



# Assessing the Regional Implementation Pathways of National Wide ETS In China

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# Contents



- **Empirical Assessment** of the pilot ETS:  
Contradictory Stylized facts
- **Numerical Simulation** of the regional impacts  
under various national wide ETS scenarios
- **Uncertainties** with the regional implementation  
pathways : remaining issues to be considered

# Empirical Assessment of the pilot ETS



## 1.1 Fiscal Expenditure and Industry Structure

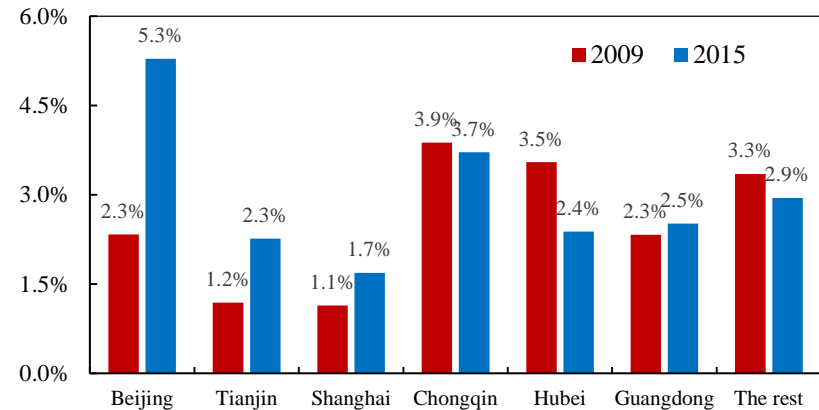
### More concern for environmental protection

- More environmental protection fiscal expenditure except for Hubei Province;
- Endogenous relationships?

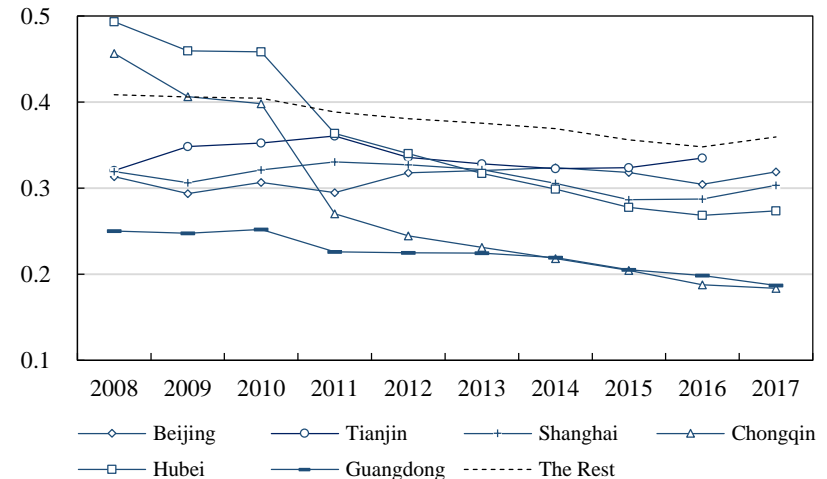
### Slight change of industrial structure

- Slight decline of energy intensity shares but also rebound in some regions;
- No great difference compared to the non treatment groups

Ratio of Environmental Protection Fiscal Expenditure



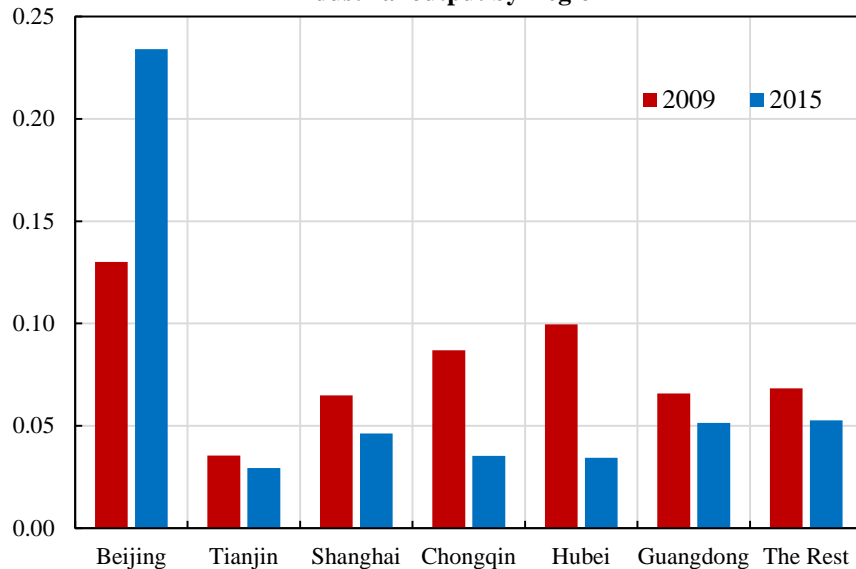
Share of Energy-Intensive Industries in the Pilots



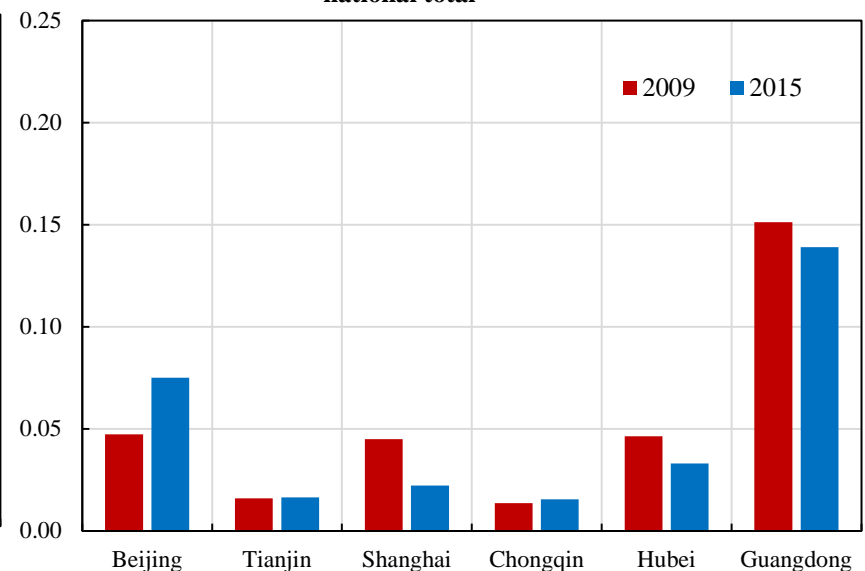
# 1.2 Electricity, Heat Production and Supply

- **Regionally:** less electricity, heat production and supply industries except Beijing;
- **Nationally:** not exactly, there are more important factors for structure;
- Purpose for pilots(not fierce)

Share for Electricity, Heat Production and Supply of Total Industrial output by Region



Share of Electricity, Heat Production and Supply of national total

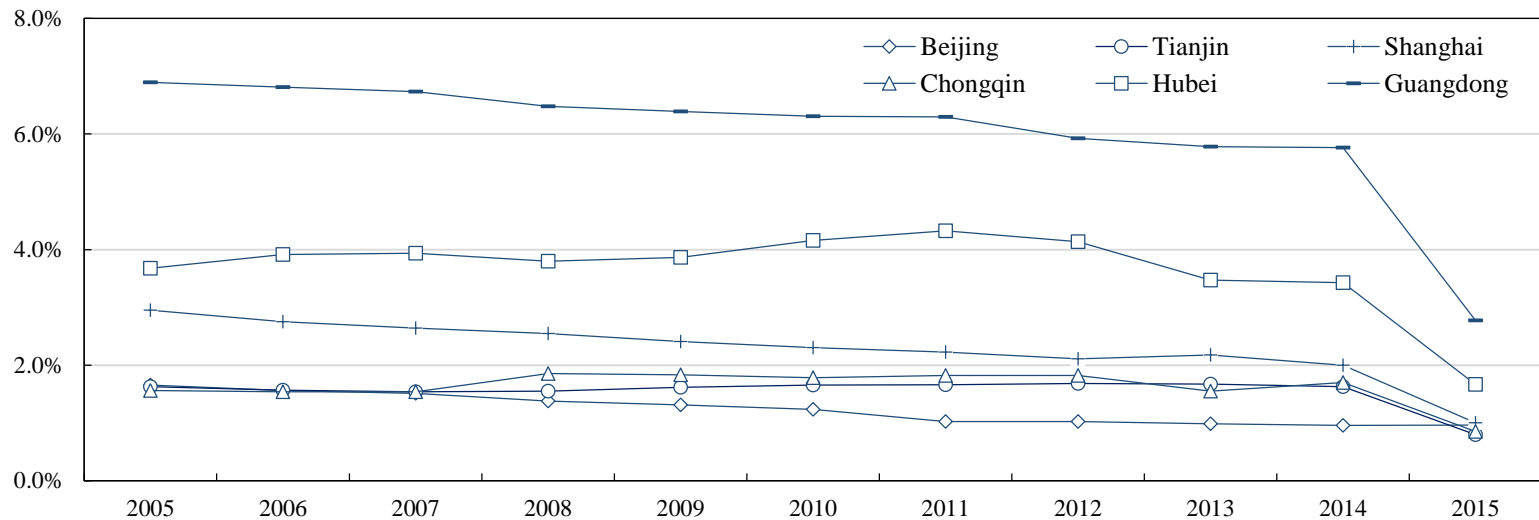


# 1.3 Share of Emission for Pilots

## ■ Decreasing share of emission for pilots

- Pollutant-haven
- Technology(Energy efficiency, energy structure and etc.)
- Relative magnitude

Share of CO2 Emission to national Total in the Pilots



Source: Provincial Statistical Yearbook

# 1.4 Intensity performance

■ **Emission intensity declined significantly;**

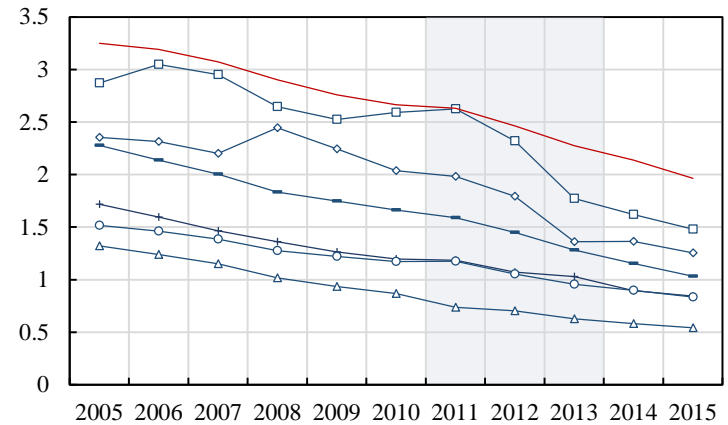
➤ The pilots declined faster than the national average, with a lower initial level.;

■ **Energy intensity also experienced a decline;**

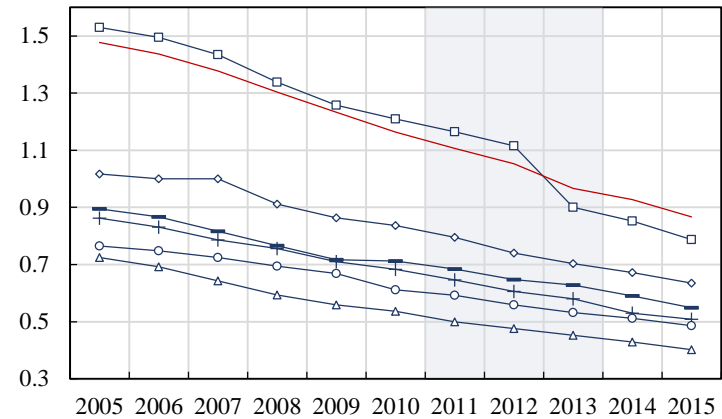
➤ Speed is similar to national average;

■ **Hubei Province performed well in intensity.**

Provincial Emission Intensity(ton/10000 yuan)



Provincial Energy Intensity(ton kgce/10000 yuan)



2011-2013
  Beijing
  Tianjin
  Shanghai
  Chongqing
  Hubei
  Guangdong
  The Rest

## 1.5 Verification for performance

	<b>Authors</b>	<b>Conclusion</b>
<b>Treatment Effect</b>	Zhang et al. (2017) Wang et al (2019)	Pilot policies of carbon market trading can effectively reduce carbon emissions; PSM-DID;
	Fan et al.(2017)	Supporting the "Weak Porter Hypothesis": Carbon market did not improve the TFP of pilots, but significantly improve technology; DEA and DID;
	Zhou et al. (2019)	carbon market effectively reduced emission intensity of pilot, mainly through industry structure; LMDI and DID;
	Wang et al.(2018)	Four factors of effectiveness: reduction potential, quota tightness, carbon price and economic fluctuation; DID;
<b>Model Simulation</b>	Qian et al.(2018)	Carbon market could bring about a decline in the total national carbon emissions; CGE;
	Tang et al.(2016)	Carbon market can mitigate pollution-heaven effect, which can be further amplified taking auction to allocate; IRD-CGE
	Li et al.(2019)	Carbon market has co-benefit in mitigating NO <sub>x</sub> and PM <sub>2.5</sub> ; MARKAL and GAINS;

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# ➤ MODEL STRUCTURE AND FEATURES



## **Model Structure & Data base:**

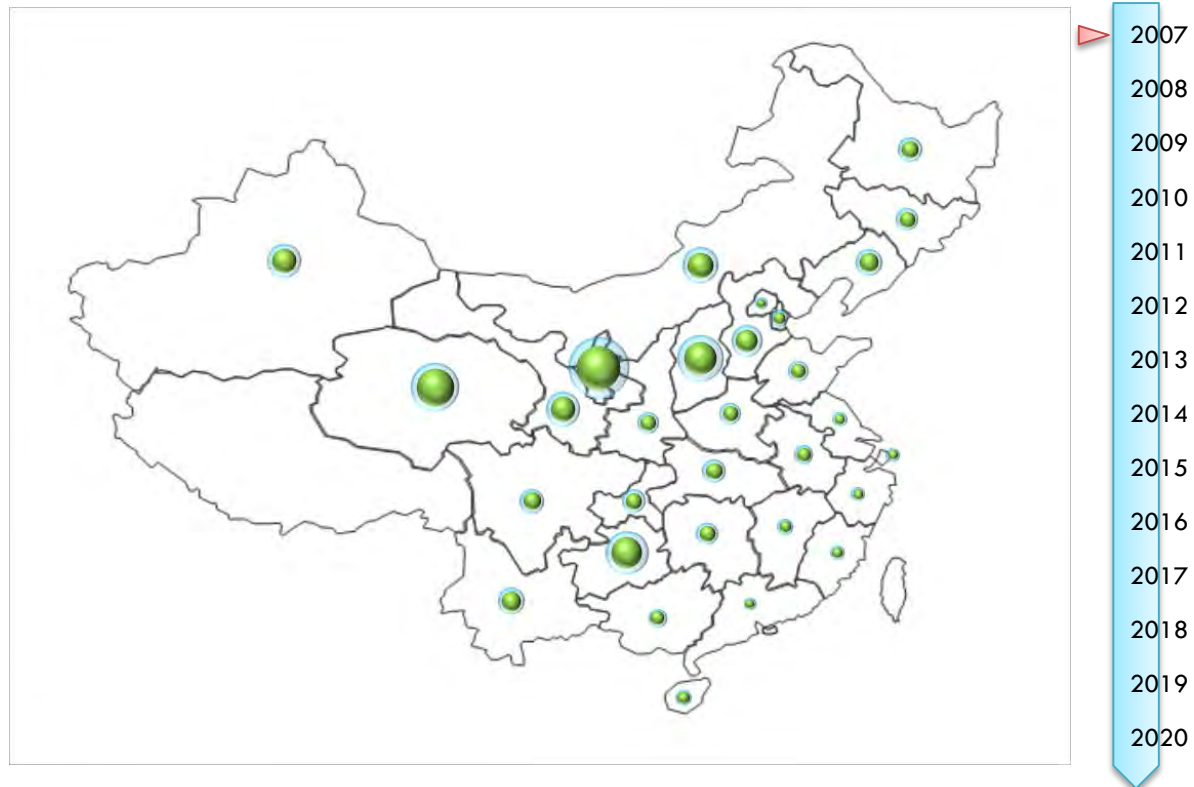
- 30 Regions, 42 industries;
- 3 factors -- Capital <sup>1</sup>, Labor & Emission Permits;
- 2 Agencies – Households & Regional Governments;
- “Small Economy” in international trade; “Large Economy” in domestic trade;
- Data base -- 2007 Regional Input-Output Data.

## **Function Module:**

- Production & Demand Module;
- Recursive Dynamic Module;
- Inter-regional economic interaction and correlation module;
- Energy & Emission Module.

# ➤ SCENARIOS -- BAU

	CODE	TARGETS	ALLOCATION	FLEXIBILITY
S1	NULL	Without any climate and energy policies		
S2	BAU	2005 ~ 2010: <i>Notice on the Completion of 11<sup>th</sup> FYP Regional Energy Conservation Targets</i> 2010 ~ 2015: <i>Work Program on GHG Controlling for 12<sup>th</sup> FYP</i> 2015 ~ 2020: <i>Copenhagen Commitment of China.</i> <sup>1</sup>		

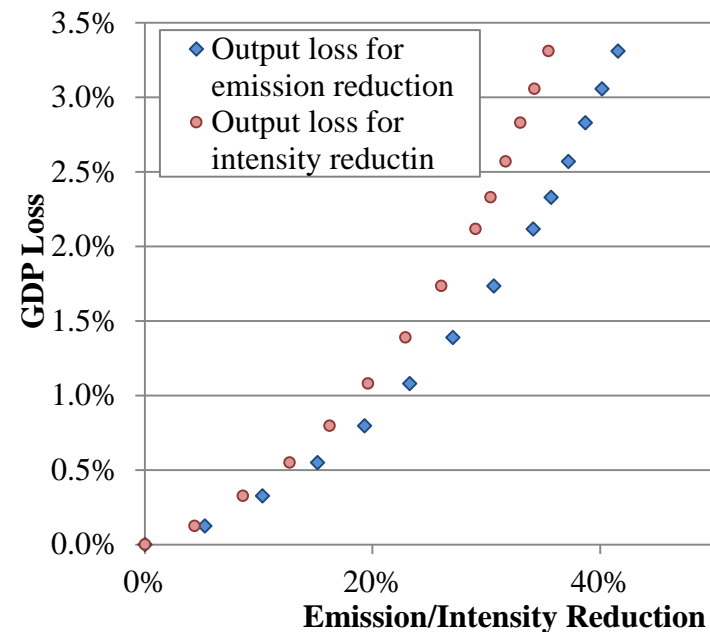
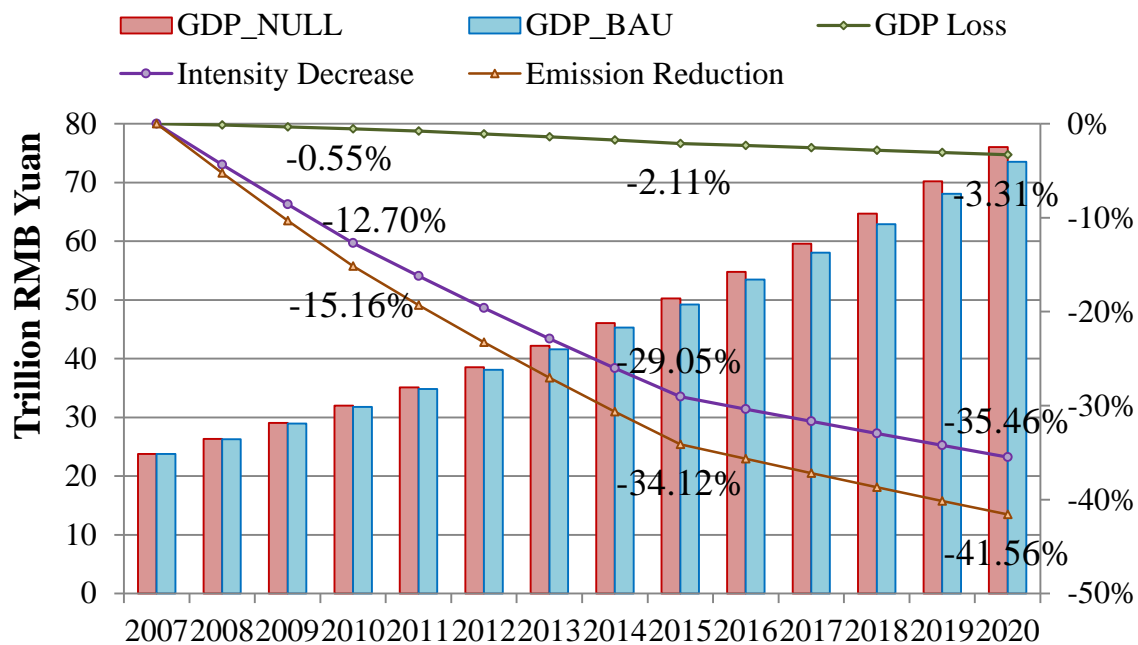


# ➤ SCENARIOS -- BAU



## Economic Costs:

- yearly average GDP growth 8.26% in BAU, 8.54% in NULL;
- Nonlinear correlation between economic costs & emission/intensity reduction targets.



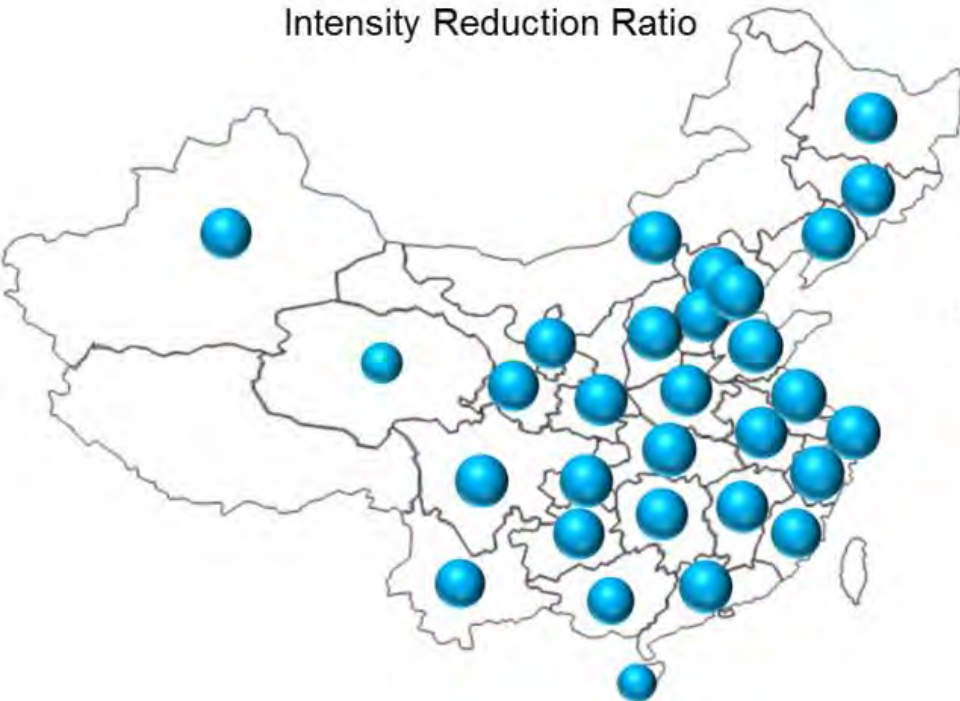
# ➤ SCENARIOS -- BAU



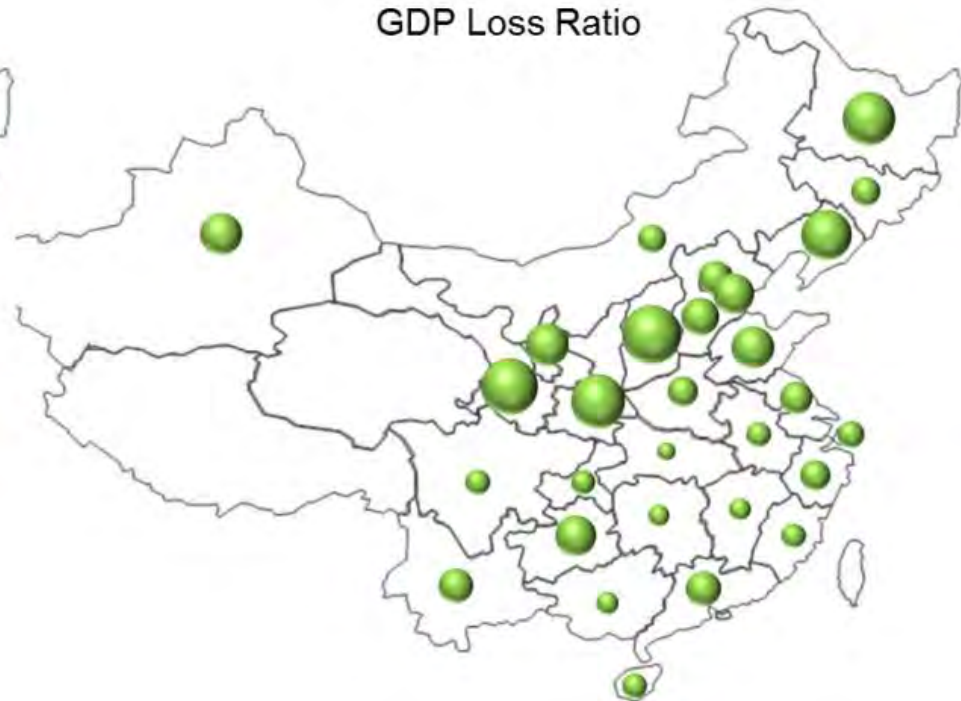
## Regional Effects:

- Energy intensive & industrializing regions (Mid/Northern) most affected;
- Energy exporting regions also affected;
- Less energy intensive regions (eastern coastal regions & southern regions) are less sensitive.

Intensity Reduction Ratio



GDP Loss Ratio

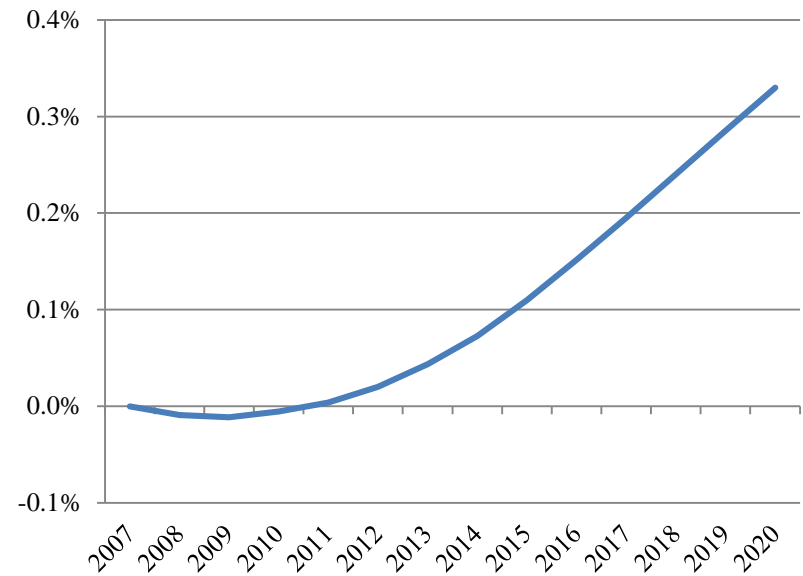
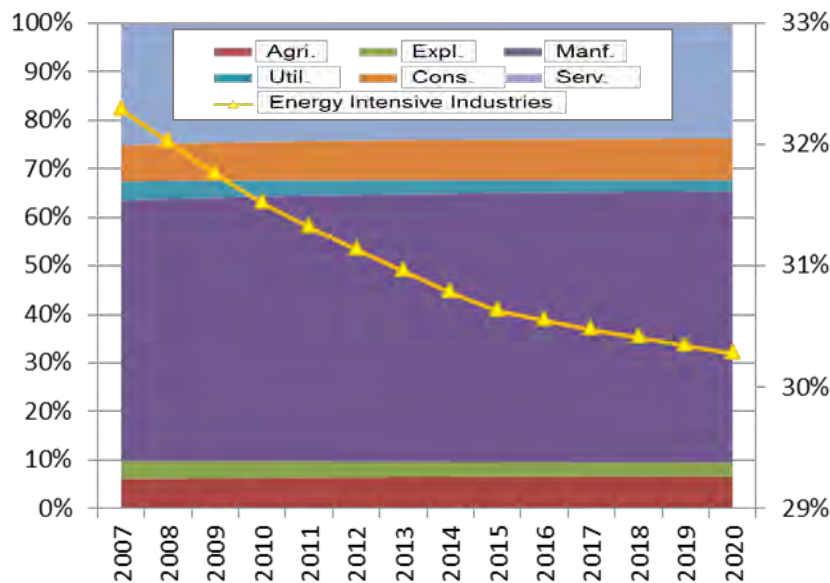


# ➤ SCENARIOS -- BAU



## Industrial Effects:

- General industrial structure is slightly changed, given the industrialization process in China;
- Share of energy intensive sectors<sup>1</sup> decreased observably;
- Industrial Structure change mitigates the impacts of policy shocks .



# ➤ SCENARIOS -- Overview



## Climate Policies:

	CODE	TARGETS	ALLOCATION	FLEXIBILITY
S3	EM_NT	Total Emission Constraint (Set According to BAU)	Regional Emission in Base-year	Non-tradable
S4	EM_T			Tradable
S5	OPT_NT		Regional Output in Base-year	Non-tradable
S6	OPT_T			Tradable
S7	WLF_NT		Regional Welfare in Base-year	Non-tradable
S8	WLF_T			Tradable

## Allocation Criteria:

Criterion	Allocation
Emission	$EM_r \leq \tau \cdot \overline{EM}_r$
Output	$EM_r \leq \tau \cdot (\overline{OP}_r / \sum_r \overline{OP}_r) \cdot \sum_r \overline{EM}_r$
Welfare	$EM_r \leq \tau \cdot (\overline{U}_r / \sum_r \overline{U}_r) \cdot \sum_r \overline{EM}_r$

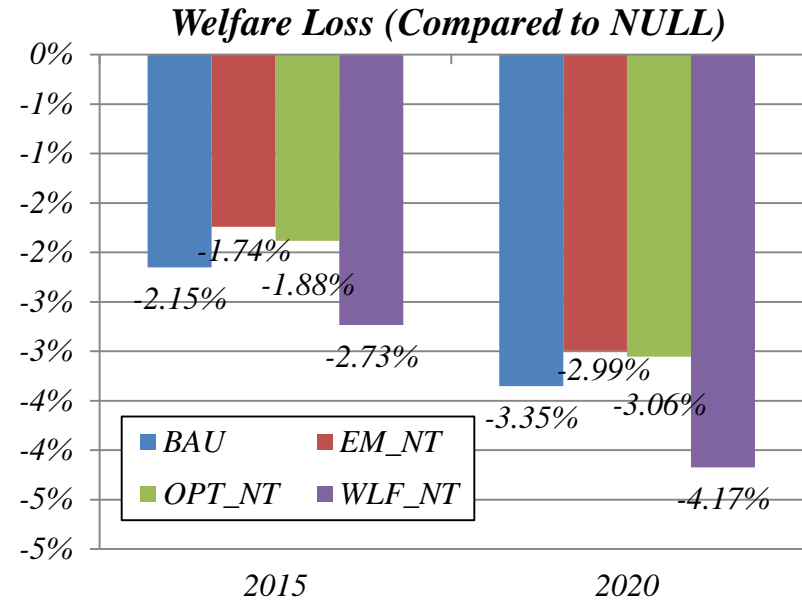
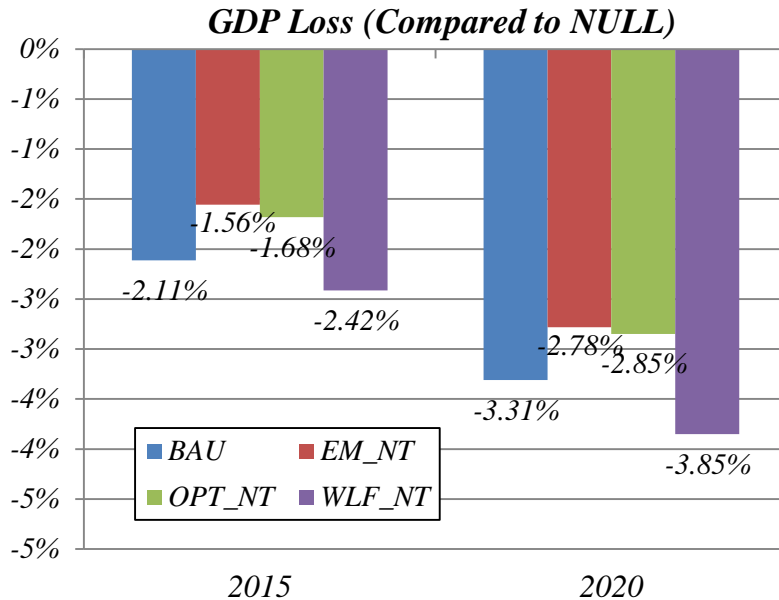
# ➤ SIMULATION RESULTS -- Nontradable

## Conflicts between Efficiency & Equity:

- Allocation of permits determines regional MAC;
- Economic Efficiency: equalized MAC;
- Social Equity: equalized welfare/economic losses;

⇒ *No guarantee for the existence of a certain allocation satisfies both requirements;*

⇒ *Reallocation of permits for income transfer leads to extra losses.*

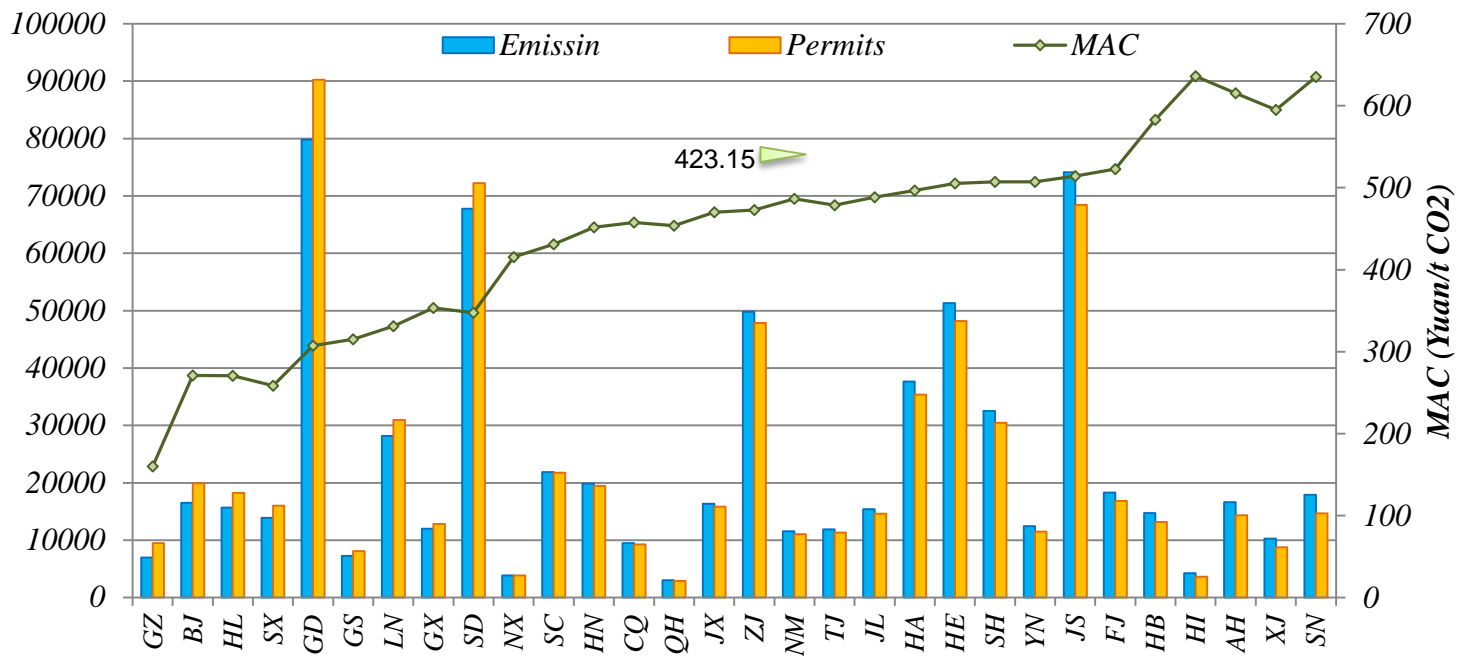
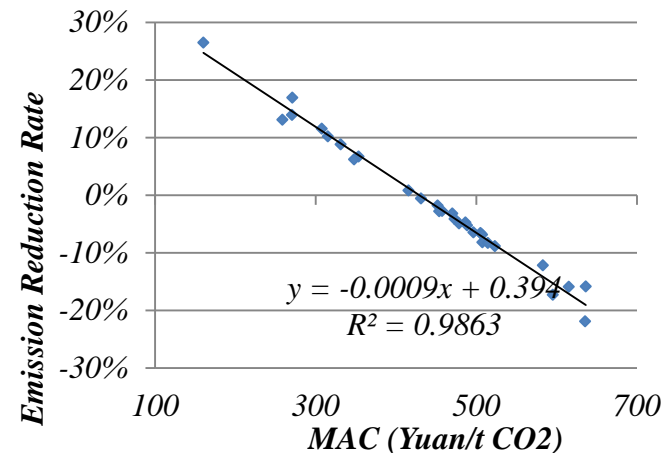


# ➤ SIMULATION RESULTS - C&T

## Decoupled Economic Efficiency with Initial Allocation:

- High MAC: Buy permits; Low MAC: Sell permits;
- Pareto optimization: equalized MAC.

⇒ *Emission reduction rate negatively related to MAC*



# ➤ SIMULATION RESULTS – C&T

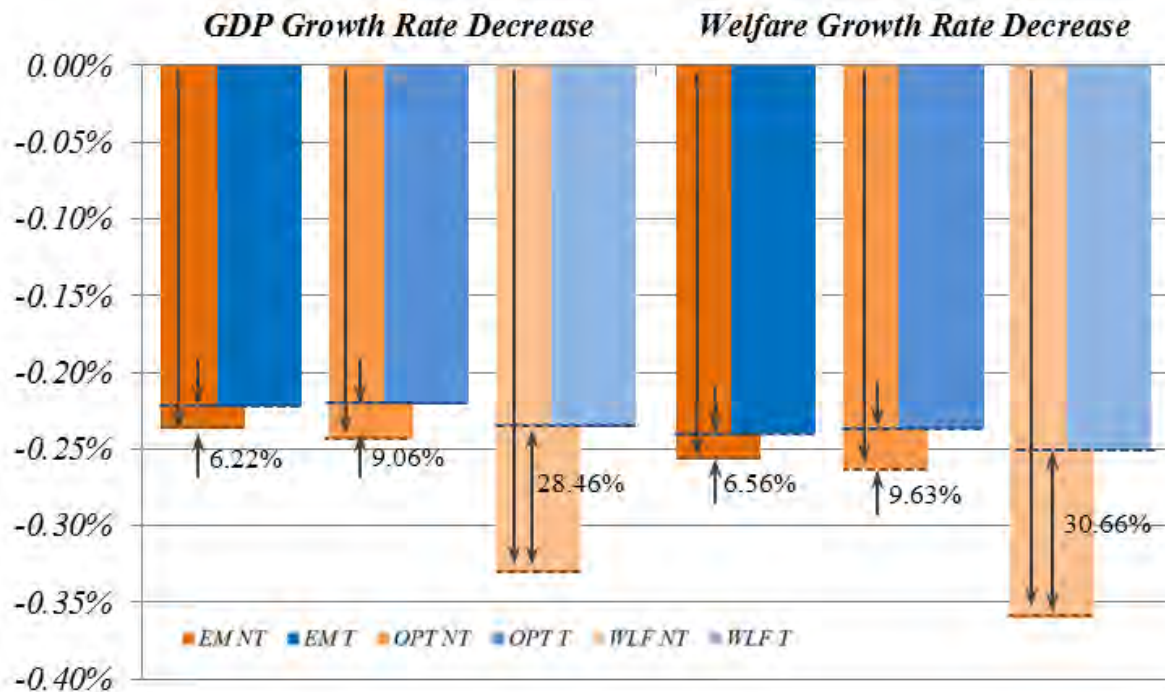
## Effects of Emission Trading Scheme:

- Economic efficiency – by equalizing MAC across regions
- Policy flexibility – by narrowing economic/welfare losses across alternative allocation criteria

⇒ *Emission trading bridged concerns for efficiency & equity.*

⇒ *Emission trading provide permits with financial value;*

⇒ *Reallocation of permits would lead to income redistribution without significant losses in economic efficiency.*



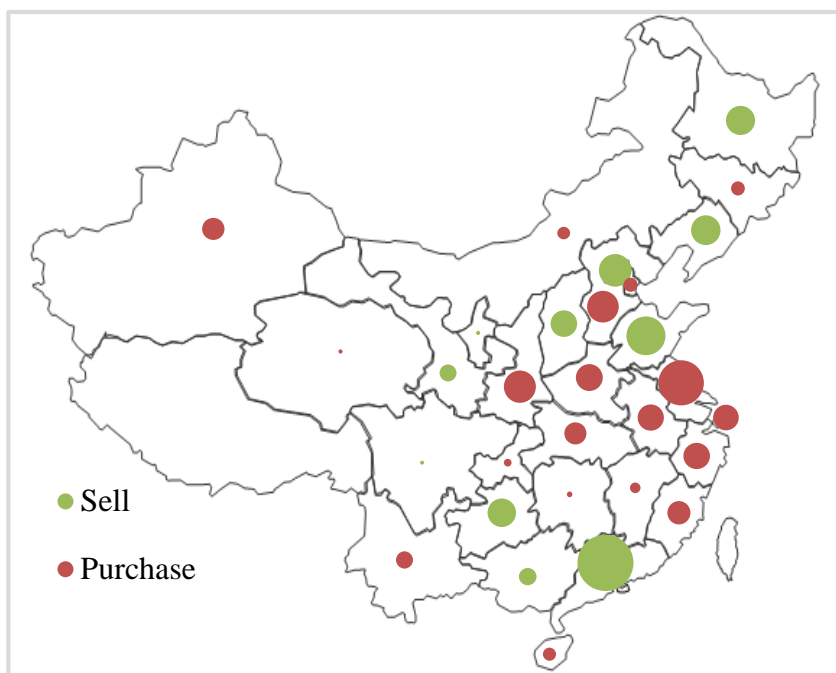
# ➤ SIMULATION RESULTS – Reallocation



## Base-Year Emission Criterion:

- Least distortion and lowest economic loss in non-trading scenario;
- Income transfer from industrialized to industrializing areas;
- Favorable to energy-intensive regions;

*Emission Trading in EM\_T Scenario*



*GDP Growth Rate Decrease in EM\_T Scenario*

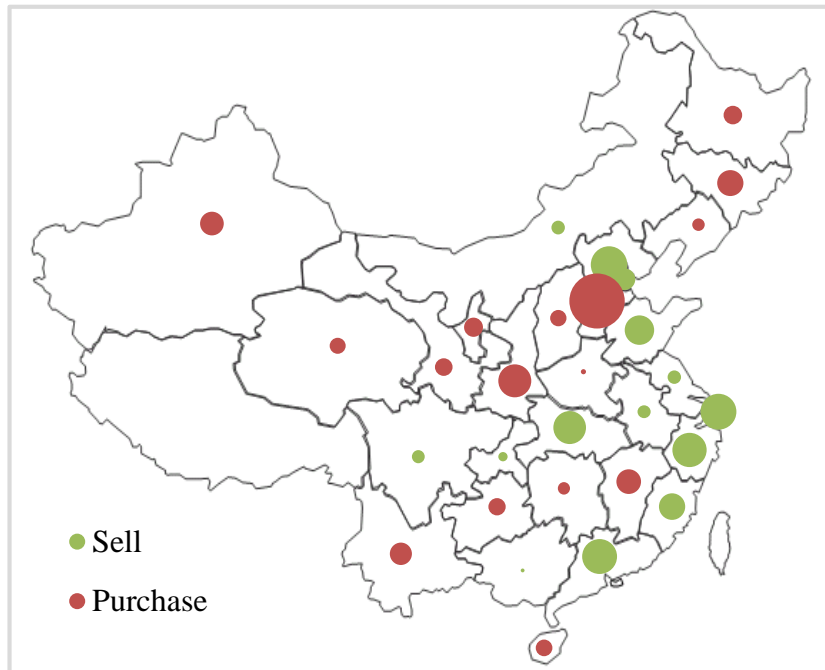


# ➤ SIMULATION RESULTS – Reallocation

## Base-Year Output Criterion:

- Income transfer opposite to EMT criterion;
- Low income western and middle areas and most affected;

*Emission Trading in OPT\_T Scenario*



*GDP Growth Rate Decrease in OPT\_T Scenario*

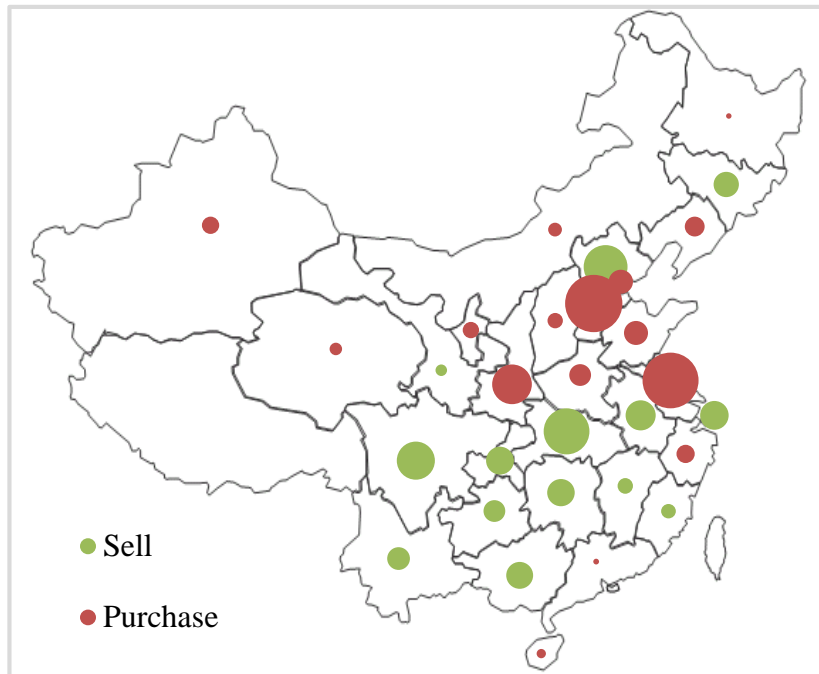


# ➤ SIMULATION RESULTS – Reallocation

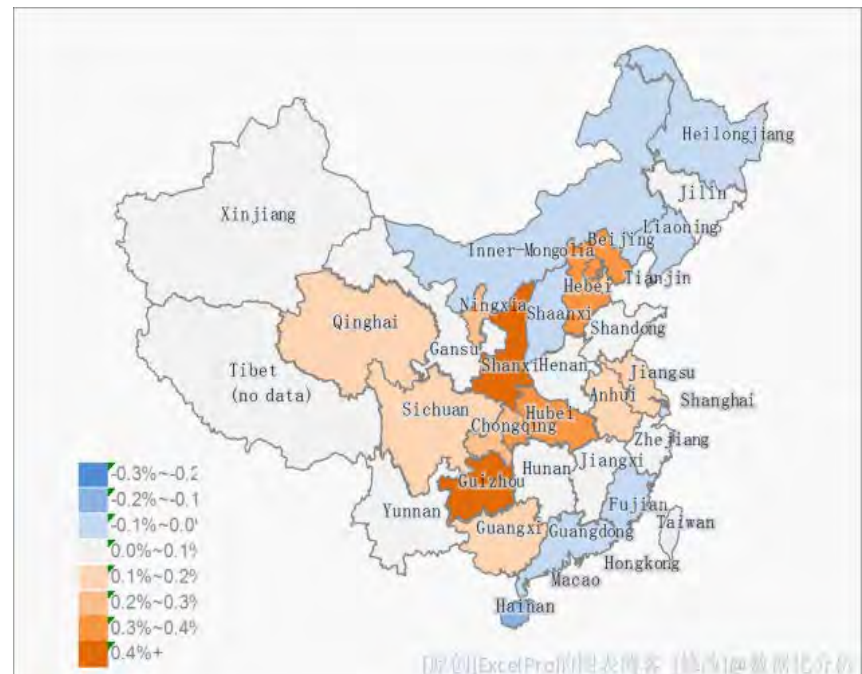
## Base-Year Welfare Criterion:

- Highest distortion in non-tradable scenarios;
- Income transfer from Southern to Mid & Northern areas;
- Favorable to areas with higher consumption share.

*Emission Trading in WLF\_T Scenario*



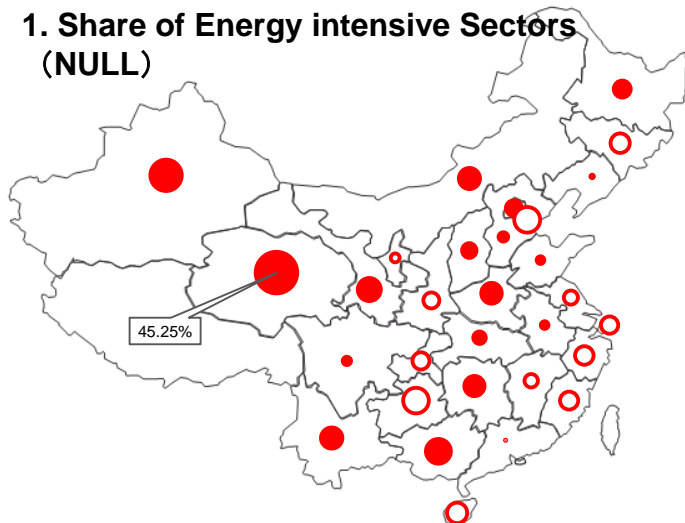
*GDP Growth Rate Decrease in WLF\_T Scenario*



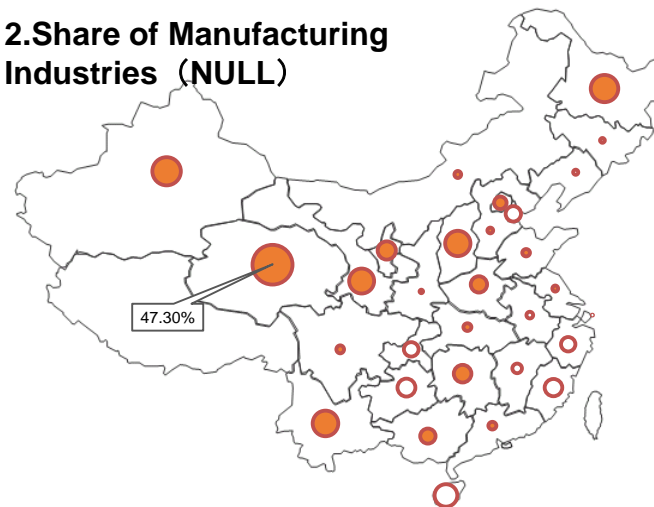
# Without any policy intervention, the pollution haven in western-northern China will be intensified



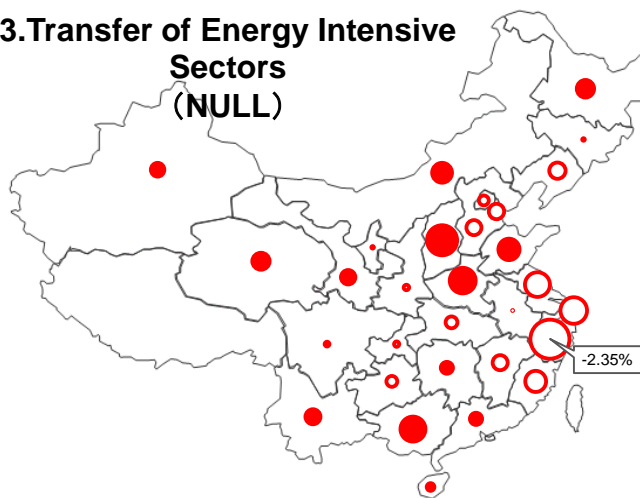
1. Share of Energy intensive Sectors (NULL)



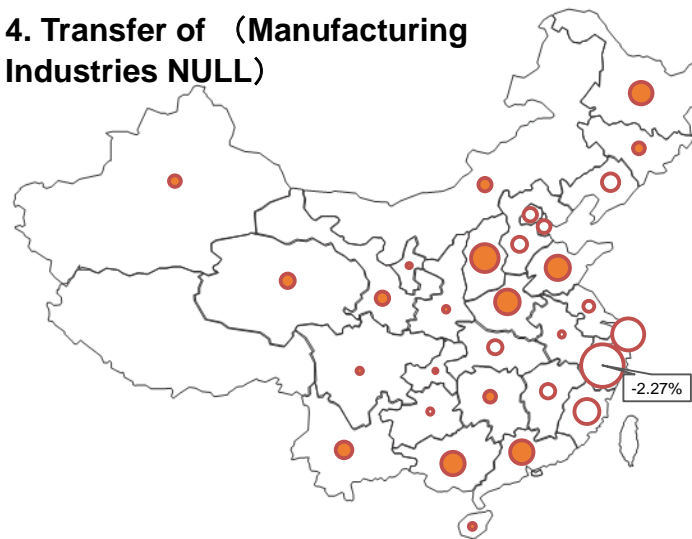
2. Share of Manufacturing Industries (NULL)



3. Transfer of Energy Intensive Sectors (NULL)

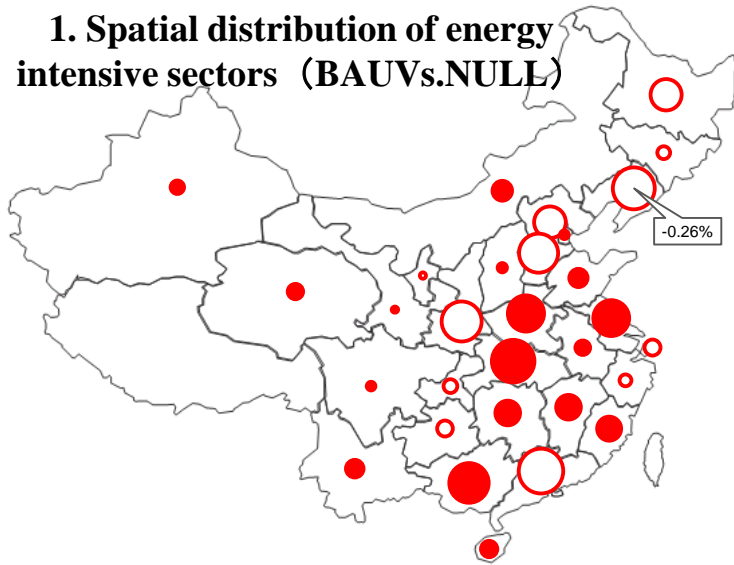


4. Transfer of (Manufacturing Industries NULL)

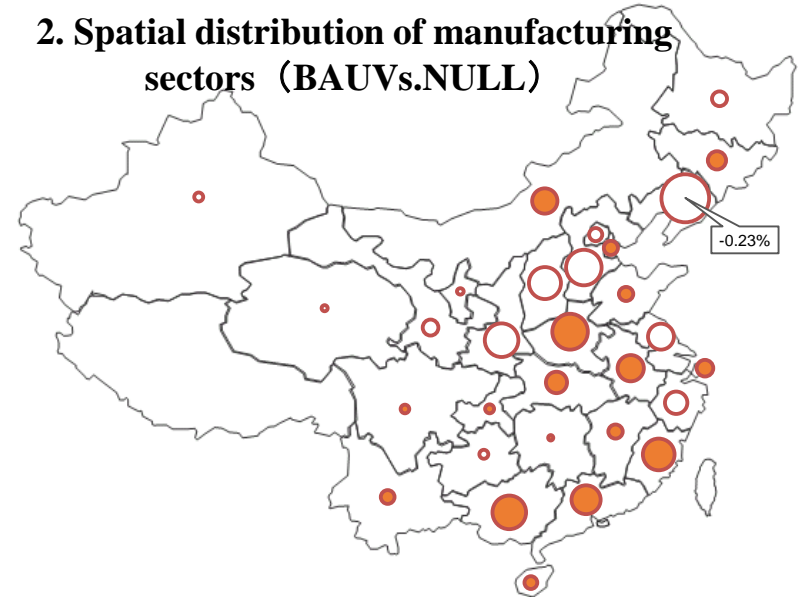


- **Intensity targets can strengthen the pollution haven in western-northern China**

1. Spatial distribution of energy intensive sectors (BAUVs.NULL)

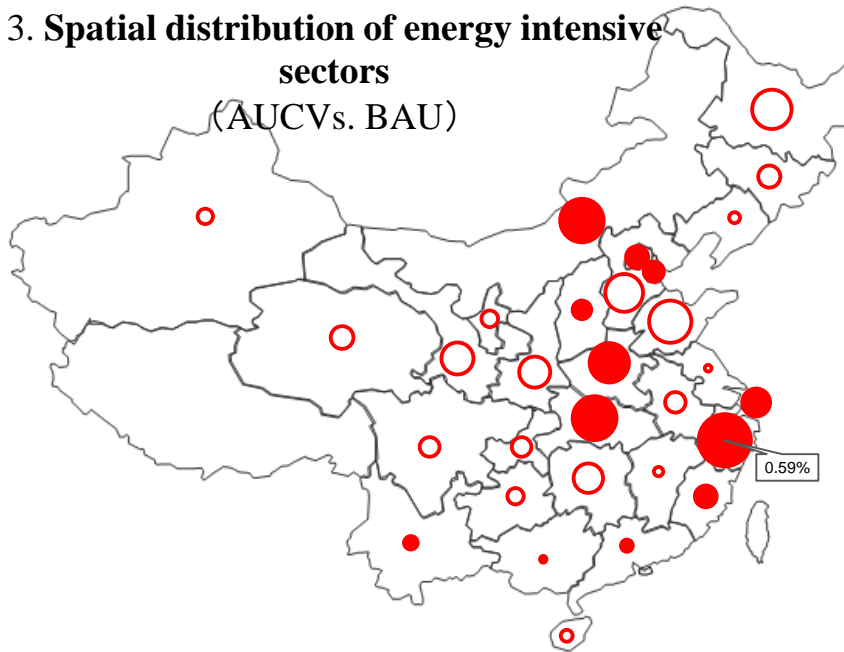


2. Spatial distribution of manufacturing sectors (BAUVs.NULL)



- **ETS using auction can reduce the transfer of energy intensive sectors**

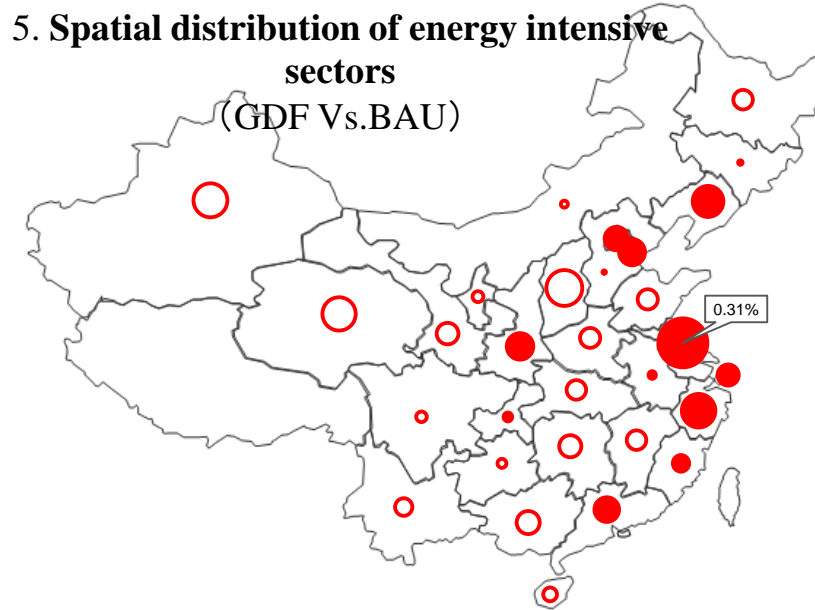
3. Spatial distribution of energy intensive sectors (AUCVs. BAU)



4. Spatial distribution of manufacturing sectors (AUCVs. BAU)

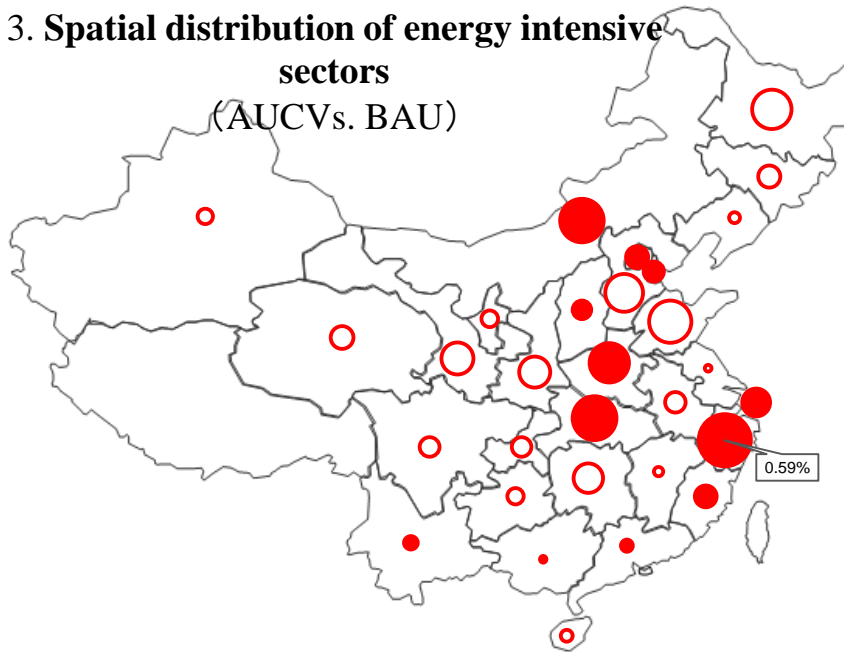


- **GDF can switch the transfer of energy intensive sectors significantly**



- Auction can reduce the transfer of energy intensive sectors significantly

3. Spatial distribution of energy intensive sectors (AUCVs. BAU)

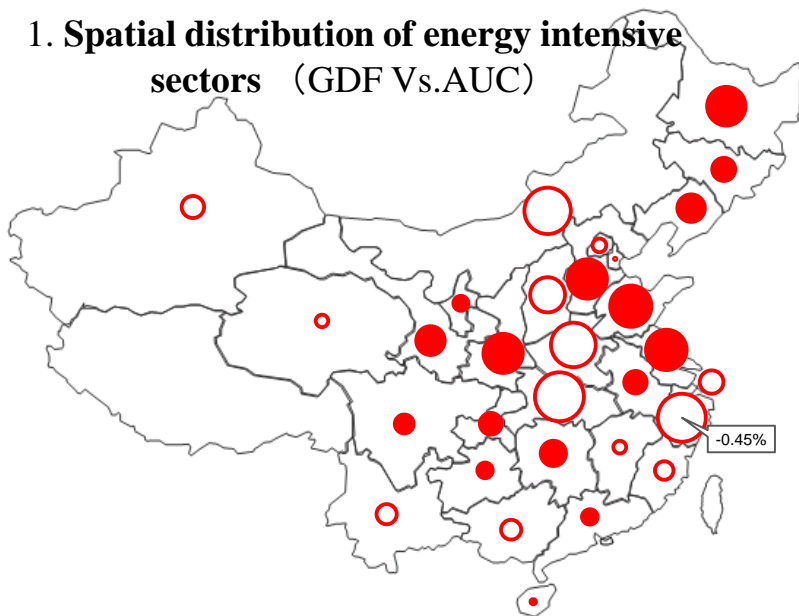


4. Spatial distribution of manufacturing sectors (AUCVs. BAU)

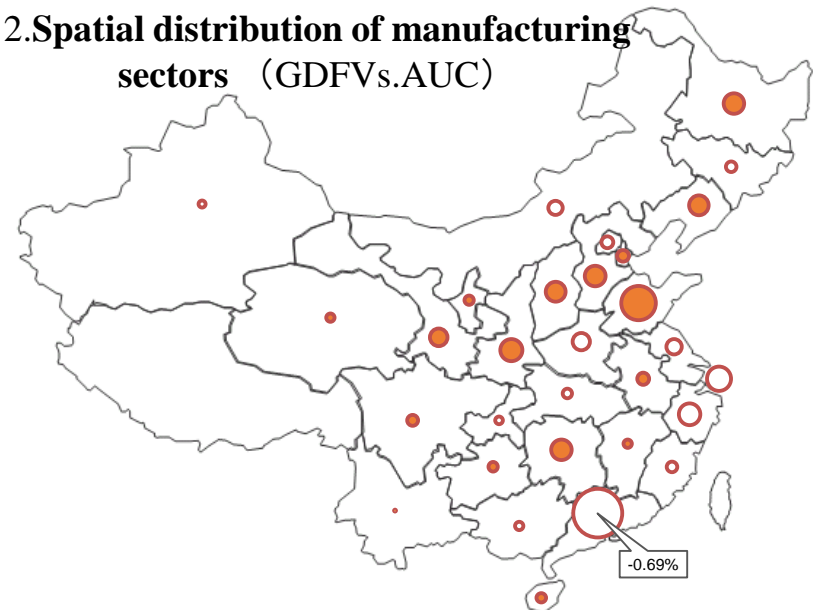


# Auctioning outperforms Grandfathering in terms of reducing transfer of energy intensive sectors to western regions

1. Spatial distribution of energy intensive sectors (GDF Vs.AUC)



2. Spatial distribution of manufacturing sectors (GDFVs.AUC)



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# Uncertainties with the Factors Incentivizing the national ETS



## Regional disparity of **Co-benefits** of climate policies

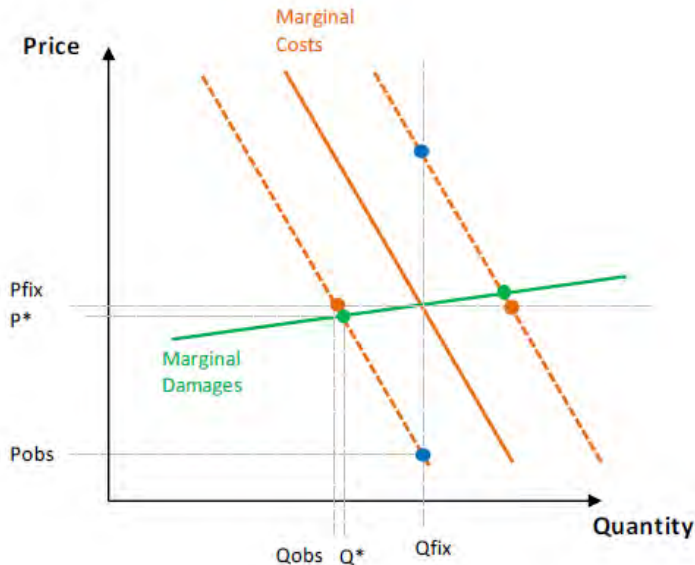
- Co-benefits of climate policies: reduced local pollutants and its related health impacts
  - **Production choice of firms:** reducing output, energy structure change, end-of pipe treatment, production technology innovation, management efficiency improvement
  - **Policy choice of government: Optimal alternative policies realizing same pollution emission reduction and health effects** :environmental protection policies with diversified social welfare change and output change
  - **Consumption choice of consumers:** income disparity across regions and the consumption mode of energy service, diversified WTP for environmental goods and global public goods

## Interaction of other relevant policies in place with climate policies

- **Mandatory standards(latent subsidies to output):** energy intensity, carbon intensity, renewable portfolio standards
- **Direct Subsidies to specific sectors:** electricity and natural gas subsidies to residential sectors, renewable producers, nuclear producers,
- **Mixed Price signal from three pillars of ETS:** carbon permits, pollutant permits, energy saving credits
- **Investment intervention from** Industrial policies, trade policies and financial policies
- **Incomplete cost Pass-through and deviation from optimal choice due to the factor market:** especially electricity market , natural gas market and so on

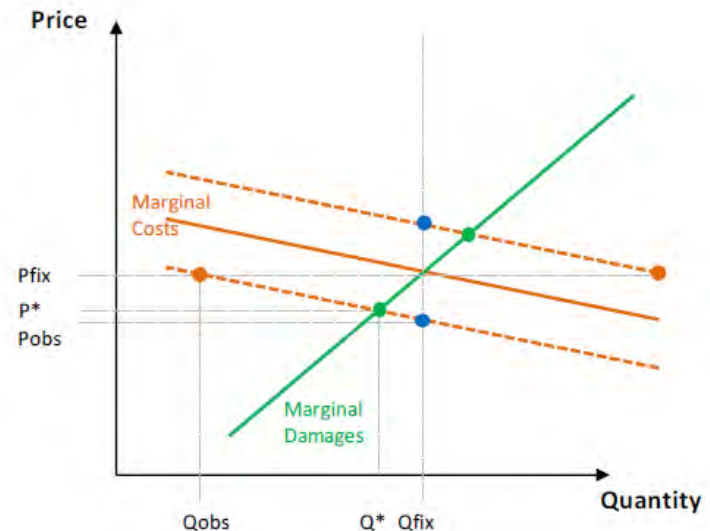
For global public goods, can price signal generate effective supply and demand at regional level?

If not, can regional environmental policies generate enough co-benefits of climate change targets? Or we need complementary policies for quantity control and strengthen the fiscal transfer at national level?



**Price control is more effective**

To fix the price level, the observed emission under real marginal abatement costs will differ slightly from the optimal emission



**Quantity control is more effective**

To fix the emission level, the observed price under the real marginal abatement cost will not differ greatly from the optimal price

**欢迎批评指正!**  
*Thank you for your attention*