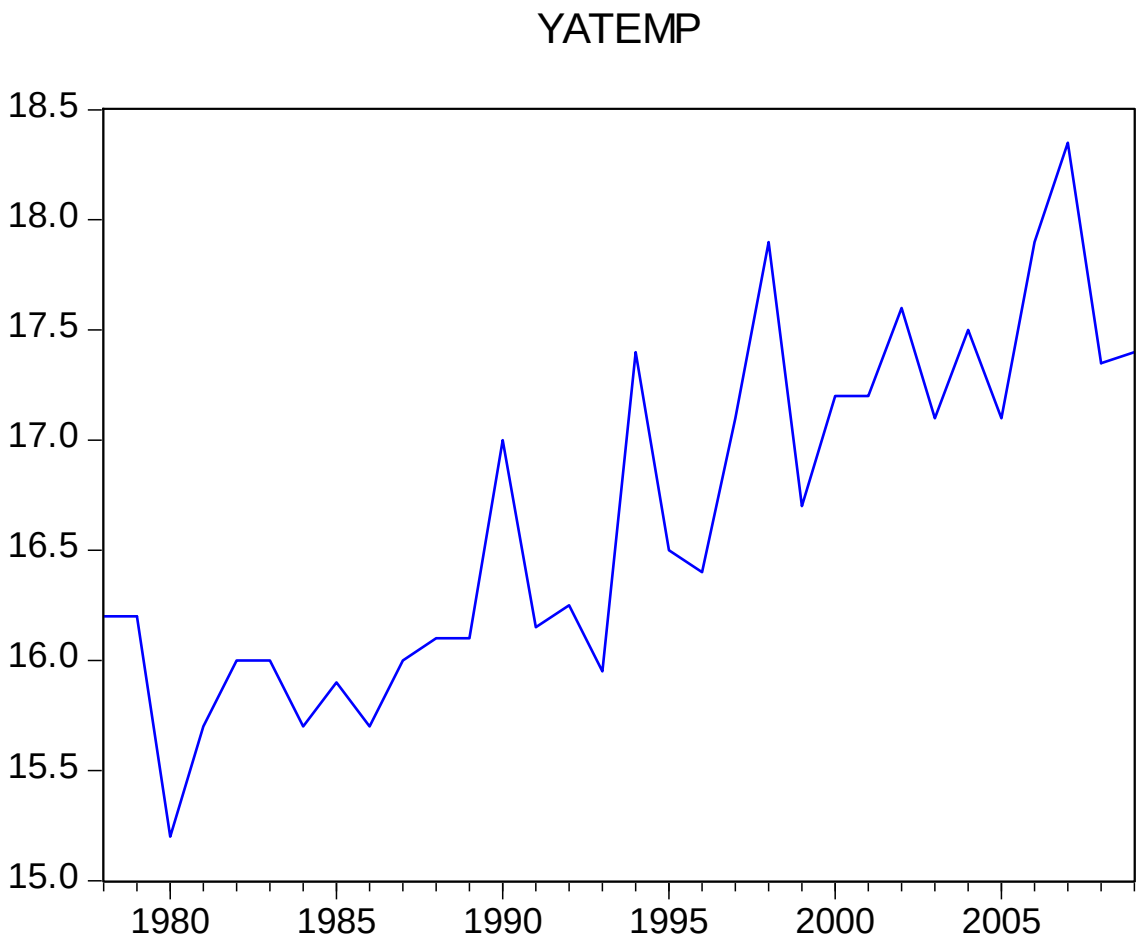
House construction, capital formation and temperature

Where there is more house construction, and capital formation, there is high temperature



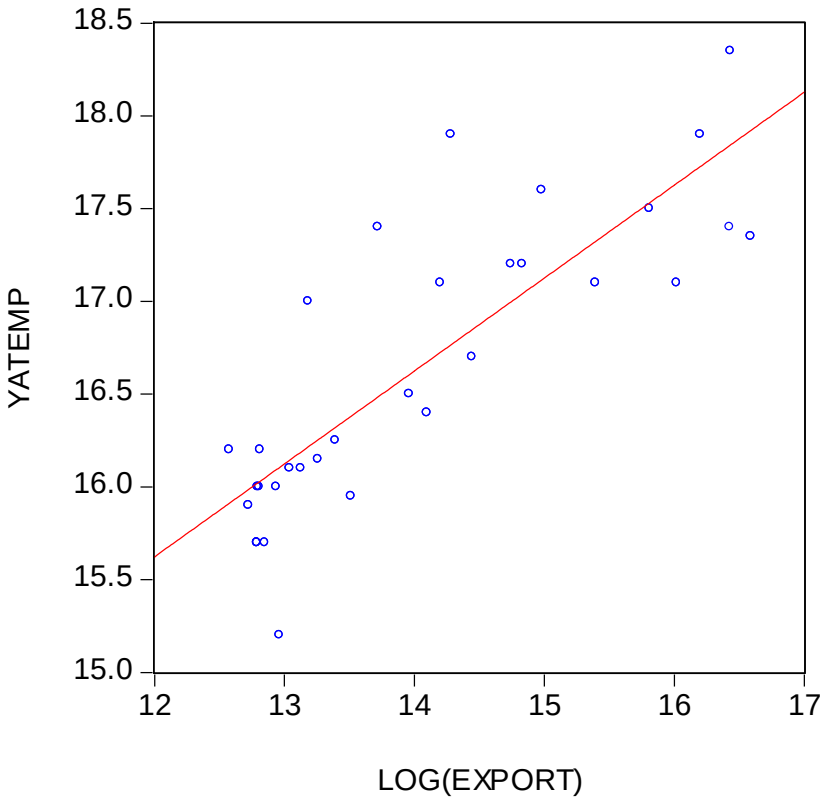


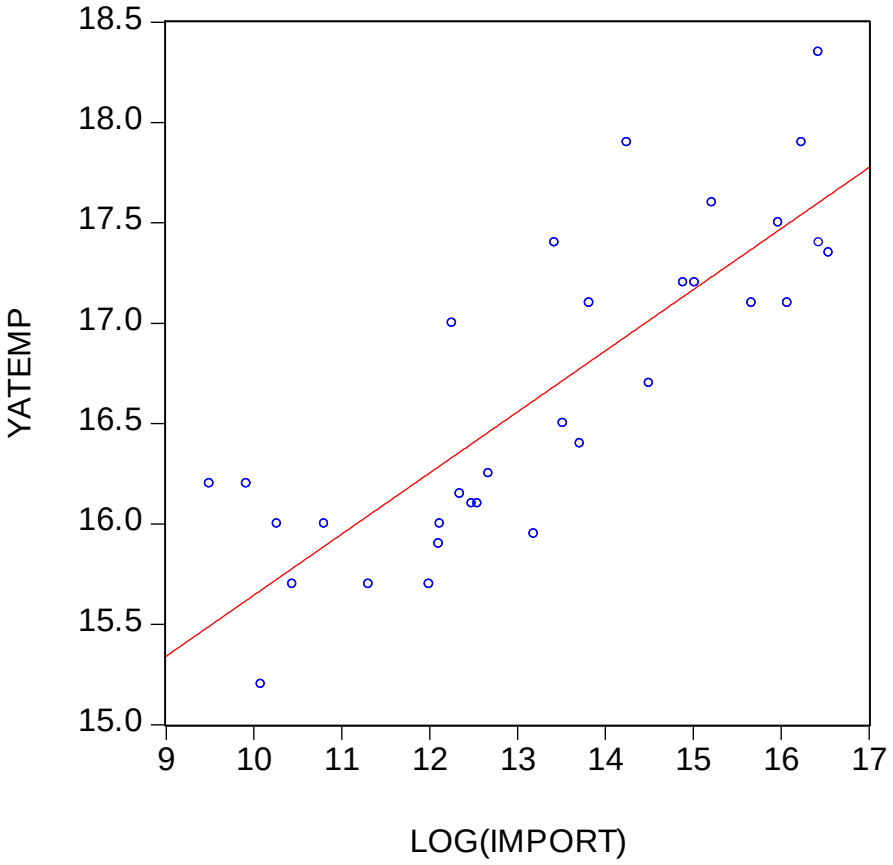
Yearly average temperature in SH 1978-2009



Export ,import and temperature in SH

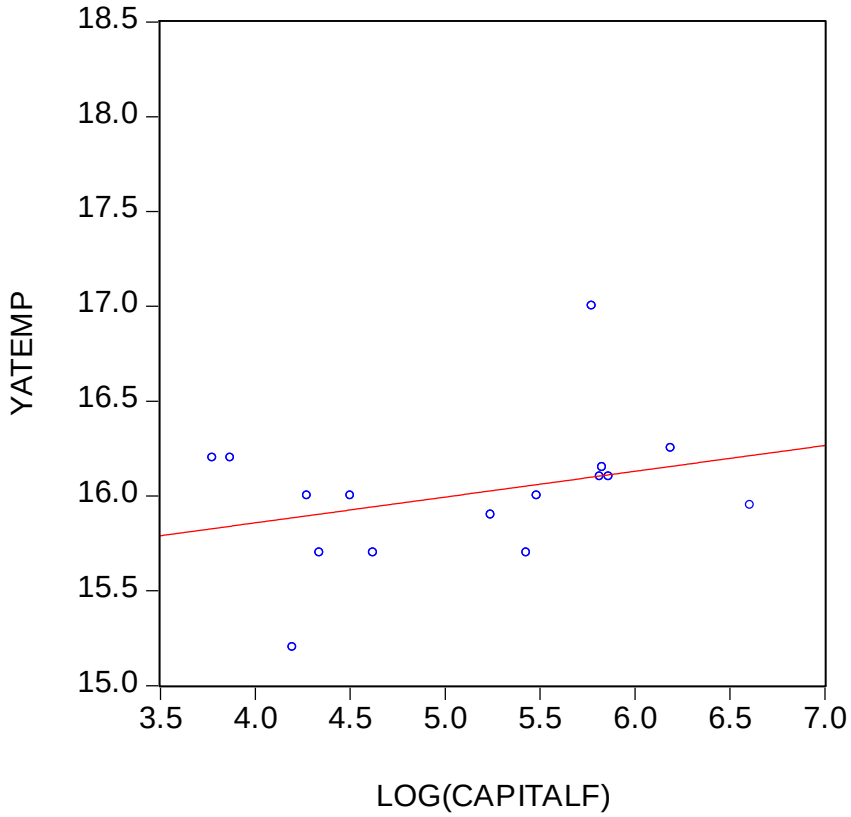
The more you trades, the high temperature you have

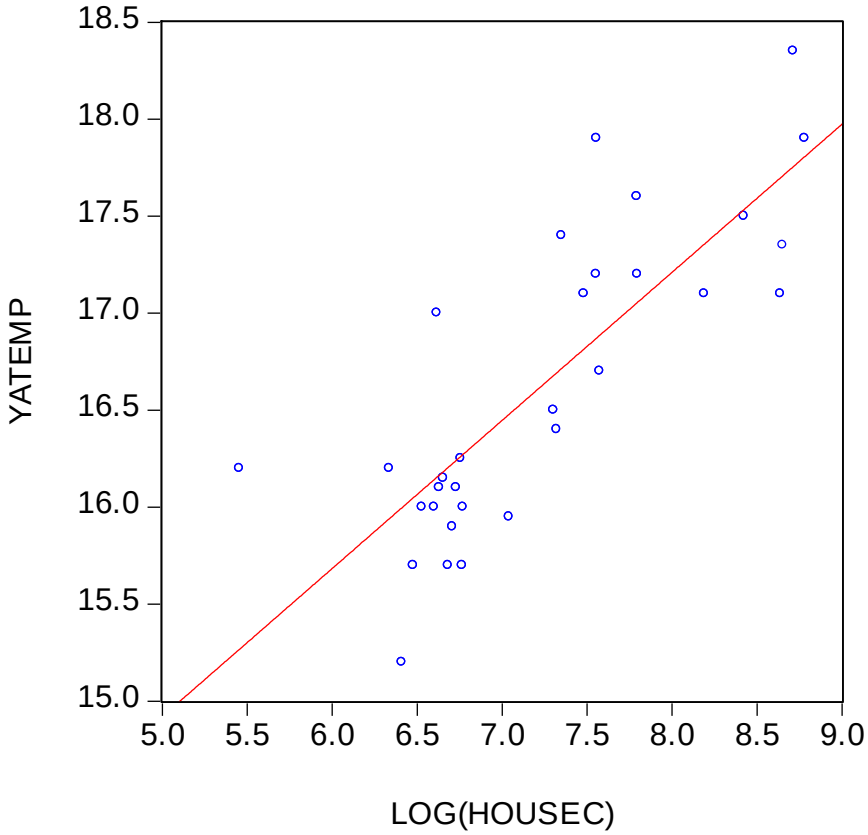




Capital formation, household and temperature in SH

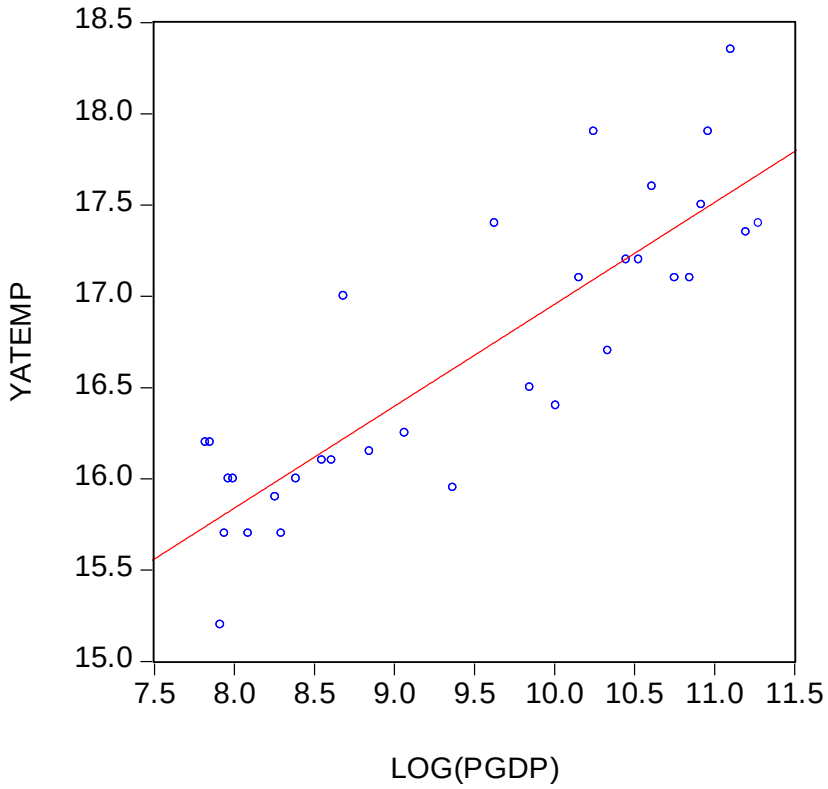
The more construction you have, the high temperature you have



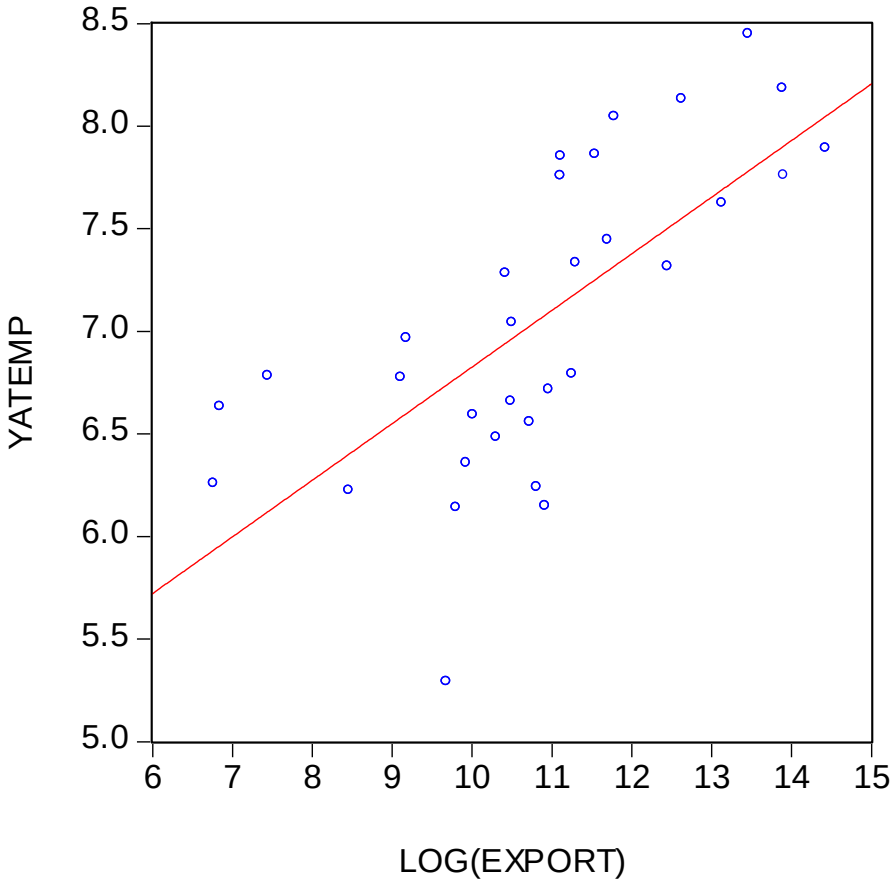


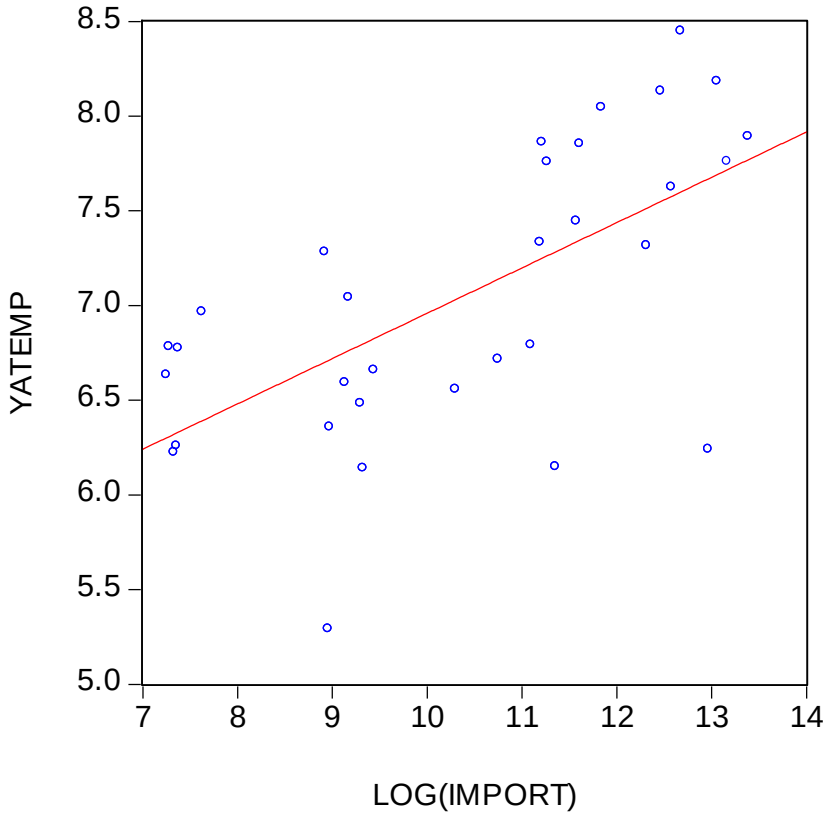
the More money you have, the higher temperature you have to endure in SH

This is true for east, west and central reigons

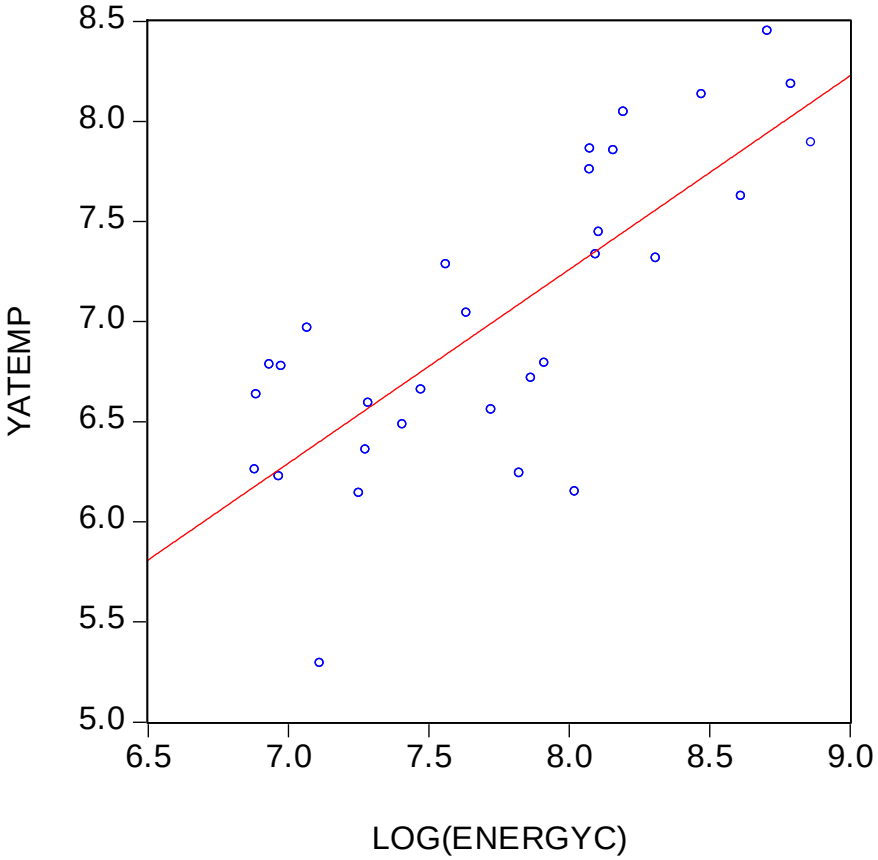


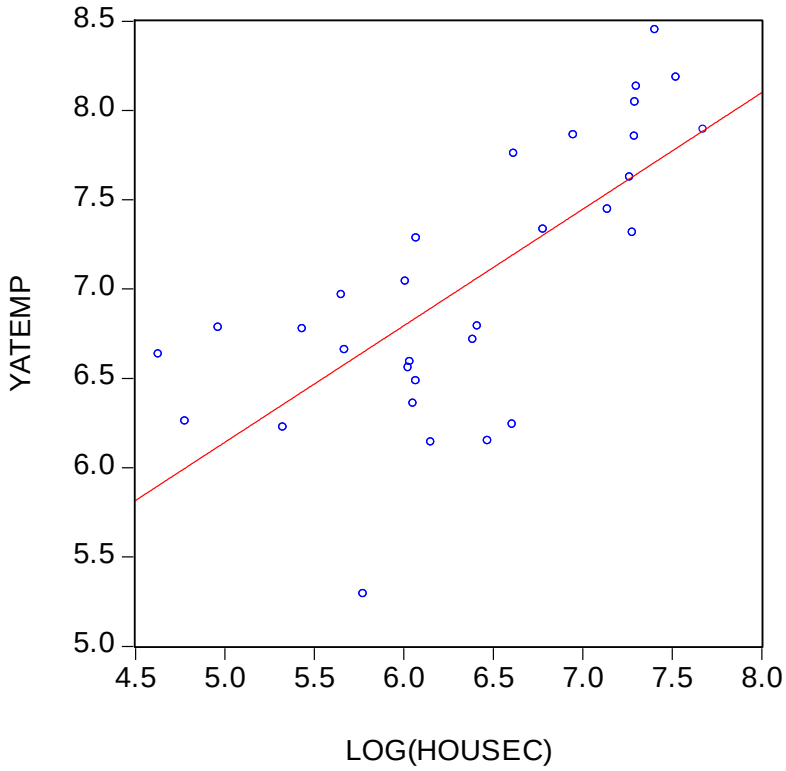
It is enve true for XJ





It is true for XJ either





What is the implications?

- Trade makes China well off but raise temperature higher in our dataset
- We can have high speed development in very short time, but we can not make tree, grass grow in very short time, in the end the capability of nature for absorbing green house gas become much weaker
- implications
  - Chinese Production pattern should be ungraded into more greenness, more cleaner pattern
  - China should upgrade its trade pattern into more cleaner, more greener pattern
  - China should keep a good balance between development and environment, otherwise we will lose all

碳生产率变动与出口产品的质量演进

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碳生产率变动与出口产品的质量演进

内容提要：提高碳生产率是各国应对低碳发展要求的必由之路。碳生产率变动将改变各国的要素禀赋结构，使参与国际分工的要素种类和质量发生变化，导致对外贸易产品质量的演进。本文得到以下主要结论：

（1）碳生产率作为一种新的比较优势决定因素，对提高各国出口复杂度至关重要；不论是高收入国家还是低收入国家，碳生产率的提高都能够显著促进出口复杂度的提升；

（2）各类资本禀赋与出口复杂度间存在倒“U”型关系，并且这种关系在高收入国家和低收入国家中存在差异；

（3）自然资源禀赋不利于出口复杂度提升的“资源诅咒”现象更容易在低收入国家出现；高收入国家的国家制度和基础设施等对出口复杂度的促进作用更为明显；经济开放度的扩大更有利于低收入国家的出口复杂度提升。因此，提高碳生产率、扩大经济开放度等对于包括中国在内的发展中国家而言非常重要。

汇报内容

一、选题背景及意义

二、国内外研究动态

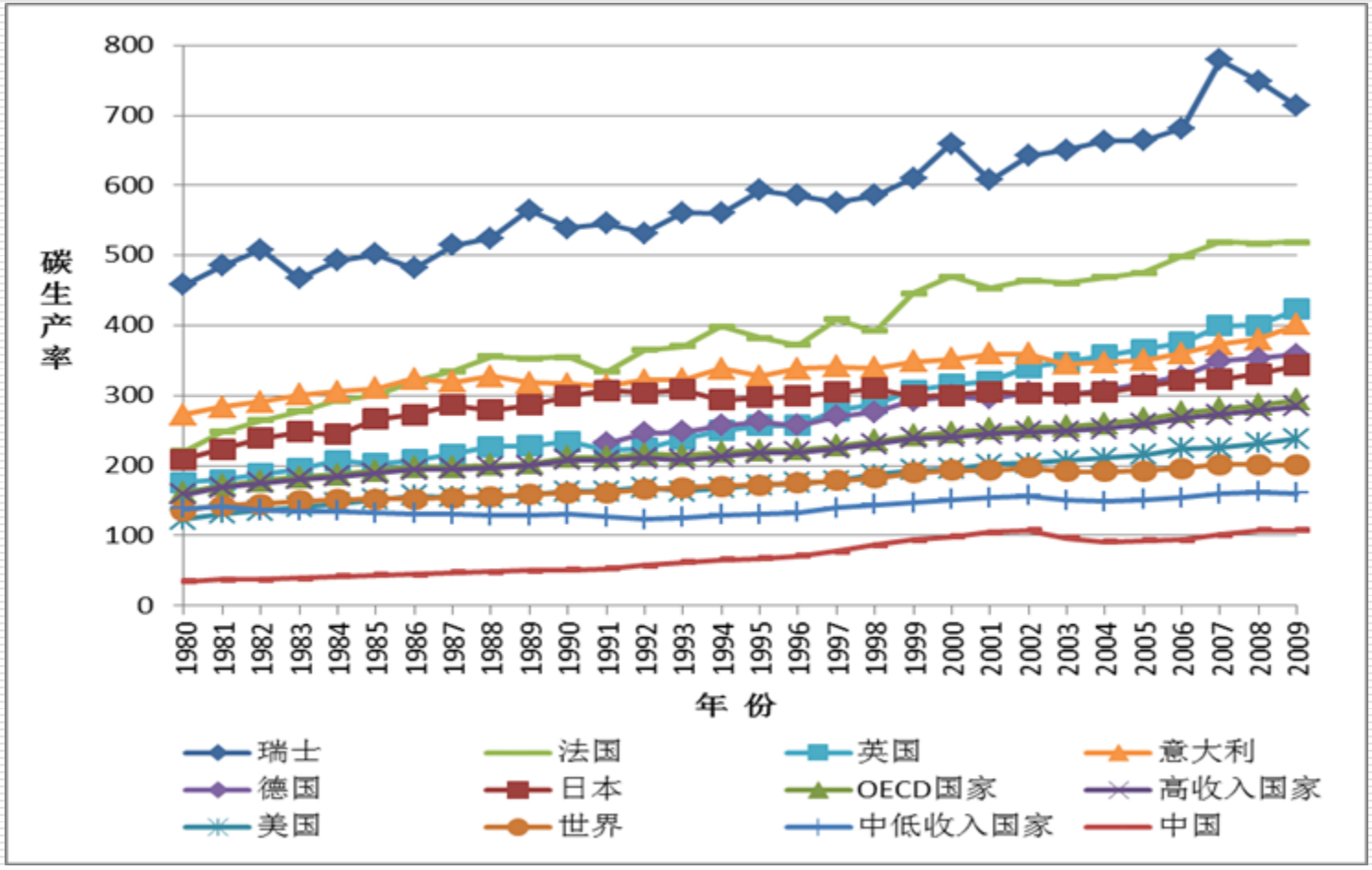
三、出口复杂度演进分析

四、实证方法和过程

五、研究结论

一、选题背景及意义

- 提高碳生产率是世界各国应对低碳发展要求的**必由之路**。
- 在低碳背景下，**减少碳排放**和**保持经济增长**是当前世界各国共同面对的两大目标，而实现这两个目标的唯一途径就是**提高碳生产率**（Beinhocker et al, 2008）。
- 发展低碳经济的**核心**在于提高碳生产率。


碳生产率
800
700
600
500
400
300
200
100
0
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1983
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2007
2008
2009
年 份
瑞士
法国
英国
意大利
德国
日本
OECD国家
高收入国家
美国
世界
中低收入国家
中国

图1 世界碳生产率变动

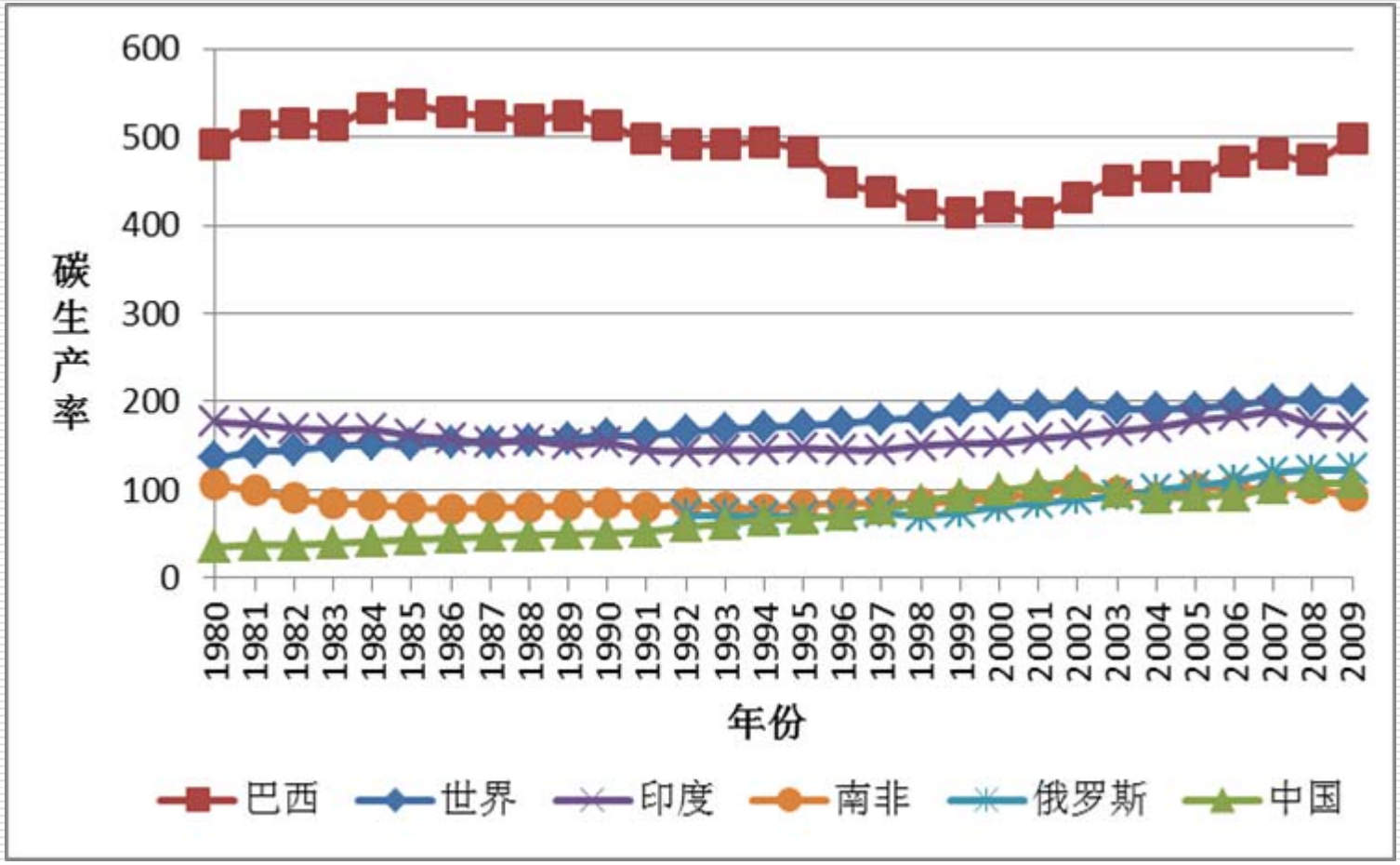


图2 金砖五国的碳生产率变动

- 碳生产率变动的经济影响如何？
- 碳生产率提高意味着该国产品的竞争力要从依赖于低成本的资源、环境要素向依赖于技术创新、人力资本和信息管理等要素的转变，参与国际分工的要素种类和质量等会发生质的变化，表现为对外贸易产品的质量和技术等的提升。

- 而出口复杂度是集要素禀赋、技术结构、质量等为一体的综合概念（Rodrik，2006；陈晓华，2012），其为衡量出口产品的质量和技术等提供了新视角。
- 因此，碳生产率变动将改变世界各国对外贸易赖以发展的资源禀赋结构，从而改变现有的国际分工及其贸易格局。

- 如何在碳生产率变动导致的新一轮国际贸易格局演变中，提升中国对外贸易的质量和效益，是当前中国政府和理论界迫切需要解决的重大问题，它符合中国外贸发展质量效益提高的转型战略。

- 国家“十二五”规划明确提出了“**加快转变外贸发展方式，推动外贸发展从规模扩张向质量效益提高转变、从成本优势向综合竞争优势转变**”的战略目标。

- 现有文献更偏重于分析国际贸易对碳排放的影响（闫云凤，2011），分析碳排放对国际贸易影响的很少。
- 因此，分析碳生产率变动对各国出口复杂度演进的影响，**具有重要的理论和现实意义**。

二、国内外研究动态

- 近十年来，国内外学者对国际贸易的研究重点由出口数量转向出口质量，而出口复杂度是衡量出口质量的常用分析工具；
- 与此相对应，出口复杂度变动及其成因等成为国际经济学界研究的热点问题（Rodrik，2006；Schott，2008；Wang and Wei，2010；Xu and Lu，2009；祝树金、涂志敏，2012）。

- 已有研究主要运用两种方法来测算各国的出口复杂度：

  （1）基于收入水平的测算指标

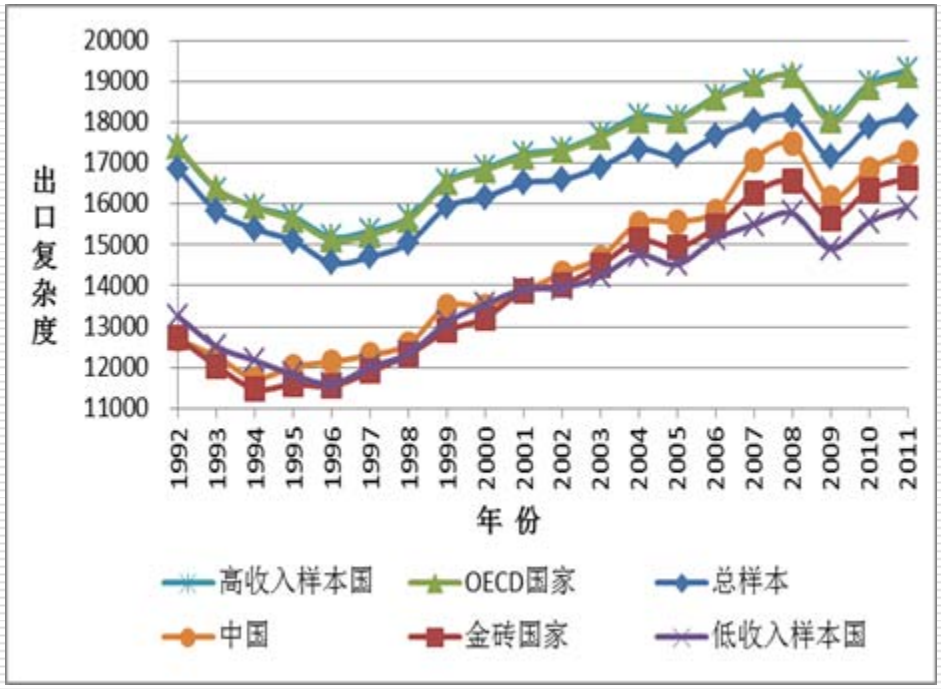
  （2）出口相似度指标

- 本文在Xu（2010）的思路基础上，构建考虑产品异质性的出口复杂度测算方法，测算出171个国家1992~2009年间的出口复杂度。

- 关于出口复杂度演进的原因，在跨国层面上，已有研究强调传统要素禀赋（**资本、劳动力、自然资源等**）及其制度变量、贸易等的作用。忽略了碳生产率变动这个核心变量的影响。

- 在低碳经济背景下，碳生产率作为一个核心的内生变量，其变动如何影响出口产品的质量？本文引入碳生产率这个新的影响因素，采用171个国家1992-2009年的面板数据，实证检验了碳生产率等因素对出口复杂度演进的影响。

三、出口复杂度演进分析



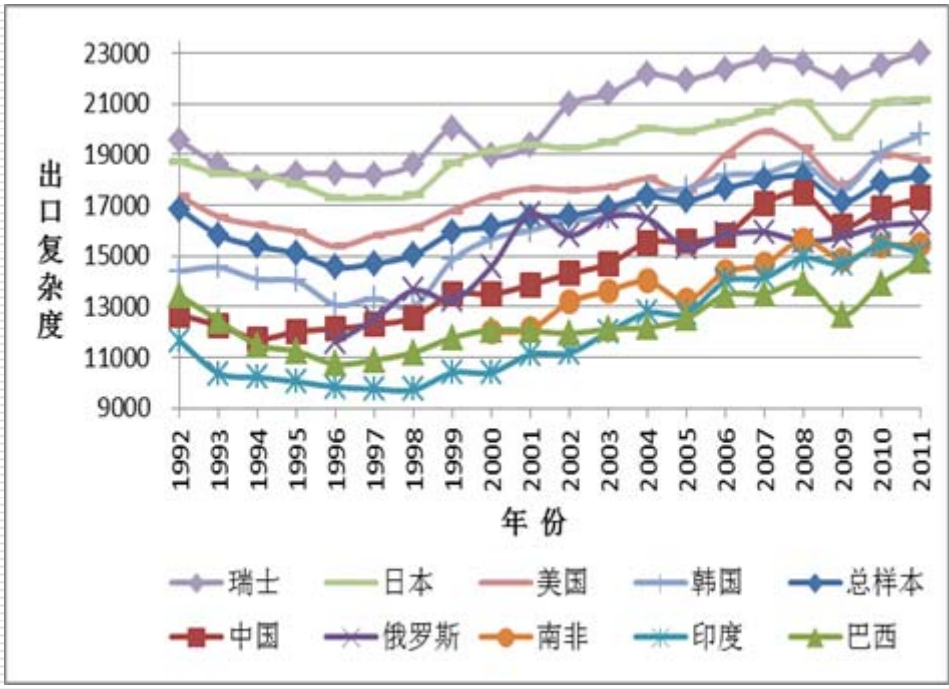


图3　典型国家（地区）的出口复杂度演进

四、实证方法和过程

（一）计量模型及变量选取

本文借鉴Xu(2010)、王永进等（2010）模型的思路，在考虑传统资源禀赋等影响的基础上，引入碳生产率变量的影响，构建如下的出口复杂度演进决定因素的计量模型：

$$lnEXPY_{ct} = \gamma_c + \tau_t + \beta_1 \ln CP_{ct} + \beta_i contr_{it} + \varepsilon_{ct}$$

- 其中，ln指取对数；EXPY表示出口复杂度；c表示国家（地区），t表示年份；CP指碳生产率；contr指其它控制变量，分别指各种资本禀赋、自然资源禀赋、基础设施、制度因素及其经济开放度等变量。
- Γ_c、τ_t、ε_{ct}分别表示反映国家之间差异的国家效应、随时间而变化的时间效应、其他干扰项。

（二）数据来源及处理

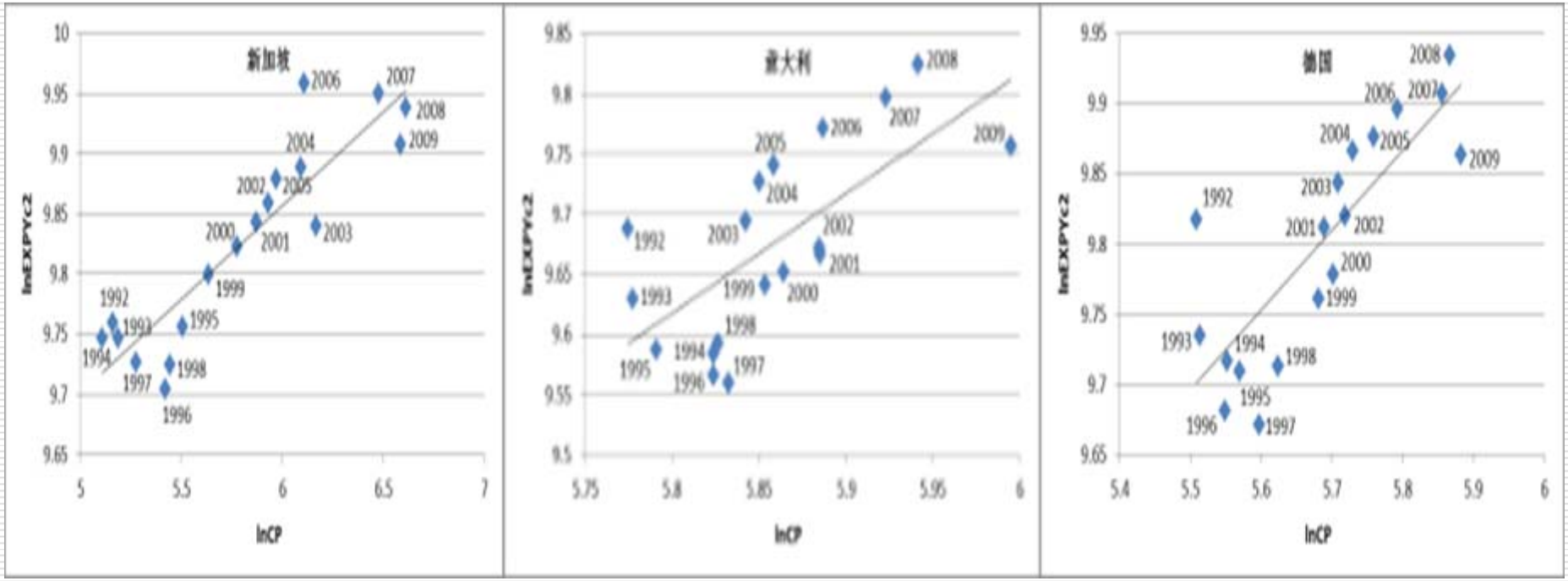
- 本文实际GDP及其人均GDP数据为2005年不变美元价，来源于世界银行开放数据库；碳排放量数据来源于美国田纳西州橡树岭国家实验室环境科学部二氧化碳信息分析中心，时间跨度为1992-2009年。
- 出口贸易及其价格数据来源于UN comtrade统计数据库，时间跨度是1992-2011年。

- 制度质量（rq）来自于世界银行Worldwide Governance Indicators数据库中的规制质量（Regulatory Quality）指标，
- 高等教育总入学率（setg）、资本劳动比（kl）、研发占GDP的比重（rdgdp）、每百人拥有手机数（mcs）、人均陆地面积（lpp）、FDI占GDP的比重（fdigdp）、出口占GDP的比重（exgdp）以及进口占GDP的比重（imgdp）等的原始数据都来源于世界银行公开数据库；

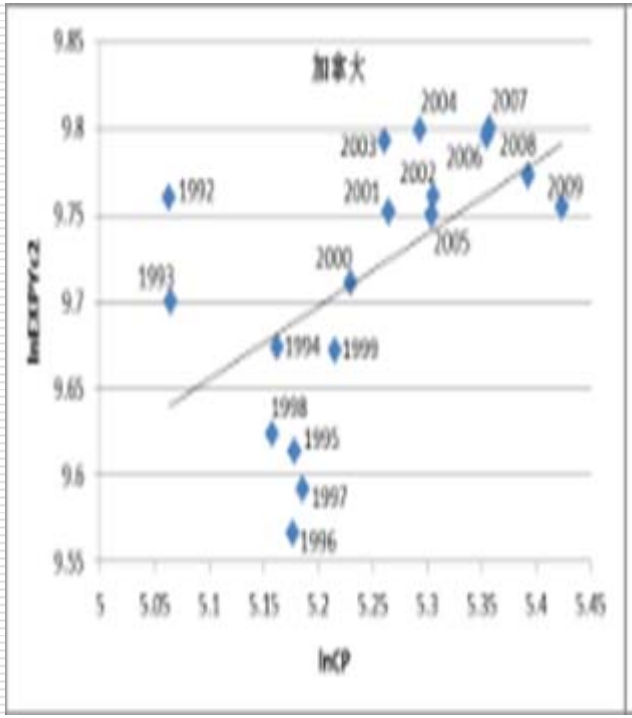
- 由于有些国家某些年度的数据缺失，因此，我们所采用的面板数据是非平衡的，最后确定的回归样本区间为1992-2009年。
- 为了检验结论的稳健性，我们分别对包含和没有包含其它控制变量、考虑和没有考虑内生性的情况都分别进行了回归分析。

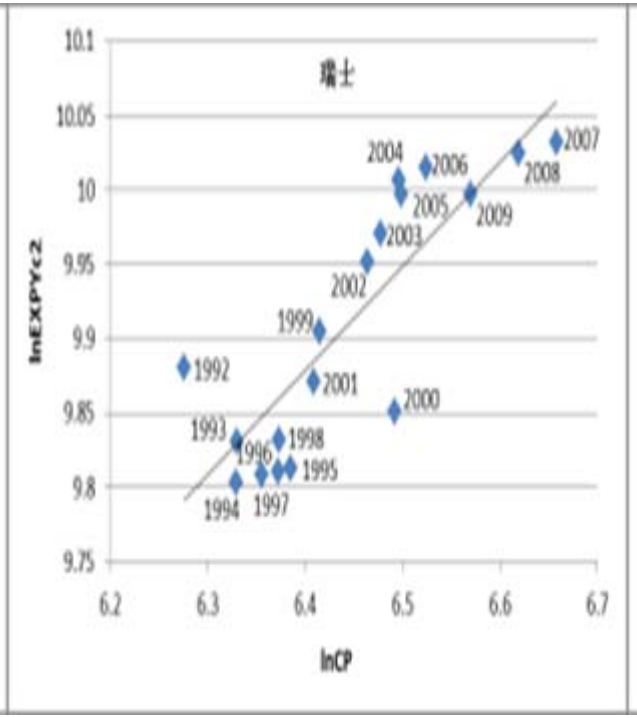
- 由于碳生产率等因素对不同收入水平国家出口复杂度的影响可能存在差异，我们还根据各国人均收入水平均值的大小，将由171个国家组成的总样本划分为53个高收入国家样本和118个低收入国家样本，分别对这两个样本进行回归并比较分析。

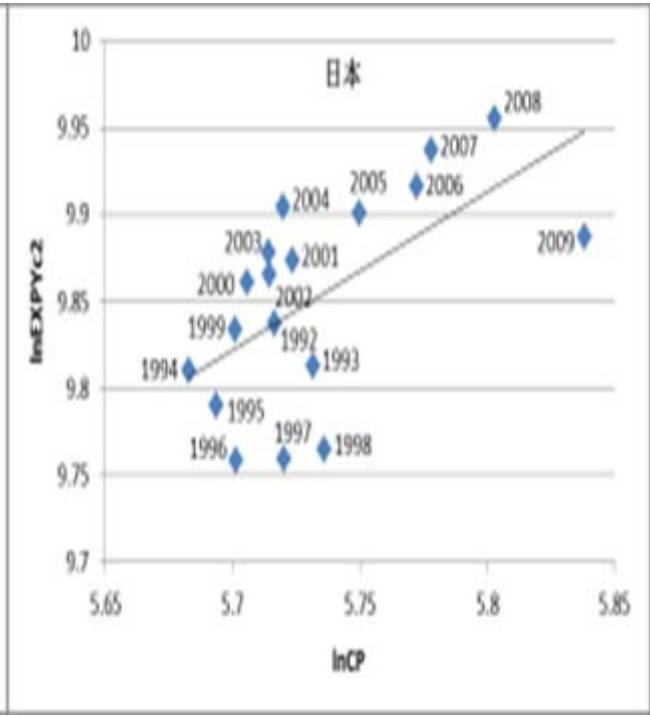
典型高收入国家的碳生产率与出口复杂度散点图



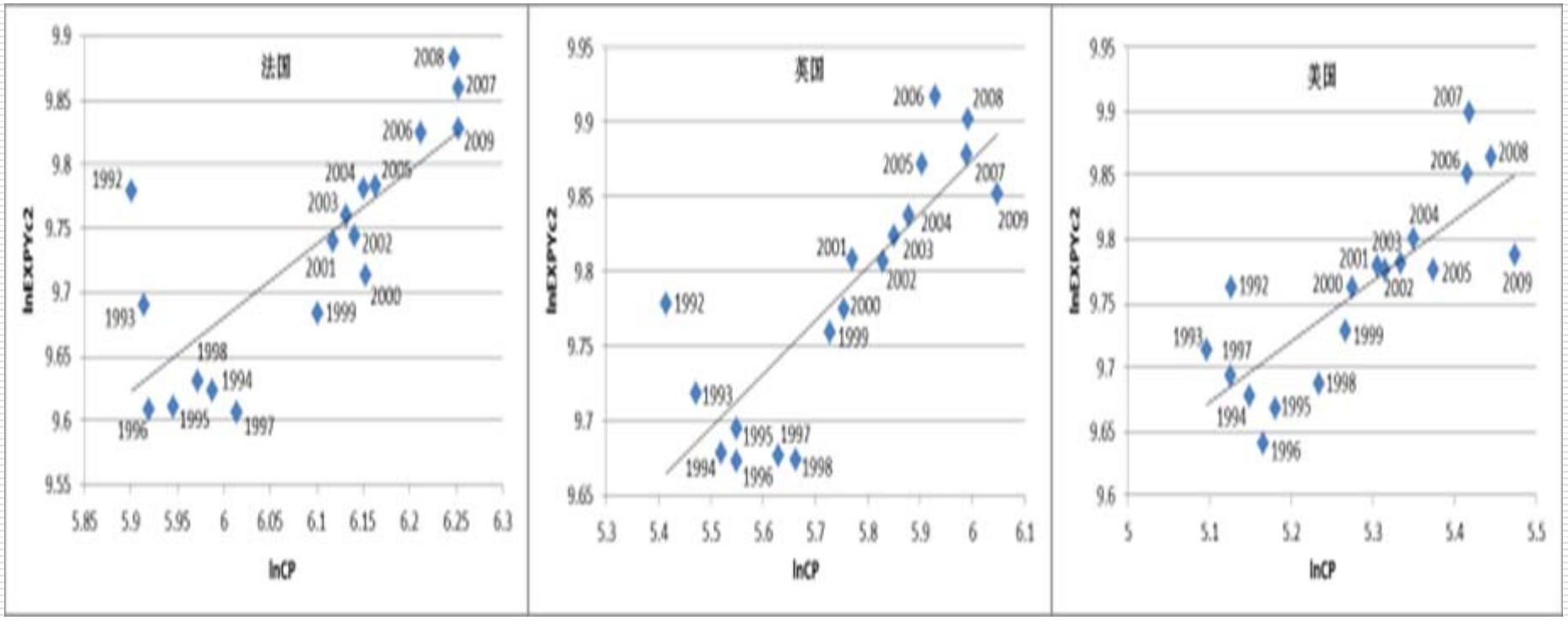
典型高收入国家的碳生产率与出口复杂度散点图



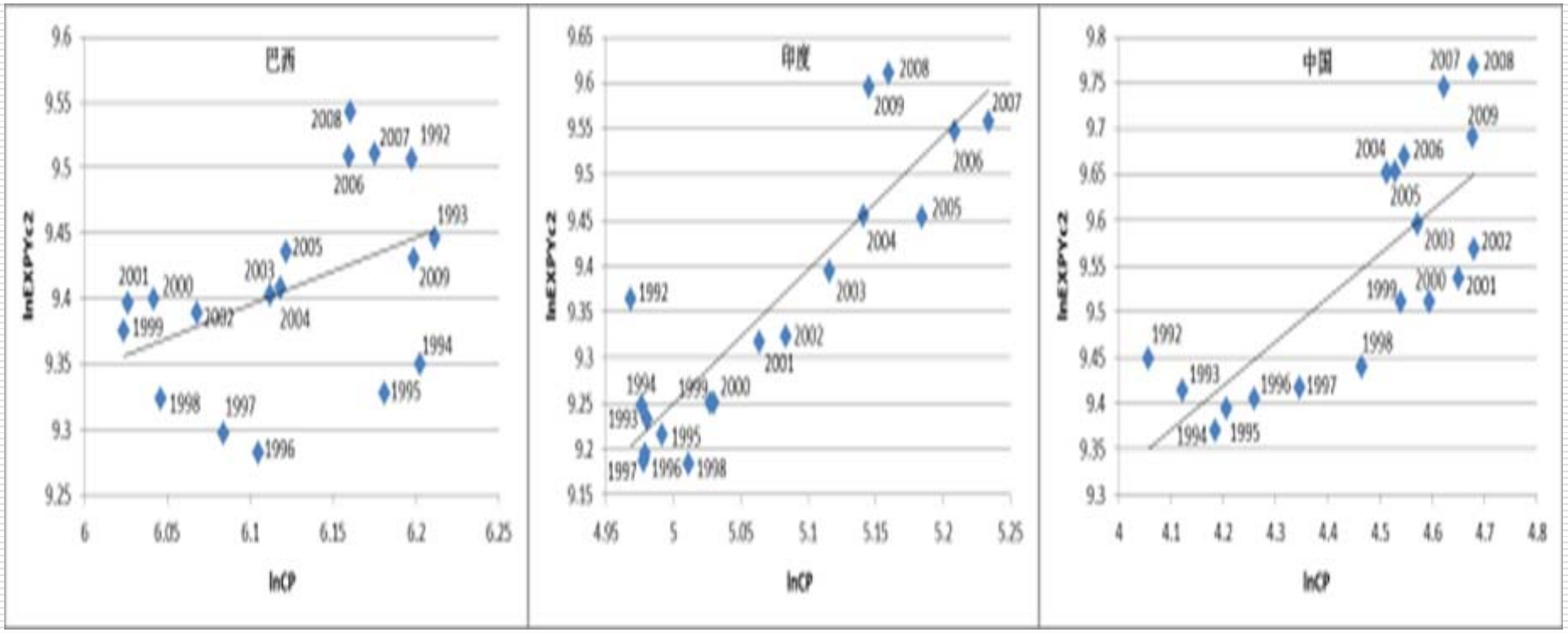




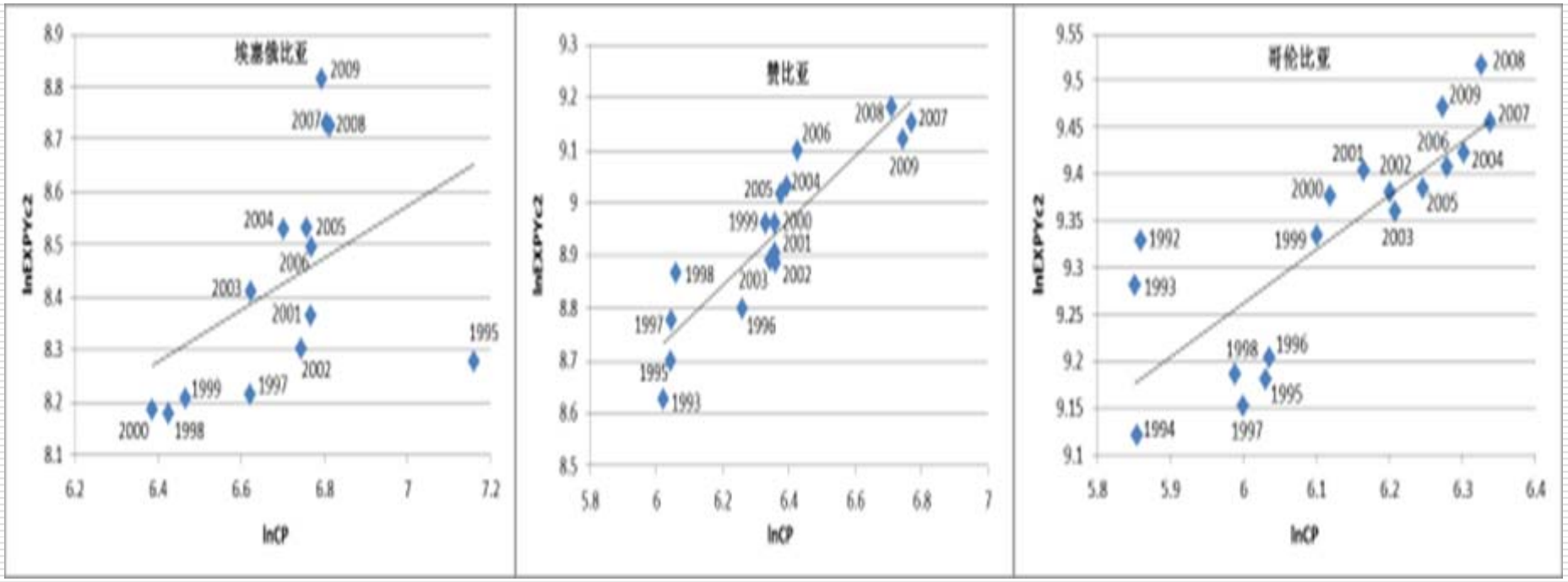
典型高收入国家的碳生产率与出口复杂度散点图



典型低收入国家的碳生产率与出口复杂度散点图



典型低收入国家的碳生产率与出口复杂度散点图



典型低收入国家的碳生产率与出口复杂度散点图

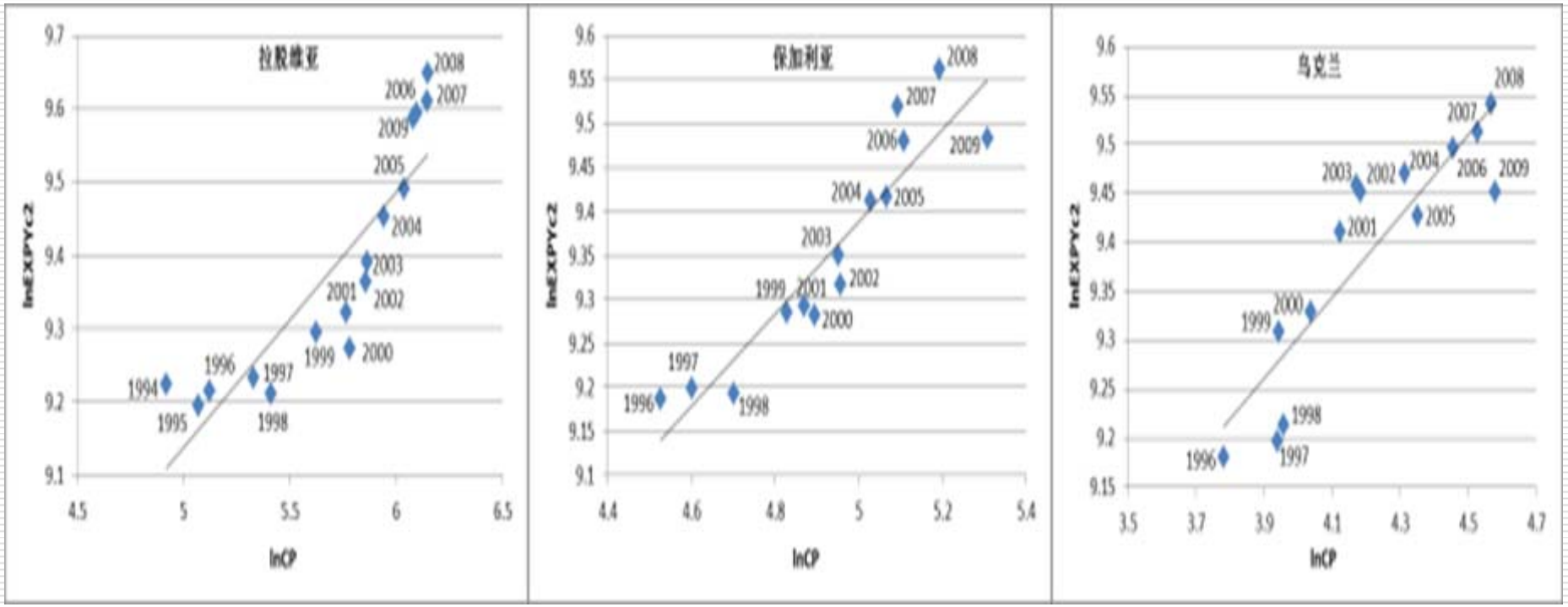


表1　高收入国家样本回归结果

解释变量	(1) $lnEXPY_{c2}$	(2) $lnEXPY_{c2}$	(3) $lnEXPY_{c2}$	(4) $lnEXPY_{c2}$	(5) $lnEXPY_{c2}$	(6) $lnEXPY_{c2}$	(7) $lnEXPY_{c2}$	(8) $lnEXPY_{c2}$
lnCP	0.229*** (11.30)	0.034** (2.22)	0.249** (2.45)	0.249** (2.43)	0.284*** (2.69)	0.283*** (2.67)	0.259*** (2.62)	0.260*** (2.61)
setg			-0.002 (-1.26)	-0.0004 (-0.85)	-0.002 (-1.26)	-0.0003 (-0.67)	-0.002 (-1.31)	-0.0002 (-0.43)
$setg^2$			0.00001 (1.04)		0.00001 (1.13)		0.00001 (1.26)	
kl			0.124*** (2.57)	0.127*** (2.65)	0.110** (2.26)	0.114** (2.36)	0.126*** (2.64)	0.13*** (2.74)
kl^2			-0.037*** (-2.69)	-0.037*** (-2.71)	-0.038*** (-2.83)	-0.039*** (-2.88)	-0.039*** (-2.89)	-0.040*** (-2.94)
rdgdp			0.049# (1.64)	0.048# (1.61)	0.039 (1.32)	0.039 (1.29)	0.041 (1.36)	0.040 (1.33)
$rdgdp^2$			-0.011** (-2.19)	-0.010** (-2.08)	-0.009* (-1.83)	-0.008* (-1.71)	-0.009* (-1.81)	-0.009* (-1.68)
lpp			1.413** (2.42)	1.444** (2.47)	1.449** (2.51)	1.491*** (2.58)	1.422** (2.47)	1.467** (2.55)
mcs			0.0001 (0.39)	0.00003 (0.11)	0.0001 (0.37)	0.00002 (0.06)	0.00001 (0.34)	-0.000004 (-0.01)
rq			0.004 (0.45)	0.004 (0.41)	0.004 (0.50)	0.004 (0.45)	0.004 (0.44)	0.003 (0.39)
fdigdp			0.00001 (0.02)	-0.00004 (-0.10)				

exgdp					-0.002*** (-2.68)	-0.002*** (-2.66)		
imgdp							-0.002** (-2.42)	-0.001** (-2.33)
常数项	8.36*** (73.02)	9.505*** (107.54)	-	-	-	-	-	-
年度效应	否	是	是	是	是	是	是	是
R^2	0.1374	0.5803	0.7954	0.7948	0.7968	0.7960	0.79901	0.7979
F或wald	32.88 (0.00)	1091.20 (0.00)	50.44 (0.00)	52.84 (0.00)	50.97 (0.00)	53.34 (0.00)	51.99 (0.00)	54.32 (0.00)
hausman	24.65 (0.00)	0.39 (1.00)						
Anderson canon LM			35.652 (0.00)	35.349 (0.00)	33.656 (0.00)	33.355 (0.00)	38.159 (0.00)	37.981 (0.00)
Cragg-Donald Wald F			9.26 (24.58)	9.204 (24.58)	8.678 (24.58)	8.622 (24.58)	10.003 (24.58)	9.985 (24.58)
Sargan检验			5.683 (0.1281)	6.113 (0.1063)	5.127 (0.1627)	5.527 (0.1370)	5.586 (0.1336)	6.042 (0.1096)
模型	Fe	Re	IV	IV	IV	IV	IV	IV
样本	856	856	347	347	347	347	347	347
国家数	53	53	38	38	38	38	38	38

资料来源：美国数据来自US.Census Bureau(2008),Pollution abatement costs and expenditures：2005；中国数据来自于《中国环境年鉴》和《中国统计年鉴》各年。

表2　低收入国家样本回归结果

解释变量	(1) $lnEXPY_{c2}$	(2) $lnEXPY_{c2}$	(3) $lnEXPY_{c2}$	(4) $lnEXPY_{c2}$	(5) $lnEXPY_{c2}$	(6) $lnEXPY_{c2}$	(7) $lnEXPY_{c2}$	(8) $lnEXPY_{c2}$
lnCP	0.249***	0.052**	0.564**	0.503**	0.738**	0.542**	0.757***	0.616**
	(9.21)	(2.17)	(2.13)	(2.02)	(2.49)	(2.16)	(2.61)	(2.41)
setg			0.008*	0.007*	0.010**	0.006*	0.013***	0.009**
			(1.88)	(1.81)	(2.14)	(1.67)	(2.71)	(2.42)
$setg^2$			-0.0001**	-0.0001**	-0.0001**	-0.0001**	-0.0001***	-0.0001***
			(-2.10)	(-2.02)	(-2.49)	(-1.99)	(-2.94)	(-2.67)
kl			0.015	0.008	0.007	0.021	-0.177	-0.072
			(0.08)	(0.10)	(0.04)	(0.27)	(-0.88)	(-0.86)
kl^2			-0.012		-0.013		0.052	
			(-0.10)		(-0.10)		(0.42)	
rdgdp			0.219#	0.118*	0.415***	0.101*	0.315**	0.110**
			(1.58)	(2.16)	(2.58)	(1.90)	(2.14)	(2.06)
$rdgdp^2$			-0.066		-0.210**		-0.135	
			(-0.79)		(-2.15)		(-1.53)	
lpp			-0.201	-0.199	0.767	0.569	-2.857	-2.522
			(-0.10)	(-0.10)	(0.37)	(0.29)	(-1.36)	(-1.28)
mcs			-0.0008*	-0.0008#	-0.001**	-0.0009*	-0.0004	-0.0003
			(-1.65)	(-1.58)	(-2.01)	(-1.79)	(-0.83)	(-0.76)
rq			0.0001	0.007	-0.001	0.016	-0.015	-0.002
			(0.00)	(0.21)	(-0.03)	(0.53)	(-0.44)	(-0.08)
fdigdp			0.003#	0.003#				
			(1.56)	(1.59)				

exgdp					0.005*** (3.88)	0.004*** (3.62)		
imgdp							0.006*** (4.92)	0.005*** (4.96)
常数项	7.698*** (49.06)	8.852*** (62.89)	-	-	-	-	-	-
年度效应	否	是	是	是	是	是	是	是
R^2	0.0561	0.3569	0.5459	0.5633	0.5107	0.5724	0.5247	0.5742
F或wald	34.11 (0.00)	46.25 (0.00)	14.83 (0.00)	17.07 (0.00)	14.17 (0.00)	17.81 (0.00)	14.94 (0.00)	18.38 (0.00)
hausman	159.78 (0.00)	65.76 (0.00)						
Anderson canon LM			15.964 (0.0031)	17.288 (0.0017)	13.962 (0.0074)	16.865 (0.0021)	14.261 (0.0065)	16.228 (0.0027)
Cragg-Donald Wald F			3.847 (24.58)	4.223 (24.58)	3.338 (24.58)	4.112 (24.58)	3.413 (24.58)	3.947 (24.58)
Sargan检验			2.296 (0.5132)	2.139 (0.5441)	2.831 (0.4184)	2.347 (0.5.36)	1.612 (0.6567)	1.865 (0.6009)
模型	Fe	Fe	IV（2SLS）	IV（2SLS）	IV（2SLS）	IV（2SLS）	IV（2SLS）	IV（2SLS）
样本	1545	1545	310	310	310	310	310	310
国家数	118	118	44	44	44	44	44	44

资料来源：美国数据来自US.Census Bureau(2008),Pollution abatement costs and expenditures：2005；中国数据来自于《中国环境年鉴》和《中国统计年鉴》各年。

五、研究结论

第一，碳生产率作为一种新的比较优势决定因素，对提高各国出口复杂度至关重要。不论是高收入国家还是低收入国家，提高碳生产率能够显著促进各国出口复杂度的提升。

第二，各类资本禀赋与出口复杂度之间存在倒“U”型关系，并且这种关系在高收入国家和低收入国家中存在差异。

第三，相比较而言，经济开放度水平的扩大更有利于低收入国家的出口复杂度提升；各经济开放度变量显著促进了低收入国家的出口复杂度提升。因此，坚持经济开放对于提升低收入国家的出口复杂度非常重要。

第四，自然资源禀赋不利于出口复杂度提升的“资源诅咒”现象更容易在低收入国家出现；高收入国家的制度因素和基础设施等对出口复杂度的促进作用更为明显；经济开放度水平的扩大更有利于低收入国家出口复杂度的提升。

恳请各位老师、同行多提宝贵意见！

谢谢！

HOW TO HARMONIZE TRADE AND ENVIRONMENT: RESEARCH ON ENVIRONMENTAL EFFECT OF CHINA'S EXPORT

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Keywords:

foreign trade, export, environment, pollution, development.

I. INTRODUCTION

- **China's foreign trade has developed increasingly since its opening up.**
- **EX+IM= US$3.64 trillion(2011); 3.87 trillion (2012);**
- **Export: US$1.89 trillion(2011);2.05 trillion (2012);**
- **Rank: No.2 in 2011; No.1 in 2012 (USA, German)**
- **However, the main export structure of China is still resource intensive and labor intensive industries. This phenomenon causes some environmental quality damage and makes China's exporting product encounter many environmental technology and standard measures which bring huge losses to China's export profit and brand reputation.**

II Features of Foreign Trade Growth

- The Growth Tendency of Foreign Trade
- Features

The Growth Tendency of Foreign Trade

- Since the opening up policy, China's foreign trade development has made great progress in the growth rate of trade volume and the improvement of import-export product structure.

- the structure of export commodities has gradually shifted from primary products to manufactured oriented products

Year	Trade Volume	Export Volume	Import volume	Trade balance	Rank
1980	38.14	18.12	20.02	-1.90	28
1981	44.03	22.01	22.02	-0.01	21
1982	41.61	22.32	19.29	3.03	18
1983	43.62	22.23	21.39	0.84	18
1984	53.55	26.14	27.41	-1.27	18
1985	69.60	27.35	42.25	-14.90	17
1986	73.85	30.99	42.86	-11.870	16
1987	82.65	39.44	43.21	-3.770	16
1988	102.79	47.52	55.27	-7.750	16
1989	111.68	52.54	59.14	-6.60	14
1990	115.44	62.09	53.35	8.74	15
1991	135.70	71.91	63.79	8.12	13
1992	165.53	84.94	80.59	4.35	11
1993	195.70	91.74	103.96	-12.22	11
1994	236.62	121.01	115.61	5.40	11
1995	280.86	148.78	132.08	16.70	11
1996	289.88	151.05	138.83	12.22	11
1997	325.16	182.79	142.37	40.42	10
1998	323.95	183.71	140.24	43.47	10
1999	360.63	194.93	165.70	29.23	9
2000	474.29	249.20	225.09	24.11	7
2001	509.65	266.10	243.55	22.55	6
2002	620.77	325.60	295.17	30.47	5
2003	850.99	438.23	412.76	25.43	4
2004	1154.55	593.32	561.23	32.09	3
2005	1421.91	761.95	659.95	102.0.	3
2006	1760.44	968.98	791.46	177.52	3
2007	2176.57	1220.46	956.12	264.34	3
2008	2563.26	1430.69	1132.57	298.12	3
2009	2207.54	1201.61	1005.92	195.69	2
2010	2974.00	1577.75	1396.24	181.51	2
2011	3641.86	1898.38	1743.48	154.90	2
2012	3866.76	2048.93	1871.83	231.10	1

Fig1. The growth tendency of China's foreign trade since 1980 billion US Dollar

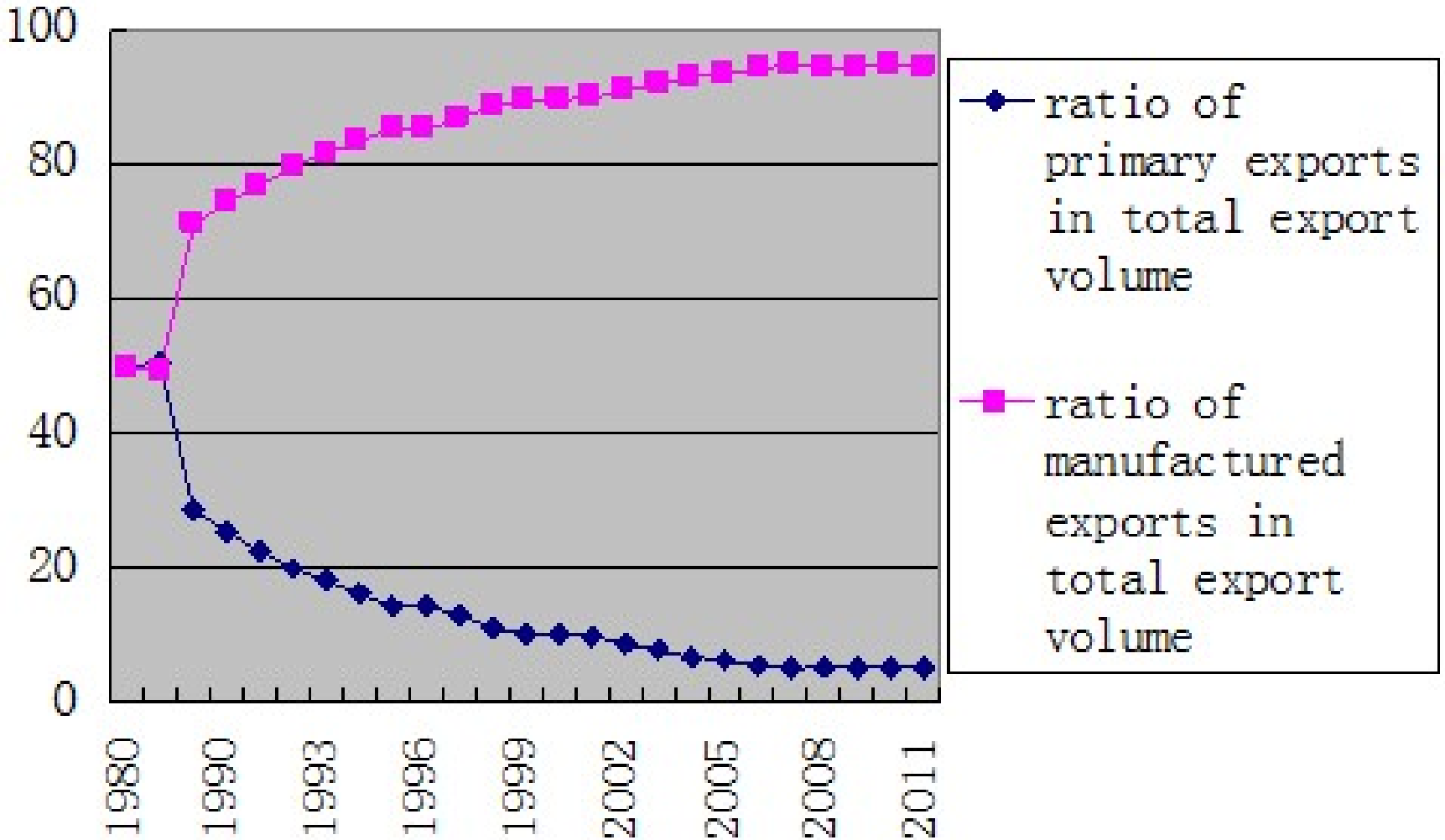

Diagram 1. Changing of China's export commodity structure 1980-2011
Source: calculated according to China Statistics Report (1980-2012)

Features

- First, from the aspect of export commodity structure, though the percentage of manufactured exports accounts for more that 90%, the proportion of high technology product is quite low.

Year	Export Volume	Import Volume	Growth rate %	Proportion in Total Export Volume %	Proportion in Manufactured Exports %
1996	12.7	22.5	25.7	8.4	9.8
1997	16.3	23.9	28.3	8.9	10.2
1998	20.3	29.2	24.5	11	12.4
1999	24.7	37.6	21.7	12.7	14.1
2000	37	52.5	49.7	14.8	16.5
2001	46.5	64.1	25.7	17.5	19.4
2002	67.9	82.8	46	20.9	28.3
2003	110.3	119.3	62.4	25.2	27.3
2004	165.6	161.4	50.1	27.9	30
2005	218.2	197.7	31.8	28.6	30.6
2006	281.5	247.3	29	29.1	30.7
2007	347.8	287	23.6	28.5	30.1
2008	415.6	341.9	19.5	29	30.7
2009	376.9	309.8	-9.3	31.4	33.1
2010	492.4	412.7	30.6	31.2	32.9
2011	548.8	463	11.5	28.9	30.5

Fig 2 The import and export tendency of high-tech products billion US Dollar
Source: calculated according to China Statistics Report (1980-2012)

- Second, the processing trade occupies half of huge foreign trade volume (see Fig. 3).

Fig 3 The proportion of processing trade in total export volume billion US Dollar

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Processing trade volume	147.4	179.9	241.8	329.0	416.5	510.36	617.7	675.1	587.0	740.3
Total export volume	266.1	325.6	438.2	593.2	762.0	968.94	1218.0	1430.7	1201.6	1577.9
Proportion %	55.4	55.3	55.2	55.3	54.7	52.7	50.7	47.2	48.9	46.9

Source: calculated according to China Statistics Report (1980-2010)

- Third, China's terms of trade has been deteriorated due to the low added value of exports.
- --In 2002, the export price declined 22% compared with that of 1995 and the terms of trade deteriorated 6% during 2003-2004 according to World Bank data.
- --From 2000-2011, China's import growth rate of crude oil, refined oil and minerals was rapidly and the trade deficit was gradually enlarged. Facing the shortage of resource and energy, the waste of resource is quite obvious.

- 3 THE ENVIRONMENTAL INFLUNENCE OF CHINA FOREIGN TRADE GROWTH

manufactured exports volume & three industrial wastes”

Figures prove that the increase of industrial three wastes and growth of manufactured exports are correlative.

- Therefore, there is positive correlation between the expanded manufactured exports and the deteriorated environmental quality.

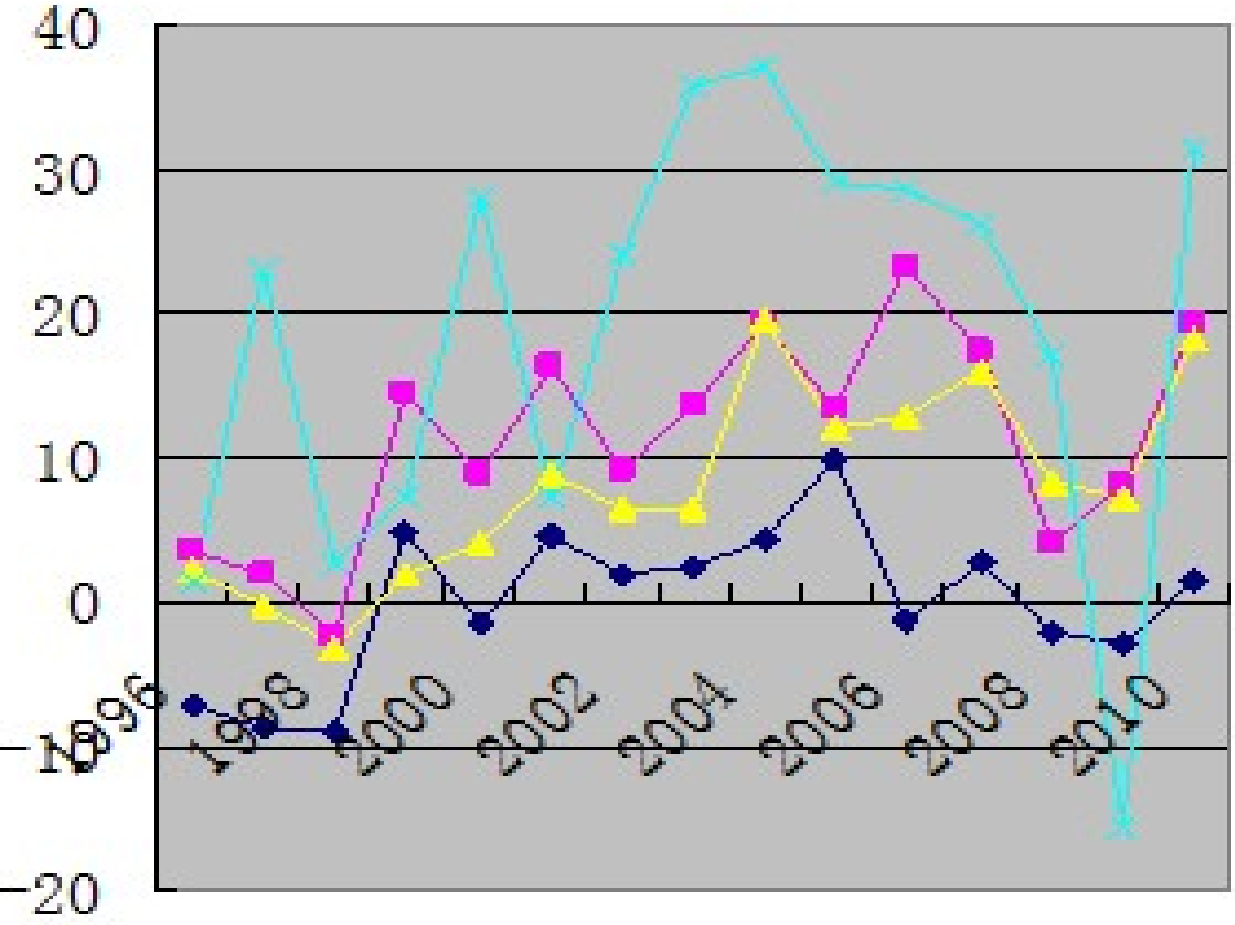

Diagram 2 The relationship between growth rate of manufactured exports and industrial wastes

3.1 Export Volume of Major Industries

- top 10：machinery and electronic equipment, textiles materials and products, metal manufacturing, chemical material and manufacturing, ferrous metal and manufacturing products, extractive industry采掘, leather fur and feather products, plastic industry, food beverage tobacco manufacturing and paper industry.

Sectors	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Extractive industries	9.206(6)	9.85 (6)	9.84 (5)	12.74 (6)	16.57 (6)	20.92 (6)	21.39 (7)	23.59 (7)	36.49 (7)	22.77 (7)	30.38 (7)	36.29 (7)
Food beverage tobacco industries	5.17 (9)	5.79 (9)	6.70 (9)	7.67 (9)	9.41 (9)	11.20 (9)	13.80 (9)	16.47 (8)	18.21 (9)	16.01 (9)	19.37 (9)	24.34 (9)
textiles materials and products	49.38 (2)	49.84 (2)	57.85 (2)	73.36 (2)	88.77 (2)	107.6 (2)	138.0 (2)	165.8 (2)	179.7 (2)	161.41(2)	199.5 (2)	240.5 (2)
leather fur and feather products	11.96 (4)	12.26 (5)	9.33 (7)	11.57 (7)	13.67 (6)	15.61 (8)	15.38 (8)	16.36 (9)	18.27 (8)	16.66 (8)	23.25 (8)	29.95 (8)
paper industry	1.85 (12)	1.98 (13)	2.34 (10)	3.03 (10)	3.80 (10)	5.11 (10)	6.90 (10)	9.19(10)	10.39 (10)	10.02 (10)	12.41 (10)	16.24 (10)
chemical raw material and manufacturing	11.64 (5)	12.80 (4)	14.61 (4)	18.53 (4)	24.58 (5)	31.85 (5)	37.75 (5)	51.09 (5)	68.87 (5)	54.03 (4)	74.97 (4)	97.09 (4)
ferrous metal manufacturing	9.09 (7)	8.25 (7)	9.70 (6)	12.86 (5)	25.21(4)	34.12 (4)	51.92 (4)	76.62 (4)	101.9 (4)	47.27 (5)	68.07 (5)	91.07 (5)
metal manufacturing	16.61(3)	16.10(3)	18.91(3)	25..2(3)	43.74(3)	57.09(3)	85.30(3)	115.53(3)	144.02(3)	77.12 (3)	110.8 (3)	144.92(3)
Plastic industry	6.39(8)	6.99(8)	8.04(8)	9.98(8)	13.11(8)	17.78 (7)	22..2 (6)	36.51 (6)	41.39 (6)	35.94 (6)	49.59 (6)	66.35 (6)
machinery and electronic equipment	72.89(1)	84.89(1)	115.92(1)	172.33(1)	247.78(1)	322.1 (1)	434.1 (1)	528.82(1)	610.75(1)	536.97(1)	698.57(1)	799.52(1)

Fig 4 Export trade volume of major industries and the rank in total export volume (Billion US dollar)

Note: number in bracket is the rank

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- 3.2 Three Industrial Wastes of Major Industrial Export Sectors

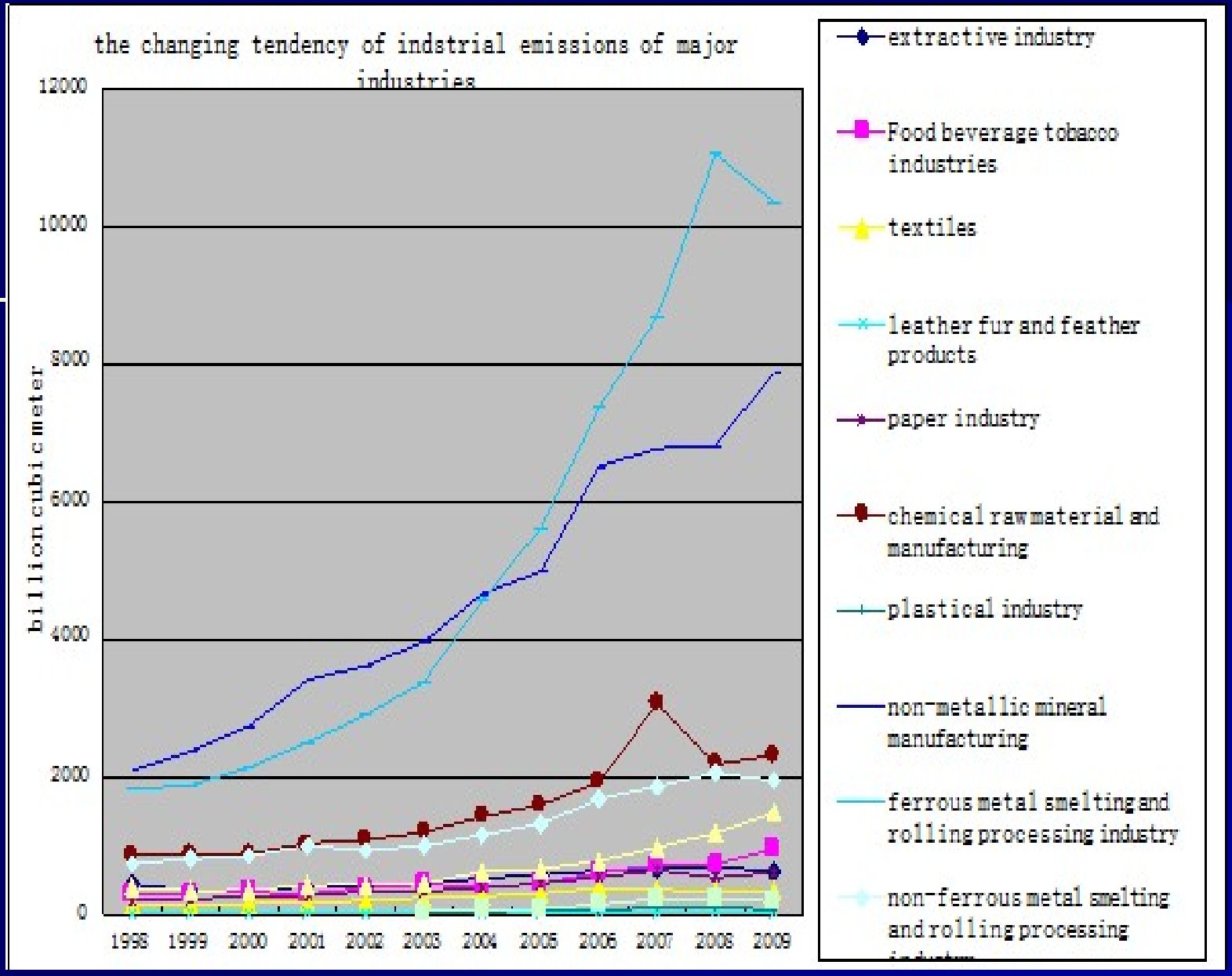

Diagram 3 The changing tendency of industrial emissions of major industries (1998-2010) 20 20
Source: calculated according to China Statistics Report (1998-2011)

- fast emission growing industries in past years are:
- ferrous metal smelting, non-metallic mineral products, chemical raw materials and manufacturing products and non-metallic mineral smelting.

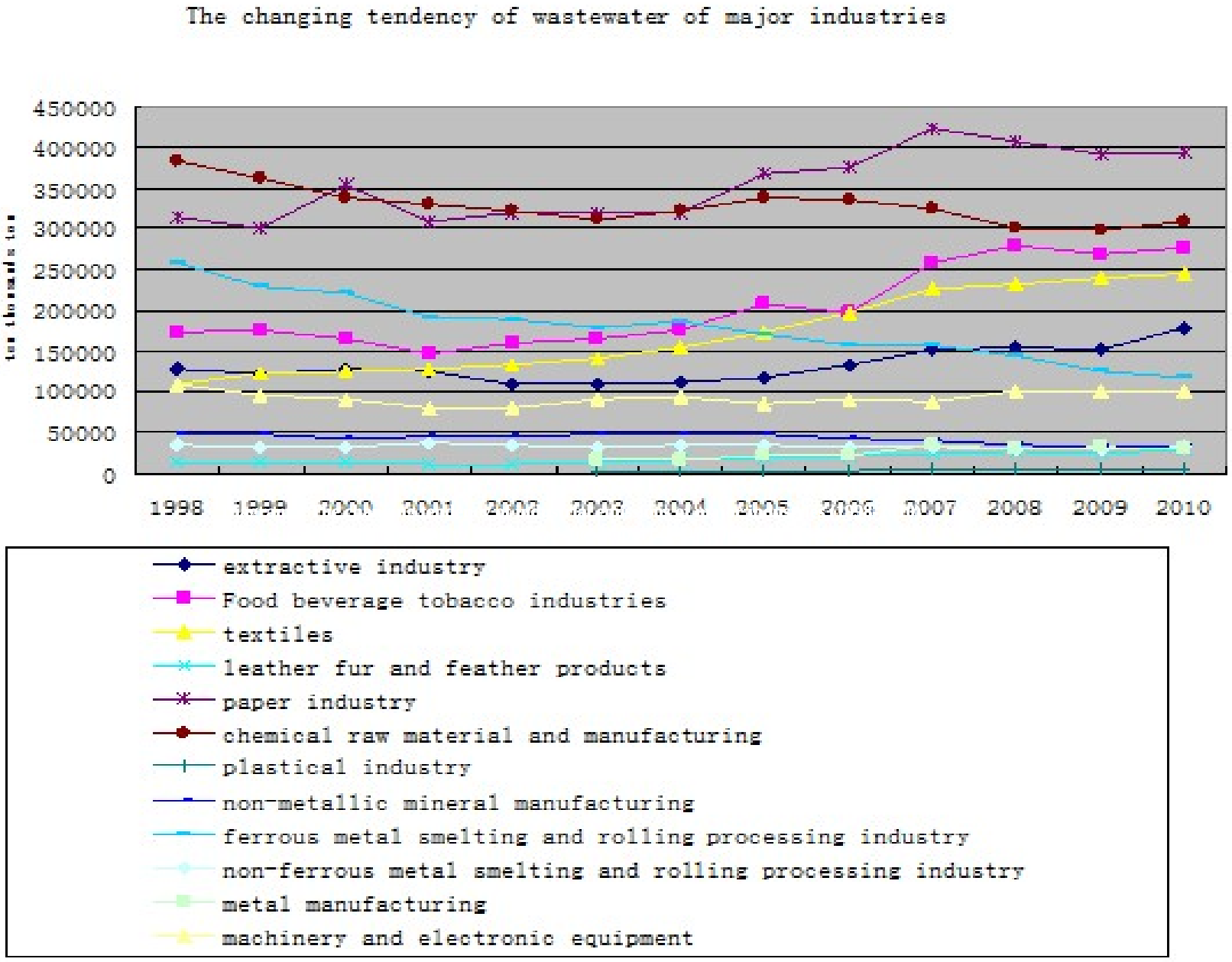

Diagram 3 The changing tendency of industrial emissions of major industries (1998-2010)

- The fast increasing of wastewater industries are extractive industry, textile, paper and paper products industry, and chemical raw materials and manufacturing products.

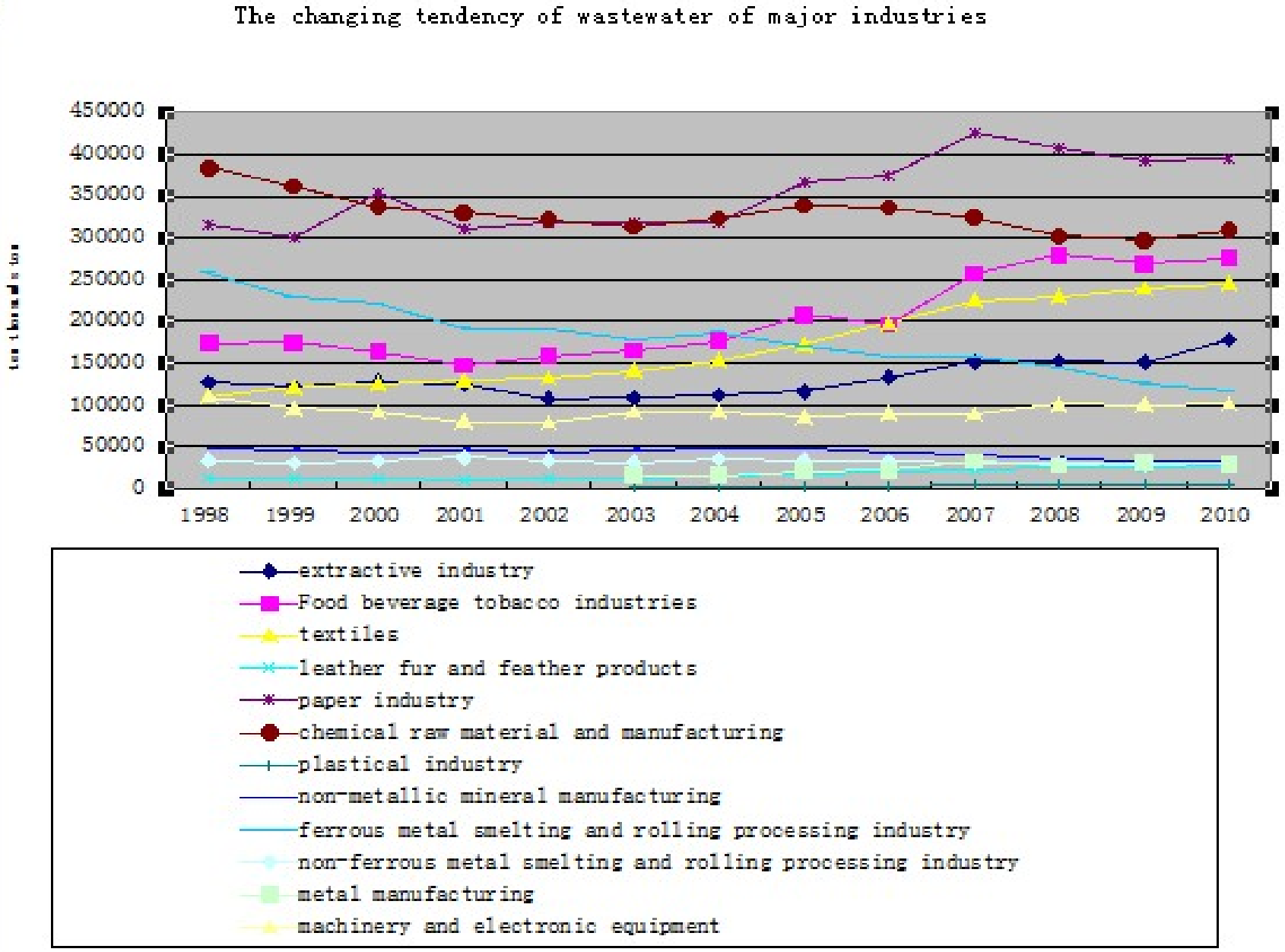

Diagram 4 The changing tendency of wastewater of major industries (1998-2010)
Source: calculated according to China Statistics Report (1998-2011)

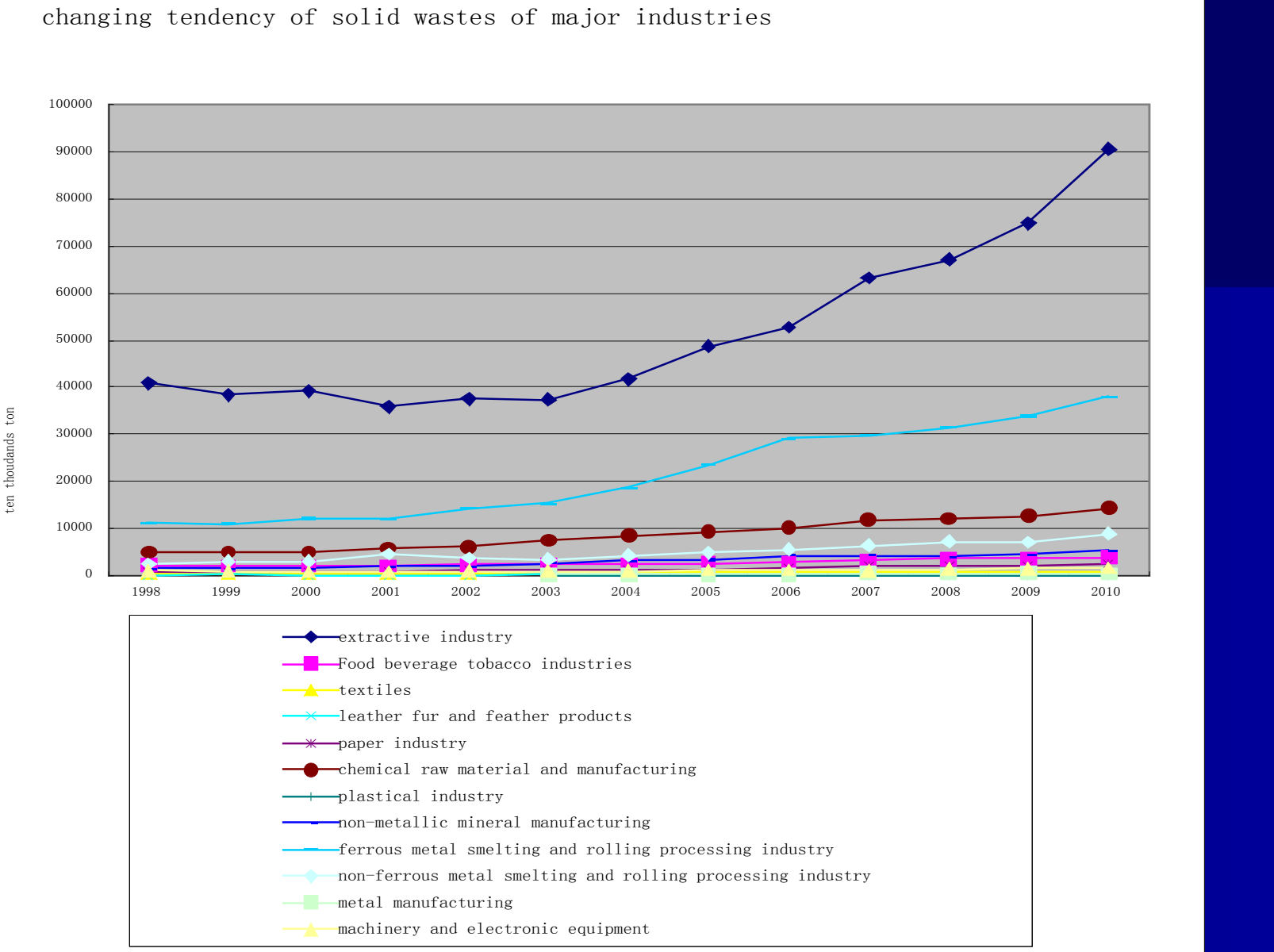

Diagram 5 The changing tendency of solid wastes of major industries (1998-2010)
Source: calculated according to China Statistics Report (1998-2011)

- The top 5 industries of solid waste discharges are: extractive industry, ferrous metal smelting and rolling processing industry, chemical raw materials and manufacturing products, non-ferrous metal smelting and rolling processing and non-metallic mineral products.
- Result:
- The export volumes of these industries occupy top 10 in the export volume of major industrial export sectors.

- The Export Trade Volume of Major Costal Cities and Three Industrial Waste Emissions
- the “three industrial wastes” gradually increase with the growth of the exports in these areas.
-

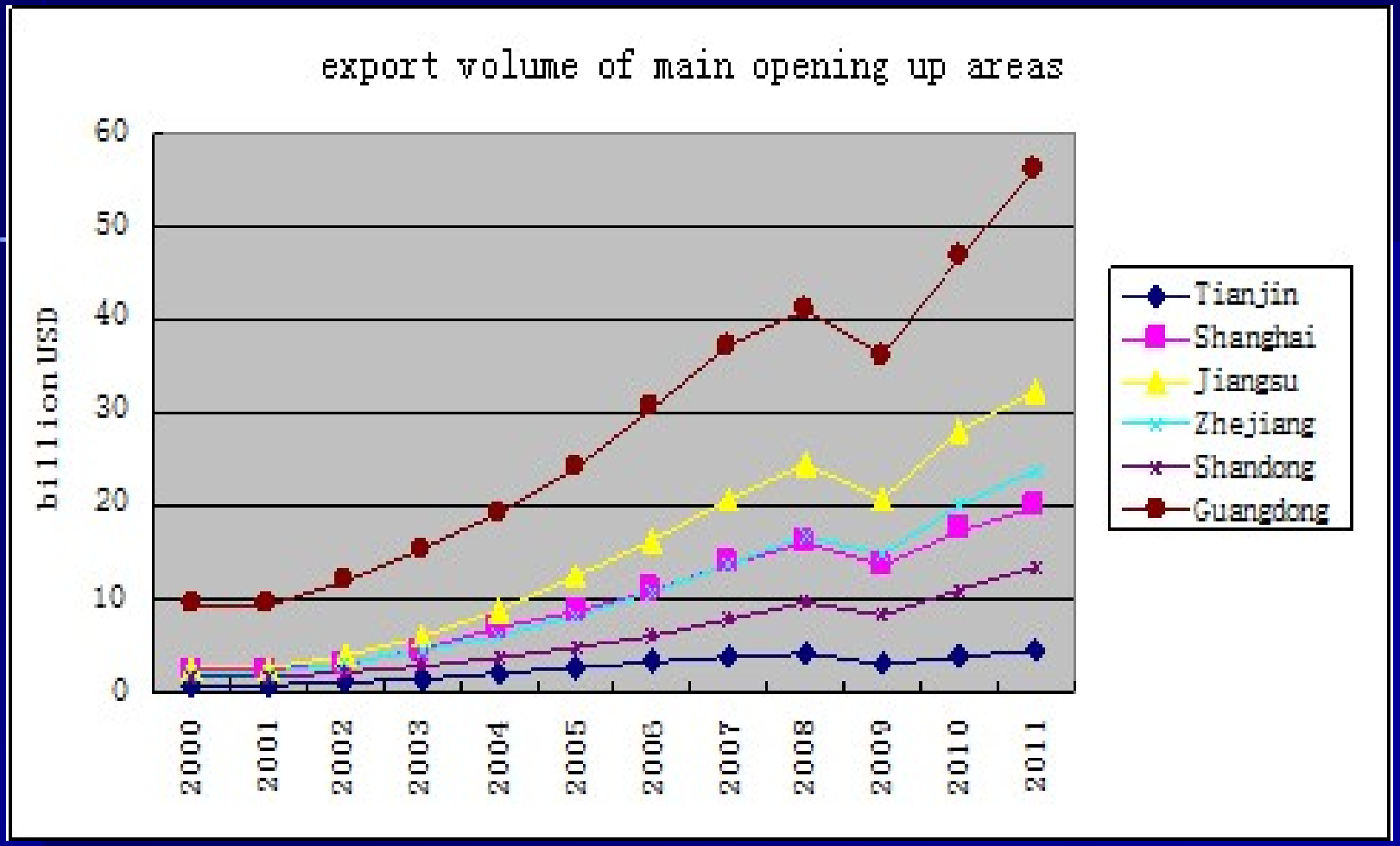

Diagram 6 Export volume of major opening up cities and provinces
Source: calculated according to China Statistics Report (2000-2012)

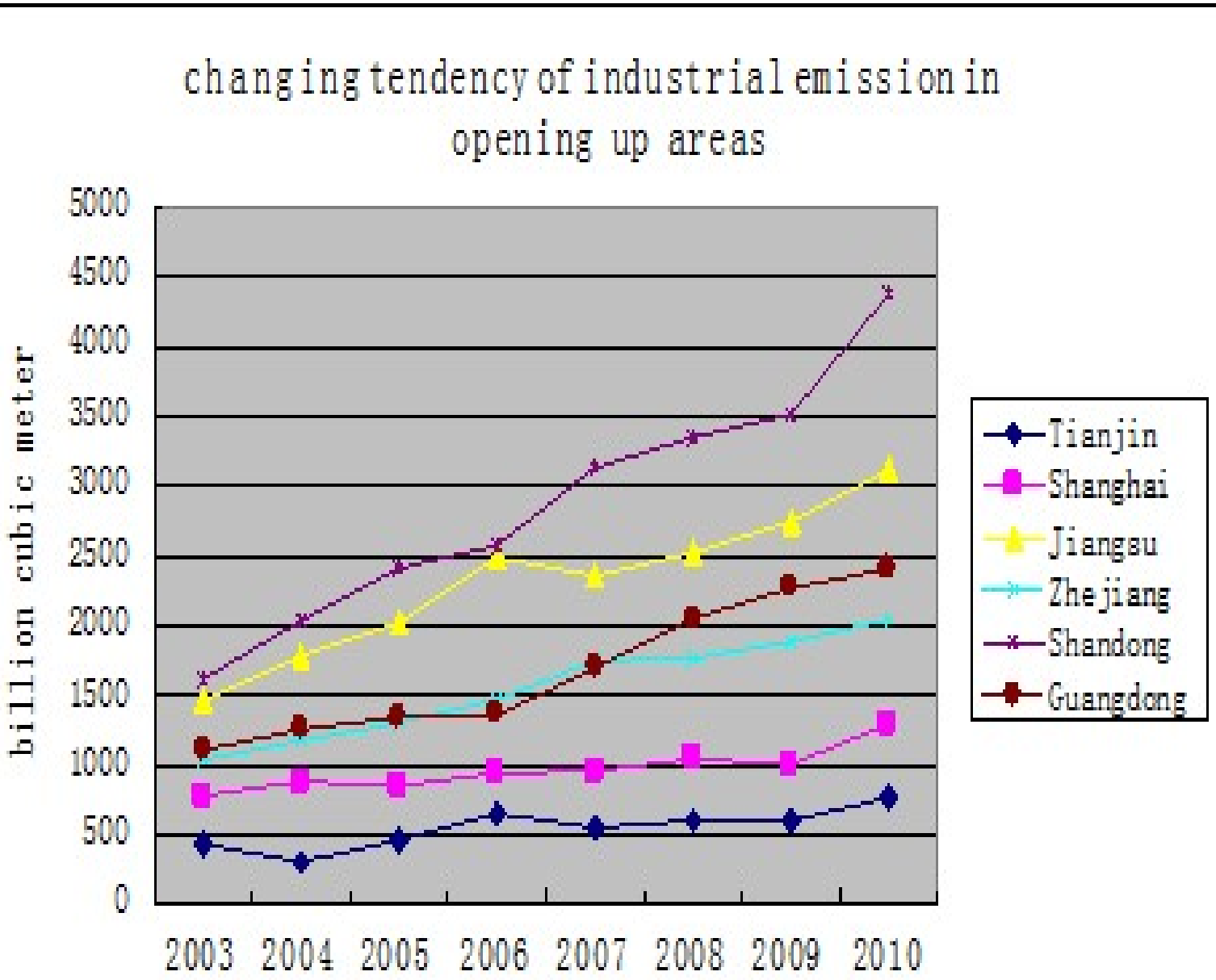

Diagram 7 the changing tendency of industrial emissions in opening up areas

Source: calculated according to China Statistics Report (2000-2011)

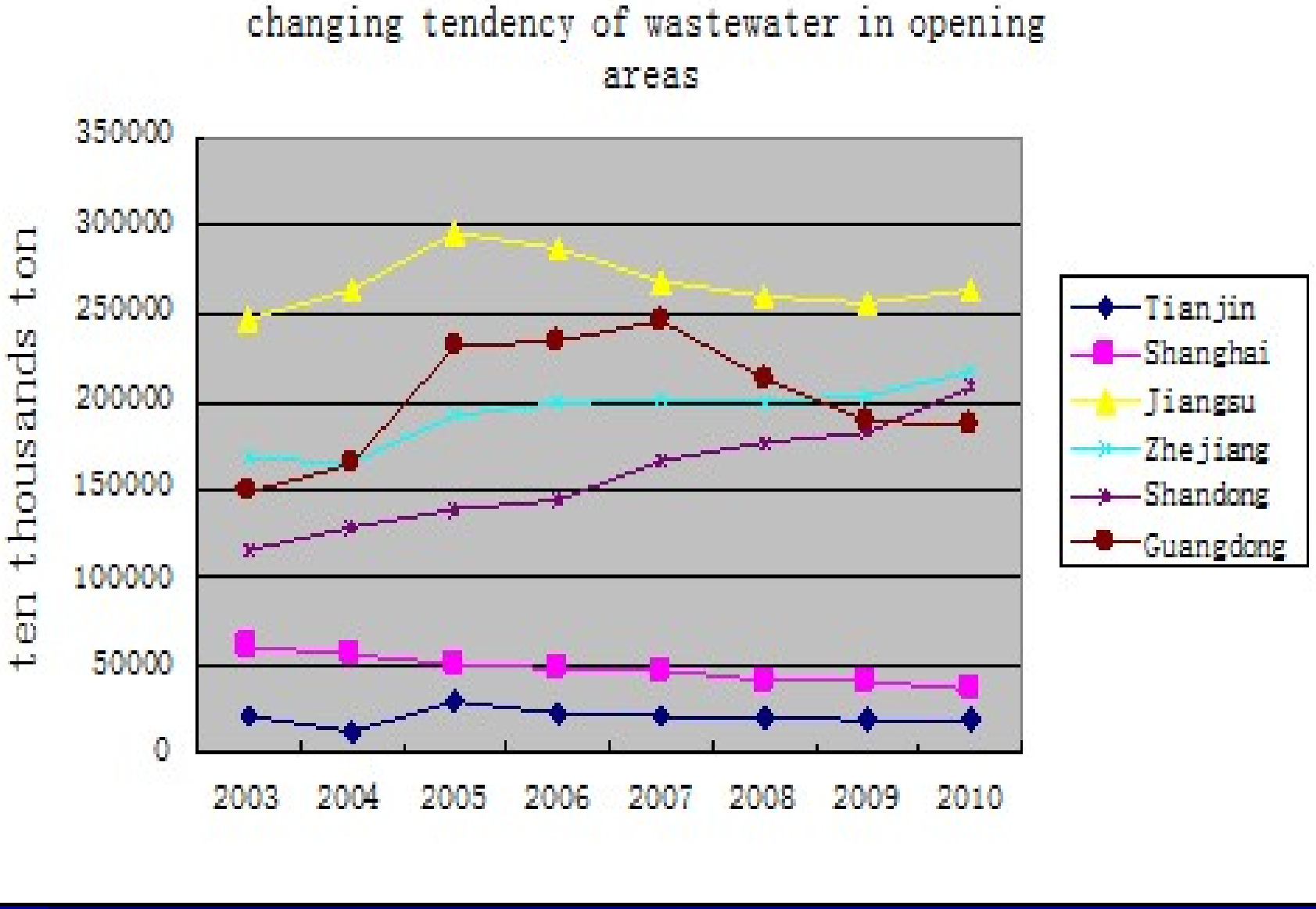

Diagram8 The changing tendency of wastewater in opening up areas
Source: calculated according to China Statistics Report (2000-2011)

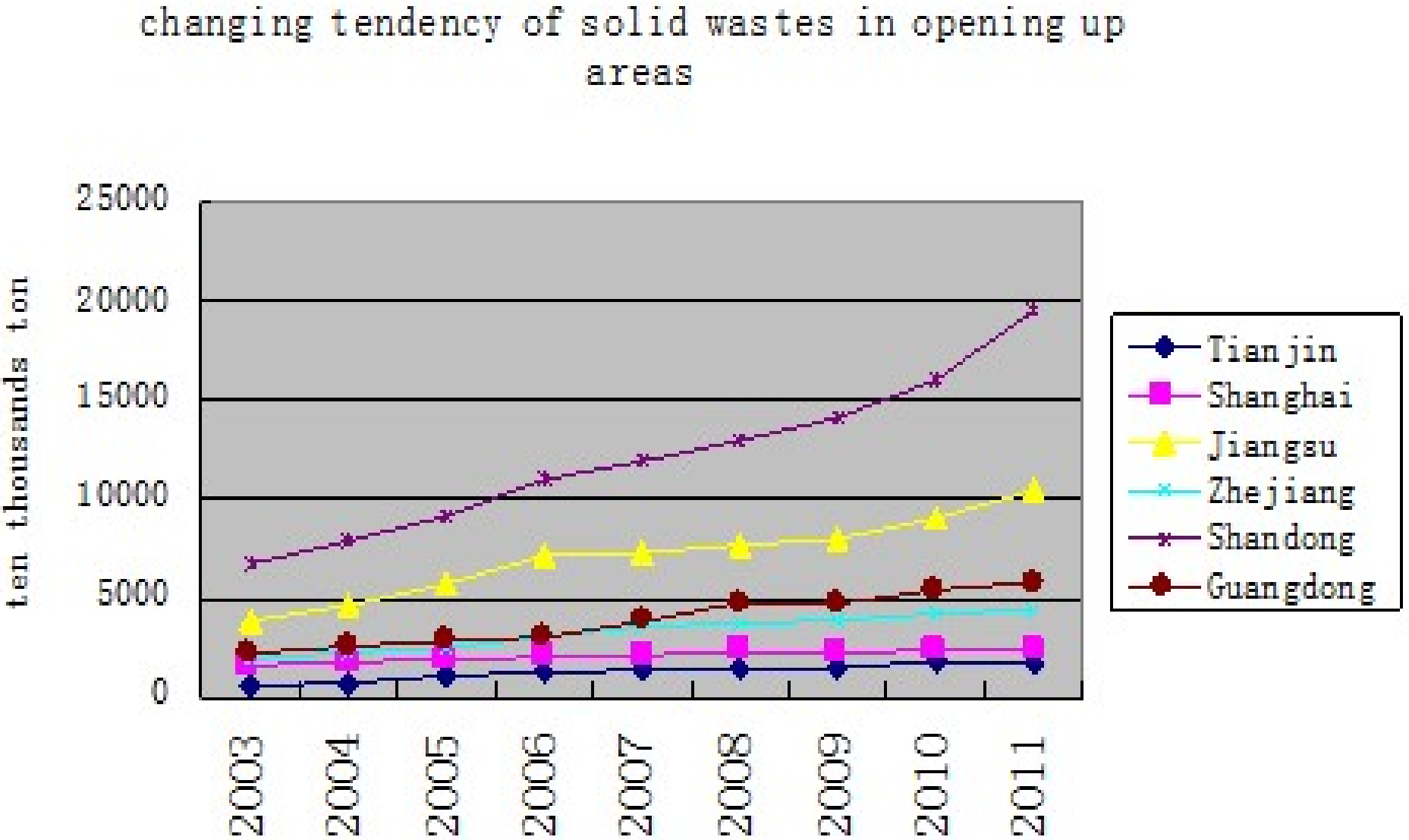

Diagram 9 The changing tendency of solid wastes in opening up areas
Source: calculated according to China Statistics Report (2000-2012)

- From the above statistics and diagrams, it can be concluded that the export comparative advantages of China's manufacturing sectors are pollution intensive and environment sensitive industries.
- With the expanding of exports, the growing of foreign trade will exacerbate the negative impact on environmental quality

4. COUNTERMEASURES TO SUSTAINABLE TRADE

- ----implement circular economy:reducing, reusing and recycling; rationally allocate the environmental resources and improve the environmental quality through circular production process.
- ---- green international trade; penetration of the ecological perspective into trade activities, and the integration of environmental elements into the whole trade process

- ----to introduce the international environment management standards and apply life cycle assessment (LCA) . LCA can be used as a scientific basis for developing sound environmental management strategies and policies in the public sector.
- the application of LCA in clean production design, waste disposal and ecological industries fields

- ----improve export structure.
- raw material-intensity, primary processing and semi-product processing with high pollution ——technology intensive industry export.
- ----adopt environmental sound technology. protect the environment; less polluting; use all resources in a more sustainable manner; recycle most of their wastes and products;

CONCLUSIONS

- One way to solve the environmental problems faced by China's export is to introduce the connation of corporation environmental responsibility.
- In fact, the relationship between businesses and natural environment are closely linked. The businesses obtain resources and energy form environment and the wastes are returned to environment.
- Unreasonable approach to development makes the corporations abuse natural resources and demolish environment as well as cause climate problem.

Thank you

Prepare for 12th SUIBE–KAS WTO-Conference 2013: Trade and Climate Change

The Schemes for the "Post-Kyoto" Era: Differentiated Carbon Taxes versus Carbon Tariffs

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Outline

- ✓ Introduction
- ✓ Literature review
- ✓ Model, data and policy scenarios
- ✓ Empirical results
- ✓ Discussion and conclusion

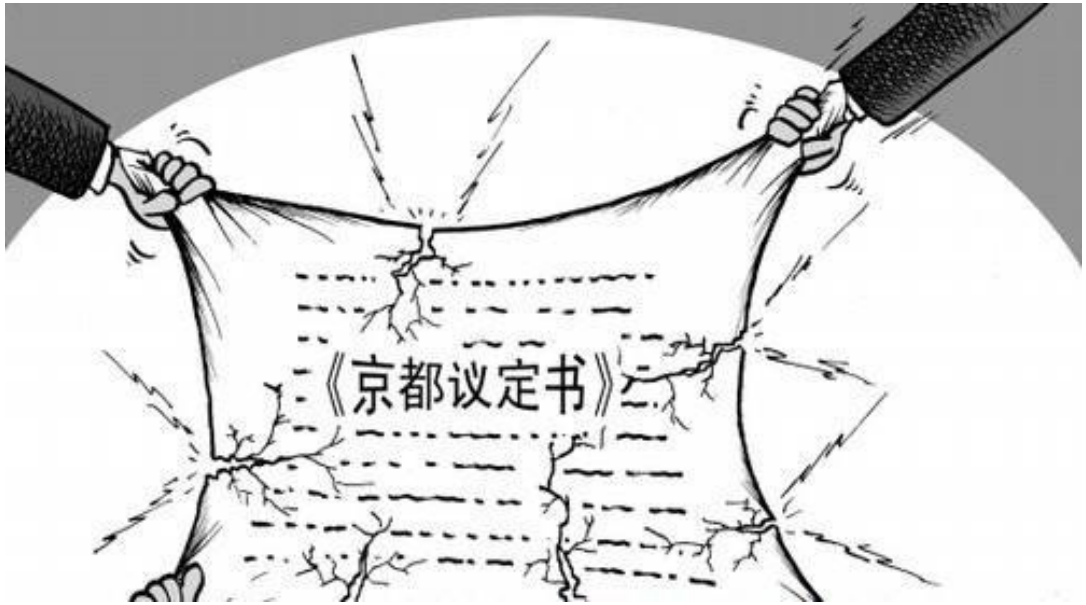
Introduction

- At the 2009 Copenhagen Summit, the agreement to limit the global average temperature increase to 2 ºwas achieved.

- However, how to achieve the target has so far failed to lead to an agreement.
- If there is no unified and coordinated action, the working proposal of the 2° C target is a mere scrap of paper devoid of meaning.

Introduction

- The present situation of global emissions reduction is most affected by the Kyoto Protocol. The developed countries to “take the lead”, under the principle of CBDR established no time frame for developing countries to follow.



- However, a consensus is now emerging in favor of the 2 ºtarget.
- The temperature target can’t be achieved without the participation of developing countries, which today emit more than half of global carbon emissions, and whose future emissions increase faster than industrialized counties under BAU.

Introduction

- Developed countries implement unilateral climate policy to achieve binding targets, which may result in competitiveness loss and carbon leakage concerns. The carbon tariffs was proposed to address this issue.

- The carbon tariff is a new environmental trade barrier with limited mitigation effects , this policy may lead to developing countries adopting trade retaliation measures, which will result in a new round of trade war worldwide .

- Motivated by this problem, this paper focuses on the global cooperation schemes in the context of carbon tariffs. The scheme named *CTAP*, which requires different countries adopt different carbon taxes, is proposed that allocates mitigation burdens on the basis of per capita GDP.

Literature Review

The allocation of emissions space (long-term issue)

- Brazilian Proposal （Rosa et al., 2004）
- The multi-stage approach (Berk and den Elzen, 2001; den Elzen, 2002)
- Per capita convergence & Contraction and convergence (Bows and Anderson,2008; Sørensen, 2008）
- Cumulated Per capita Convergence (陈文颖 等，2005；何建坤 等，2009；于胜民 等，2010；Oberheitmann，2010）

- Although many schemes related to burden sharing of emissions reduction have been proposed, the solutions have not achieved an agreement to all parties

Literature Review

The coordination of fragmented market-oriented climate policies

- **Global carbon markets**

  (Wara,2007; den Elzen et al., 2011; Hagem and Holtsmark, 2011; Silverstein, 2013)

- **The international coordination of carbon tax**

  The uniform carbon tax scheme: (Hoel, 1992; Poterba, 1993; Nordhaus, 2007)

  The global differentiated carbon tax schemes: (Aldy et al., 2003; Murty, 1996)

  The imputed price of carbon (ICT) :(Uzawa ,1991,1993,2010; Matsumoto and Fukuda ,2006; Matsumoto, 2008)

- Global carbon market is not promised for the challenge of initial allowance allocation; the uniform carbon tax scheme may be rejected by developing countries because it generates excessive economic burdens.

Literature Review

Carbon tariffs –impact evaluation

- A body of literature focuses on the economic and environmental impacts of carbon tariffs, and most of these researches are based on Computable General Equilibrium (CGE) models.

- Their results all reveal that carbon tariffs are conductive to global emissions reduction, but the effects are limited.

- Additionally, the implementation of carbon tariffs also generates negative effects on non-regulating regions that cannot be neglected .(Babiker and Rutherford, 2005; Böhringer et al., 2010; Dissou and Eyland, 2011; Dong and Whalley, 2011; Hübler, 2012; Weitzel et al., 2012)

Literature Review

The research gap

- This paper focuses on the differentiated carbon taxes scheme in the context of carbon tariffs.
- The scheme *CTAP* (carbon tax based on the principle of ability to pay) is introduced by considering regional mitigation capacities.
- The GTAP-E model is used to give an evaluation of *CTAP*.
- The results indicate that *CTAP* is better than carbon tariffs in terms of global GDP, global welfare and global emissions reduction, while also generating lower negative impacts on most developing regions.

Model, data and policy scenarios

Sectorial and regional aggregation with GTAP-E model

Countries and regions (10 regions)

Developed regions	*Developing regions*
United States of America (USA)	China (CHN)
Japan (JPN)	India (IND)
European Union (EU_27)	Brazil (BRA)
Other OECD countries (OOECD)	South Africa(SAF)
	Russia (RUS)
	Rest of world (ROW)

Commodities (21 sectors)

Energy	*Agriculture and fisheries*
Coal	Rice
Crude oil	Other crops
Gas	Livestock
Refined oil products	Forestry and Fishery
Electricity	
	Other industries and services
Energy-Intensive & Trade-exposed	Transport services
Chemicals	Paper–pulp–print
Non-metallic minerals	Fabricated metal products
Iron and steel industry	Other manufacturing
Non-ferrous metals	Services
	Construction and dwellings
	Other mining
	Food products

Model, data and policy scenarios

The concept of CTAP

- The researches on the fairness of burden sharing of emissions reduction among regions can be roughly divided into four criteria,

  1) Sovereignty principle

  2) Egalitarian principle

  3) Polluter pays principle

  4) Ability to pay principle

  Different fair principles embody different interest orientations, thus have different specific strengths, weaknesses and possible remedies (Ringius et al., 2002; Oberheitmann, 2010).

Model, data and policy scenarios

The concept of CEDS

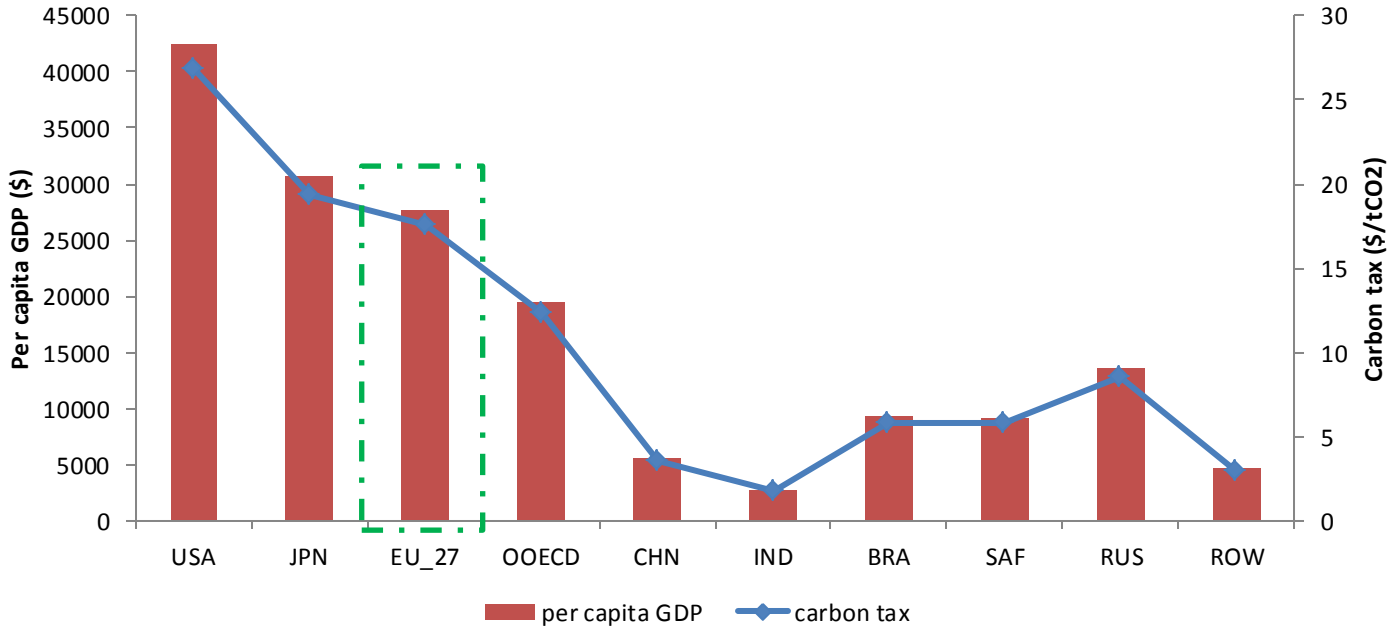


Figure 1 Regional carbon tax in CTAP

Carbon tax in *CTAP* is proportional to regional per capita GDP, which is designed in terms of the principle of ability to pay.

Model, data and policy scenarios

The concept of CTAP

Table 2 The comparison of carbon tax in CTAP and currently discussed by great emissions emitters

	CTAP ($/tCO$_2$)	Value range ($/tCO$_2$)	References
USA	26.85	10 — 40 (average：25)	Aldy et al.(2008); Metcalf (2009); Palmer et al.(2012); Adkins et al.(2012); Fischer and Fox(2012)
JPN	19.39	19.83	Liu et al (2012); Honmaa and Hu (2009); Nakata et al (2011)
EU_27	17.52	5.72 — 29.33 (average：17.52)	European Climate Exchange(ECX)
OOECD	12.35	0 — 30 (avearge：15)	Harrison (2012)[a]; Querejazu (2012)[b]; Sumner et al (2011)[c]; Bucher (2011)[d]
CHN	3.56	1.33 — 2.66 (avearge : 2.01)	Su et al (2009); Wang et al (2011)
IND	1.74	0.90	Querejazu (2012)
SAF	5.83	15	Querejazu (2012)

Note: the carbon prices for Canada range from 10 $/tCO2 to 30 $/tCO2; the carbon price for Australia is nearly 23 $/tCO2; the carbon price for New Zealand is almost 20 $/tCO2; the carbon price for Switzerland ranges from 10 $/tCO2 to 30$/tCO2.

Model, data and policy scenarios

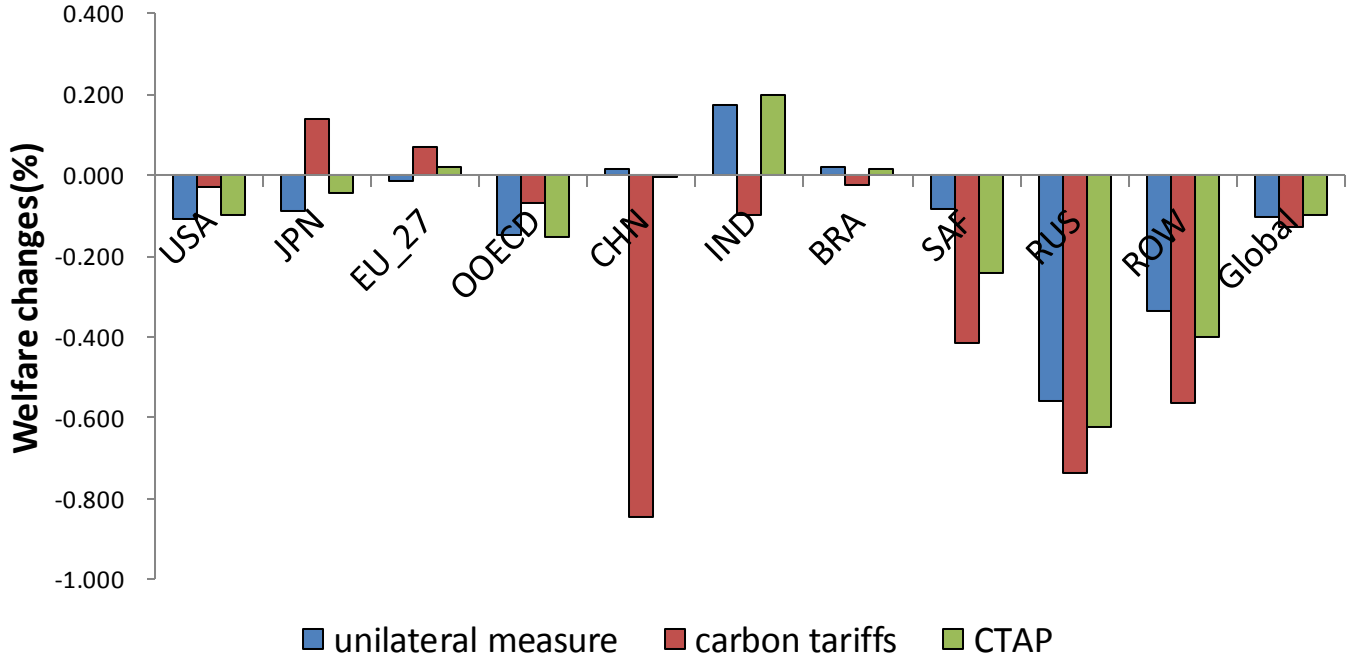
Policy scenarios

Table 3 Policy scenarios

Denotes	Description	Remarks
S1	USA, Japan, EU_27 and OOECD introduce carbon tax in their domestic markets	the reference case, developed regional carbon tax satisfy the setting in CTAP
S2	USA, Japan, EU_27 and OOECD introduce carbon tax in their domestic markets +imposing carbon tariffs on imports from developing countries	consumption-based accounting approach; energy-intensive and international transportation sectors
S3	All regions introduce carbon tax in their domestic markets	all regional carbon tax satisfy the setting in CTAP

Empirical Analysis

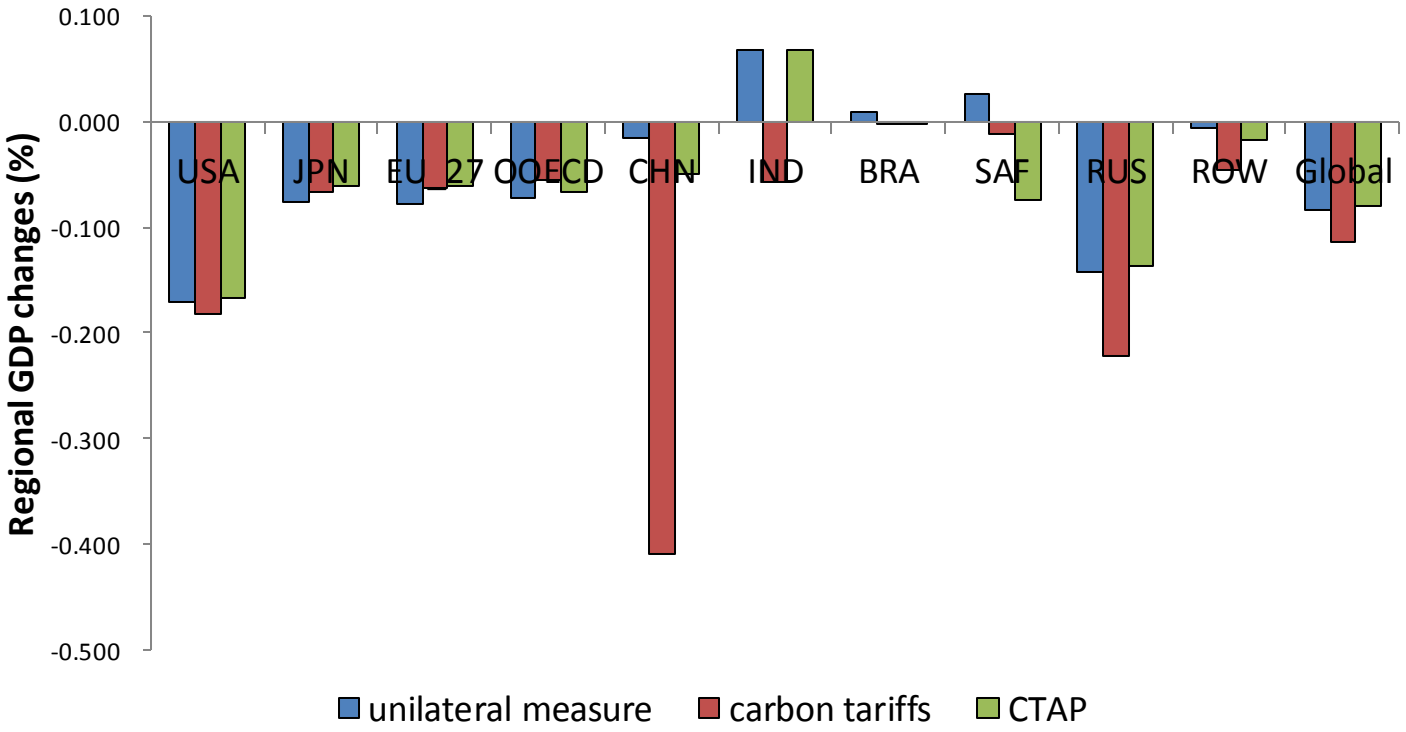
The impacts on social welfare



- ✓The CTAP scheme could yield global welfare improvement than implementing carbon tariffs.
- ✓Most developing regions will experience some welfare improvement in CTAP compared to the carbon tariffs.

Empirical Analysis

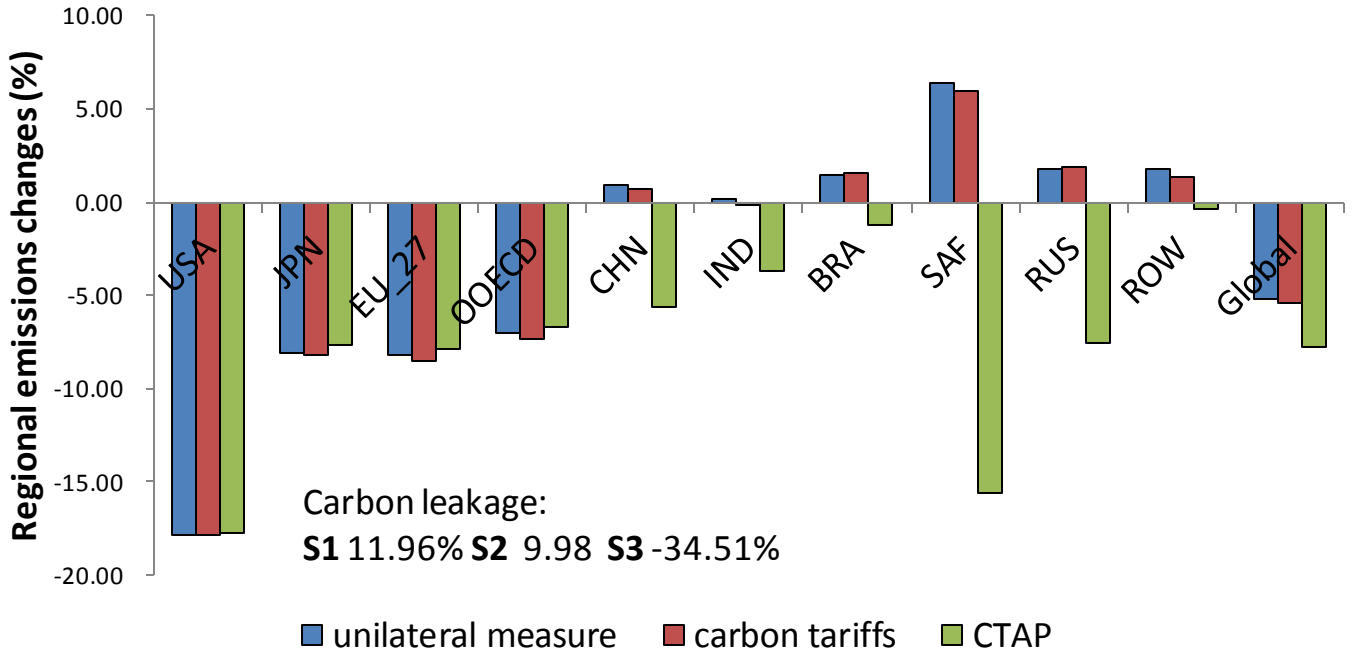
The impacts on real GDP



- ✓The CTAP scheme could yield global GDP increase than implementing carbon tariffs.
- ✓Most developing regions will experience some welfare improvement in CTAP compared to the carbon tariffs.

Empirical Analysis

The impacts on carbon emissions



- ✓The global emissions will be reduced by 7.78% in the CTAP scheme, which is larger that 5.40% in the carbon tariffs case.
- ✓In the case of CTAP, all developing regions could also achieve some mitigation, however, more than 70% of the total abatement is contributed by developed parties.

Empirical Analysis

Impacts on energy-intensive sectors

Table 4 Changes in output and exports of energy-intensive sectors

	output			export		
	unilateral measure	carbon tariffs	CTAP	unilateral measure	carbon tariffs	CTAP
USA	-0.84	-0.82	-0.79	-2.22	-2.83	-2.05
JPN	-0.47	-0.46	-0.44	-1.24	-1.45	-1.21
EU_27	-0.31	-0.26	-0.25	-0.49	-0.40	-0.39
OOECD	-0.07	0.00	0.03	-0.05	0.07	0.17
CHN	0.25	0.17	-0.02	0.61	-0.17	0.27
IND	0.41	0.34	0.39	1.30	0.56	1.28
BRA	0.19	0.15	0.05	0.73	0.09	0.31
SAF	0.52	0.51	0.12	1.26	0.78	0.63
RUS	1.06	1.00	-0.04	4.95	4.18	1.80
ROW	0.92	0.75	0.84	2.00	1.30	1.88

- ✓The carbon tariffs implemented will ease the competitiveness concerns for developed countries . However, this improvement is at the expense of the export deterioration of developing parties
- ✓The implementation of carbon tax by developing countries may alleviate the negative effects of EIS in developed countries, although it could not fully compensate for the competitiveness loss.

Discussion and Conclusion

- The main conclusions are as follows：
  - Firstly, the CTAP is effective in reducing global emissions compared to carbon tariffs, while the former would also generate a lower carbon leakage.
  - Secondly, the CTAP scheme could yield global GDP increase and global welfare improvement than implementing carbon tariffs. Thus, CTAP is better than carbon tariffs in terms of global indictors.
  - Thirdly, most developing regions experience less welfare deterioration when adopting a carbon tax based on CTAP in comparison to having a carbon tariff imposed by developed countries, and the reduction actions of developing countries could also lessen the competitive concerns of developed countries from unilateral measures.

Discussion and Conclusion

- Yet, the CTAP scheme is not cost-effective, as different countries adopt different carbon taxes.

- However, the cost-effective approaches (i.e. global uniform carbon tax and global carbon market) require the developing countries to undertake most reduction burdens because of low abatement costs, which also need the larger financial transfer from developed countries to developing countries.

- Regarding the fact that there is no solution of burden sharing of emissions reduction satisfies to all parties, and no answer of the amount of the transfer funds, thus the financial transfers may be a tremendous challenge.

- The CTAP scheme, which can be regarded as a transitional cooperation reduction scheme, is an attractive short-term option, especially for the case of no cost-effective schemes satisfied to all patties at present.

Thanks for your attention !