中国科学院广州能源研究所
GuangZhou Institute of Energy Conversion,Chinese Academy of Sciences

Impacts of carbon reduction policy on air pollutant emissions in Guangdong province of China

Wang Peng[1], Dai Hancheng[2], Zhao Daiqing[1]Toshihiko Masui[2]
1Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, China, Guangzhou
2National Institute for Environmental Studies, Japan
The 22nd AIM International Workshop 2016.12.9

Outline

1 Background in GD

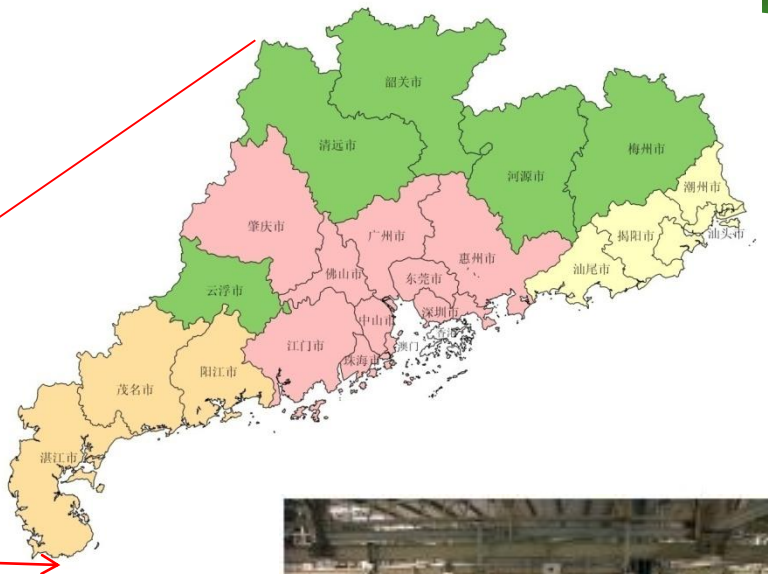
2 Carbon reduction policy and regulation

3 Methodology

4 Scenario setting and simulation results

5 Conclusion

Research background



- Guangdong (GD) - located in south of China, population of 105 million
- Economic reform and opening up since 1978, international trade, process manufacturing and electrical appliances
- Largest contribution to GDP in China

12th Five-year performance

- Contributes over 11% (7281 billion yuan) of China's GDP
- Consumes 7% (29.6 million tce) of China's energy
- Energy intensity target decreased 18% from 2010-2015
- Has reduced carbon intensity by 19.5% from 2010 to 2015
- Implementation of ETS (Carbon Emission Trading System) across industry sectors from 2012
- Power, cement, oil refinery and iron & steel sectors (200 factories) are selected, which contributes to 58% of total CO2 emissions in GD
- Other sectors have no ETS constraint

13th Five year plan in GD

- GD GDP annual growth rate is 7% (2015-2020)
- Committed to reduce energy intensity by 17% from 2015 to 2020
- Reduce carbon intensity by 20% from 2015 to 2020 (tentative)
- Implement energy total control, annual growth rate is 2.3%, increment is 37 million standard ton coal toward 2020.
- Wind power will reach 8 (3)million kW, Solar power 6 (1) million kW, Nuclear power 16 (8.3) million kW until 2020 (2015).

Source from: Guangdong 13th economy and energy development plan

Research background

- **GD reduced sulfur dioxide (SO2) emissions absolutely by 10% (2005-2010)**
- **Aim to reduce SO2 and NOx emissions by 15% and 17% (2010-2015), higher than the national target.**
- **Unclear how air pollution policy and ETS interact with each other**
- **Identifying such interactions could improve policy making in both areas.**

Current challenges

Economic :

- No primary energy. Coal, oil, gas rely on inflow and import
- Most of the manufacture level is non-automatic, heavy industry

Society:

- The gap between rich and poor in GD is the largest in China. Large population.

Environment:

- Serious risks associated with climate change: floods, heat waves, typhoons in summer.
- GHG contributes to climate change and air pollution worsens health

That's why GD is selected as the national carbon emission trading pilot.

Opportunities

Economic :

- Central government pushing the reform: electricity grid market reform, natural gas market. More access for private companies.
- Higher price of materials, energy and labour promote industry upgrade.

Environment:

- ETS, carbon finance market, air pollutant control and trading, investment in new technologies in pollutant control, CCS pilot

So to address the change and adapt to the opportunities, there needs to be an effective administration structure system.

Outline

1 Background about low carbon policy in GD

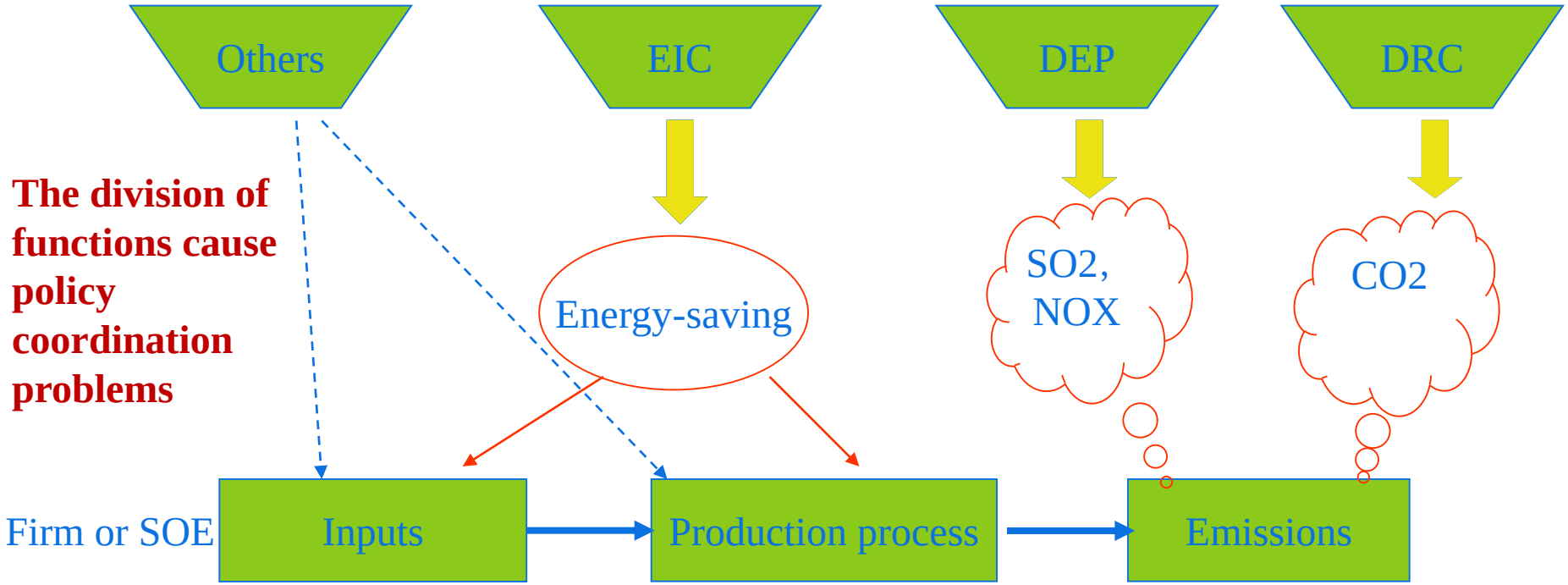
2 Emission trading scheme and regulation

3 Methodology

4 Scenario setting and simulation results

5 Conclusion

Government environment regulation system: supervising subjects



Distribution of power

EIC: Economic & Information Commission

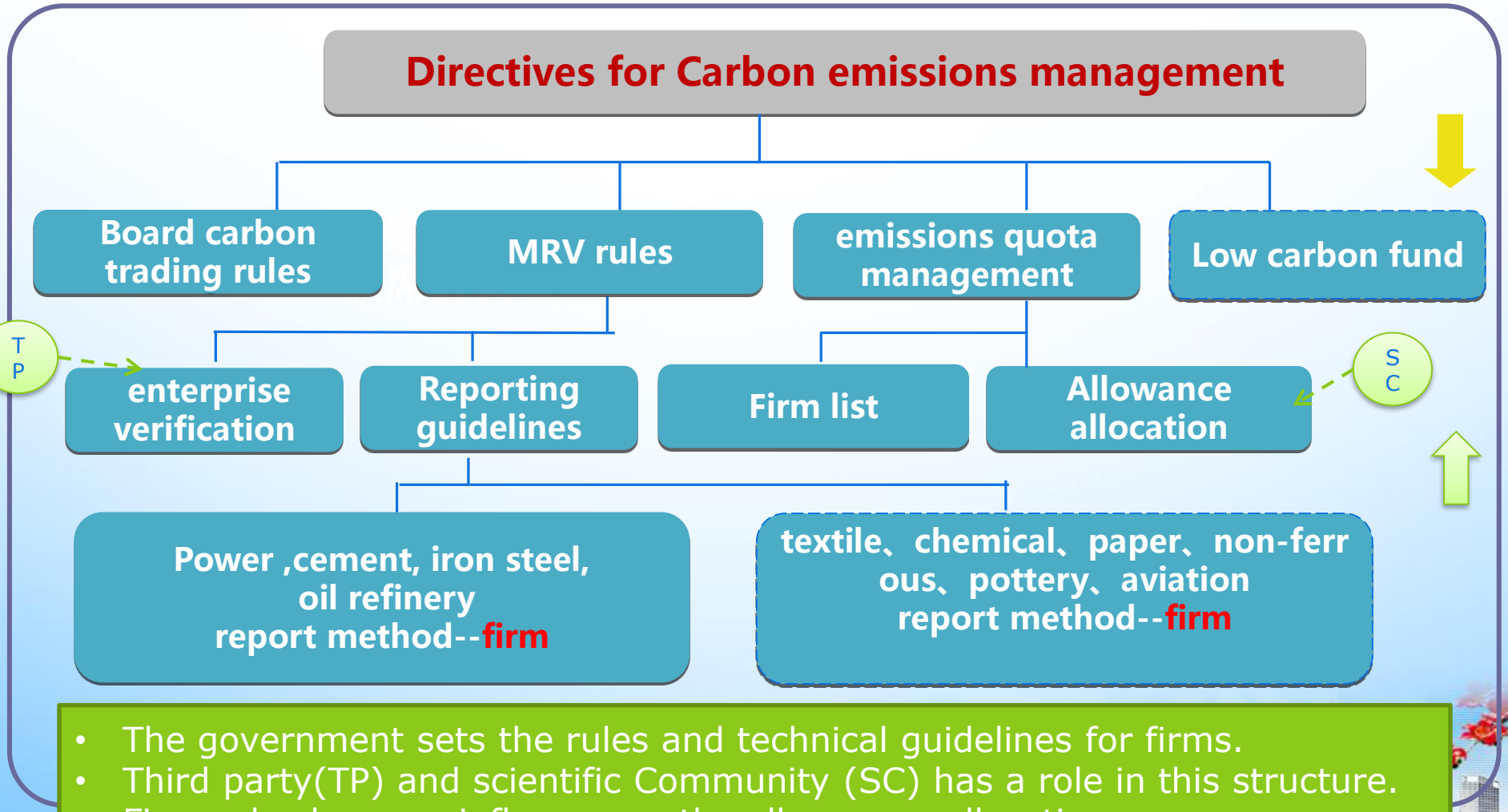
DEP: Department of Environmental Protection

DRC: Development and Reform Commission

- ✓**Difficult coordination between horizontal departments**
- ✓**On Enterprise level, policies are contradictory and overlapping**
- ✓**Increased burden on enterprises**
- ✓**Increased resistance from firms**

ETS governance structure

Laws and regulations system



- The government sets the rules and technical guidelines for firms.
- Third party(TP) and scientific Community (SC) has a role in this structure.
- Firms also have an influence on the allowances allocation.

Why assess the ETS and interrelation of different policies?

Object： policy->administration structure-> the possible effect and impact, co-benefit

❖ **Focus on research questions：**

- If the carbon market is constructed, how will the four sector trade affect the possible carbon price and trade volume?
- How to reduce policy conflict between the different supervising subjects?
- How to explore future possibilities for the carbon and air pollutants trading market?

Outline

1 Background about low carbon policy in GD

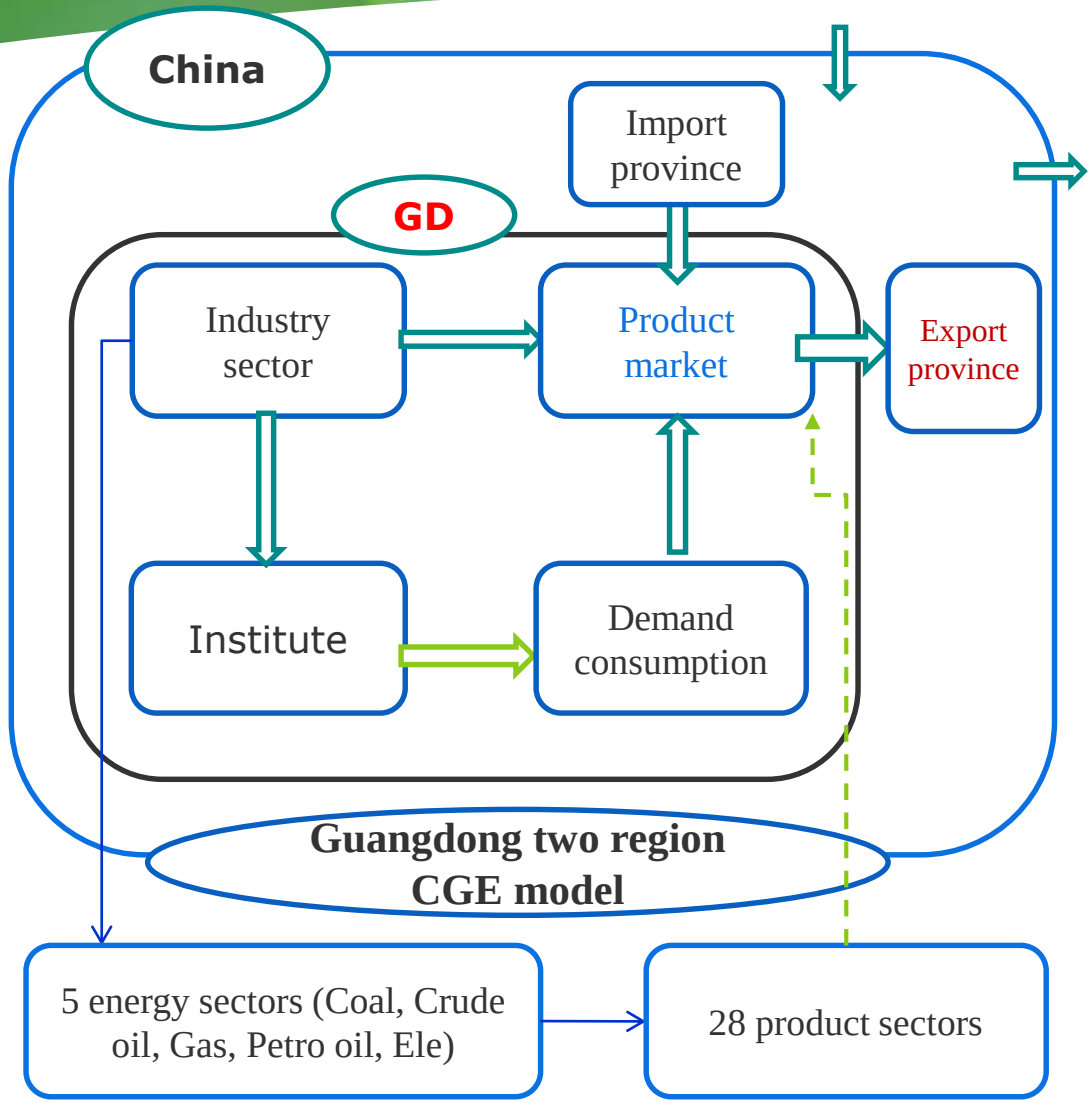
2 Emission trading scheme and regulation

3 Methodology

4 Scenario setting and simulation results

5 Conclusion

Methodology- model structure

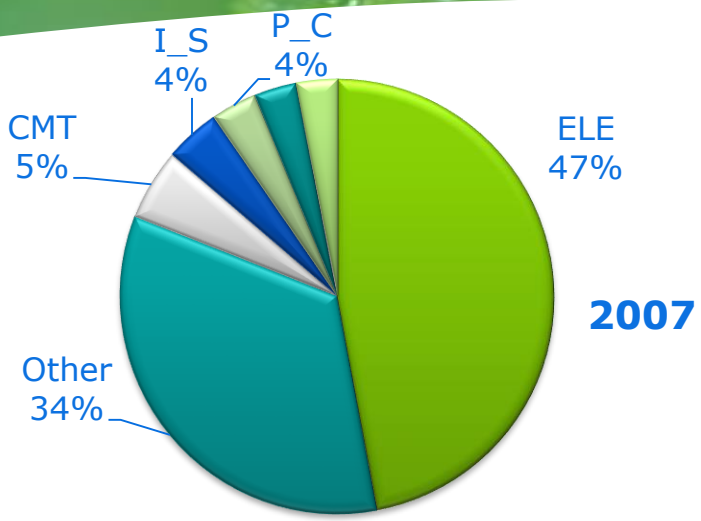


- **CGE model based on new classical economics general equilibrium theory, price mechanism is introduced into the model.**
- **Dynamic-recursive model, includes two regions and 33 sectors, 7 energy sectors.**
- **Sector carbon emissions as a factor input CES function, the emissions can be constrained.**

Research Method

- **Data includes 2007 Input-Output table**
- **Representing 33 economic sectors, two regions: Guangdong and rest of China. (CGE)**
- **Method: Simulate the trajectory of economic development, energy demand, carbon and air pollutant emissions, carbon prices.**
- **Aim: Assess impact of ETS under the constraint of carbon intensity reduction target towards 2020.**

Model assumptions



	2007-2010	2010-2015	2015-2020
Pop	3.4%	**0.6%**	**0.5%**
GDP	10.4%	**8%**	**7%**

Base scenario predicted GDP growth rate

年份	Investment growth grate (%)	GDP growth rate (%)
2008	11.8	10.40
2009	13	9.70
2010	10	12.40
2011	10	10.00
2012	8.5	8.2
2013-2015	8.5	8
2015-2020	8	7

GDP will be solved in the policy scenario

Outline

1 Background about low carbon policy in GD

2 Emission trading scheme and regulation

3 Methodology

4 Scenario setting and simulation results

5 Conclusion

Policy Scenario setting-Exogenous parameters

Scenario	Socio econo mic	Renew able energy	Emission trading	Emission constraint
BASE (baseline)	Populatio n grows by 1.1%/a, from 97.3 to 108.5 million. Investme nt grows at 8% per year.	Renewabl e developm ent plan	None	No carbon cap.
LCE (command and control policy)			None	•Carbon intensity reduces by 40% over 2010-20. •Annual growth rate of carbon between
LCET (ETS policy)			Yes	•2013-15: Power sector 0.5% Oil refinery 0.8%, cement 0.5%, iron and steel 0.5%; •2016-20: Power 0.1%, other three sectors 0.2%.

Solution

GDP?

Emission?

Carbon price?

Carbon intensity?

Output value?

《Carbon allocation method for four sectors by Guangdong government 》（trial）

- **The four sectors are power, cement, iron &steel and oil refinery**

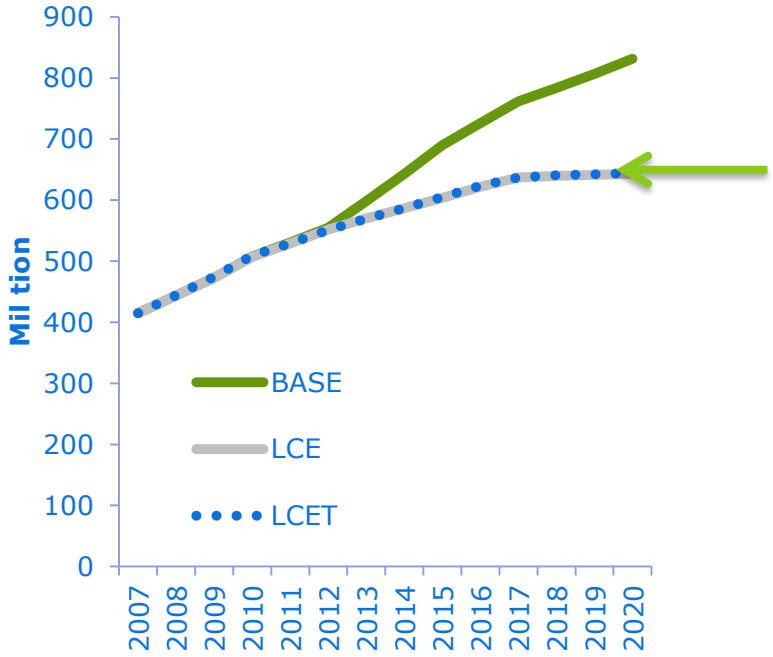
	2013	2014	2015
Total allowance（billion ton）	**0.35**	**0.356**	**0.369**

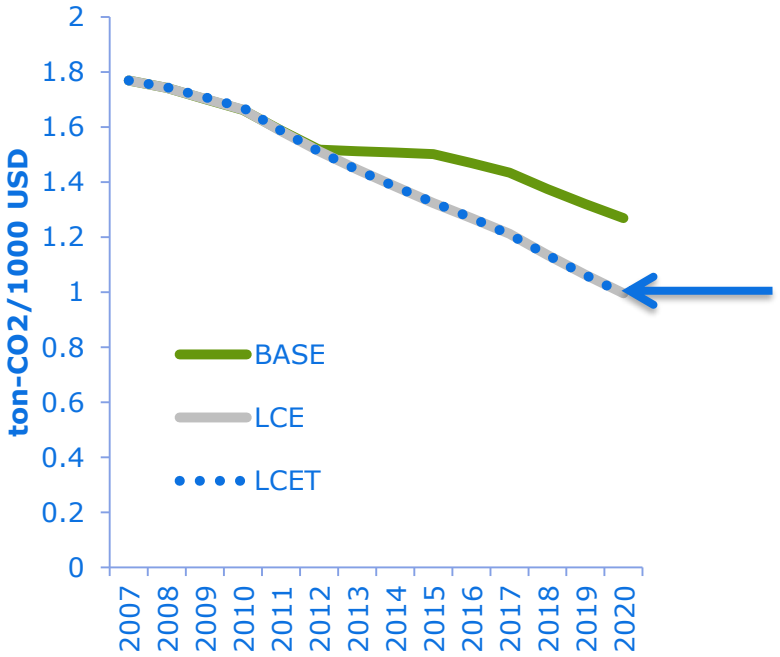
explain：2013 is the actual number , 2014、2015 is prediction

http://www.gddpc.gov.cn/xxgk/tztg/201311/t20131126_230325.htm. Retrieved on 24th June 2014.

19

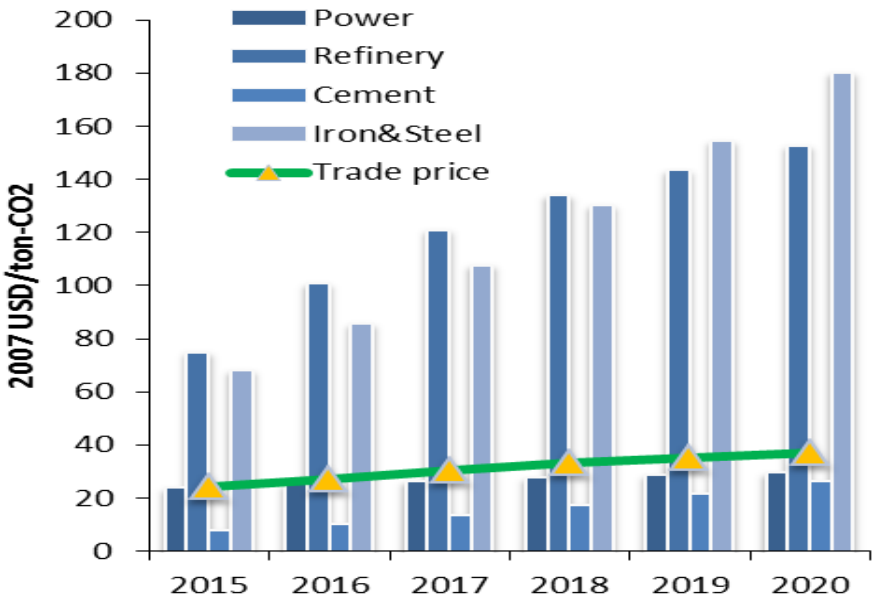
Carbon emissions and intensity change





- **Command-and-control policy and ETS both reduce CO2 compared with baseline**
- **Carbon caps leads to a carbon intensity decrease by 21%, target is exceeded**

Carbon abatement cost



- The command-and-control policy carbon abatement cost : iron & steel (170 $), refinery (140 $), power (30 $) and cement (20 $).
- **Under ETS policy, the carbon abatement cost decreases through trading, which forms a unified carbon price.**
- **ETS policy carbon price : (30 $).**

ETS impact on air pollutant emissions

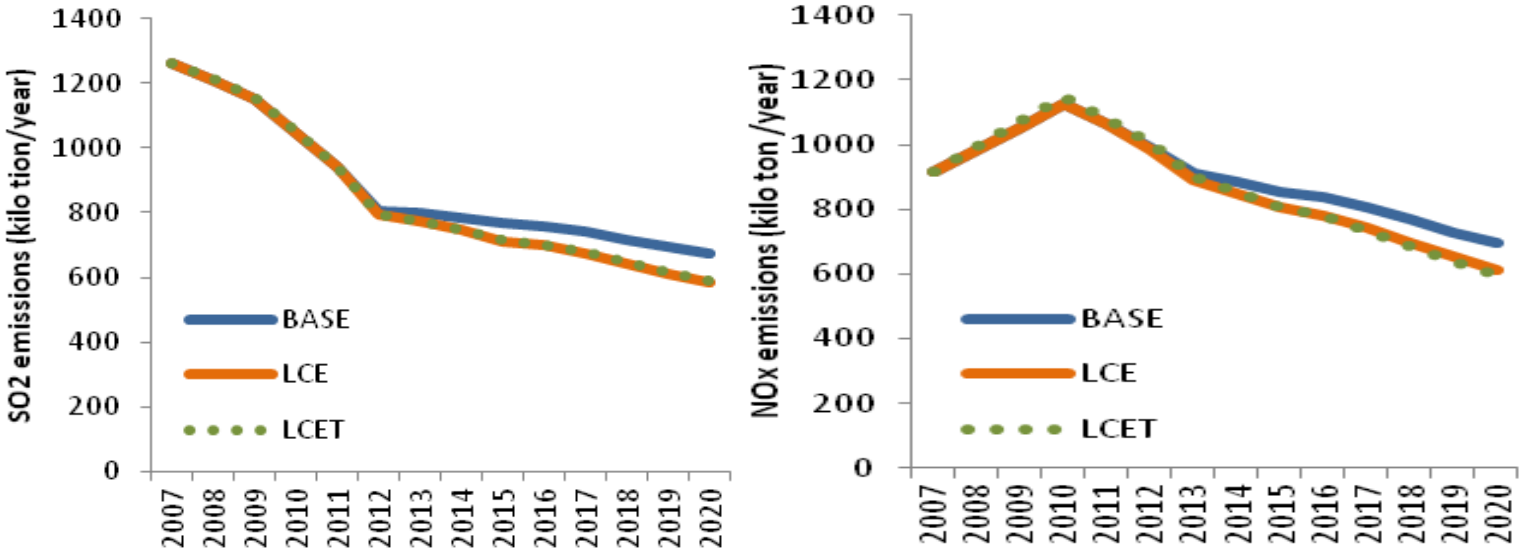


Fig.1 Total SO2 and NOx emissions trajectory over 2007-2020

- **Under command-and-control policy and ETS, SO2 and NOx emissions will significantly decrease since 2013.**
- **Interestingly, under ETS policy, total emissions of SO2 is projected to increase by 1.3%, whilst NOx will fall by 3.0% (compared with command-and-control policy).**

ETS impact on sector air pollutant emissions

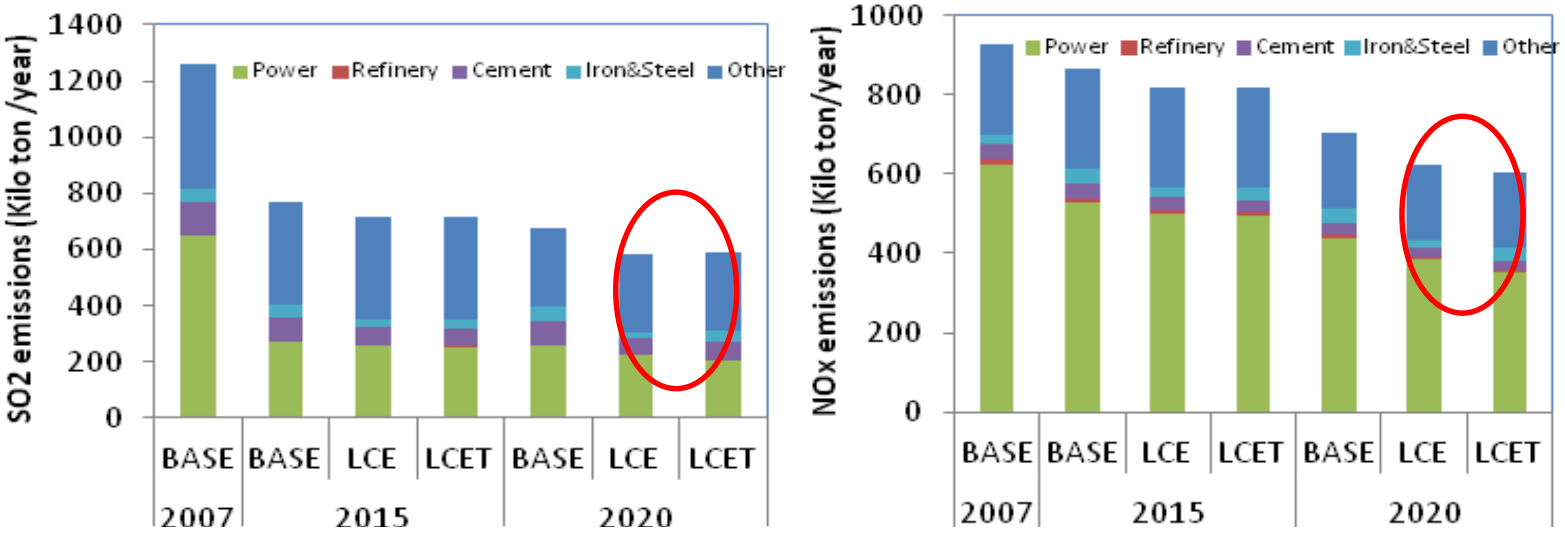
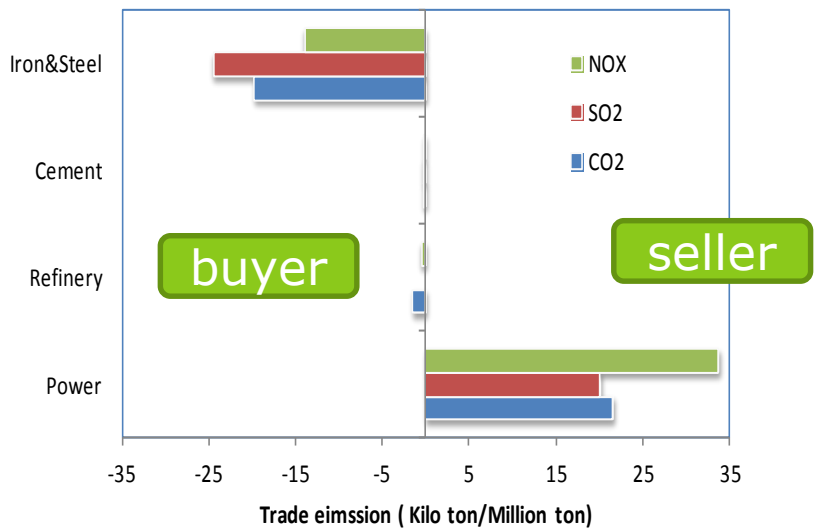


Fig.2 SO2 and NOX emissions in ETS sectors over 2007-2020

- From sector distribution, the power sector emits the highest level of air pollutants.
- ETS policy compared with Command-and-control policy:
  - In the power sector, the share of SO2 and NOx will decrease by 13% and 5%
  - In the industrial sectors, the share of SO2 and NOx will increase by 10% and 2% in 2020
  - Overall (across all sectors), SO2 emissions will increase, whilst Nox emissions will decrease.

ETS impact on embedded air pollutant trade



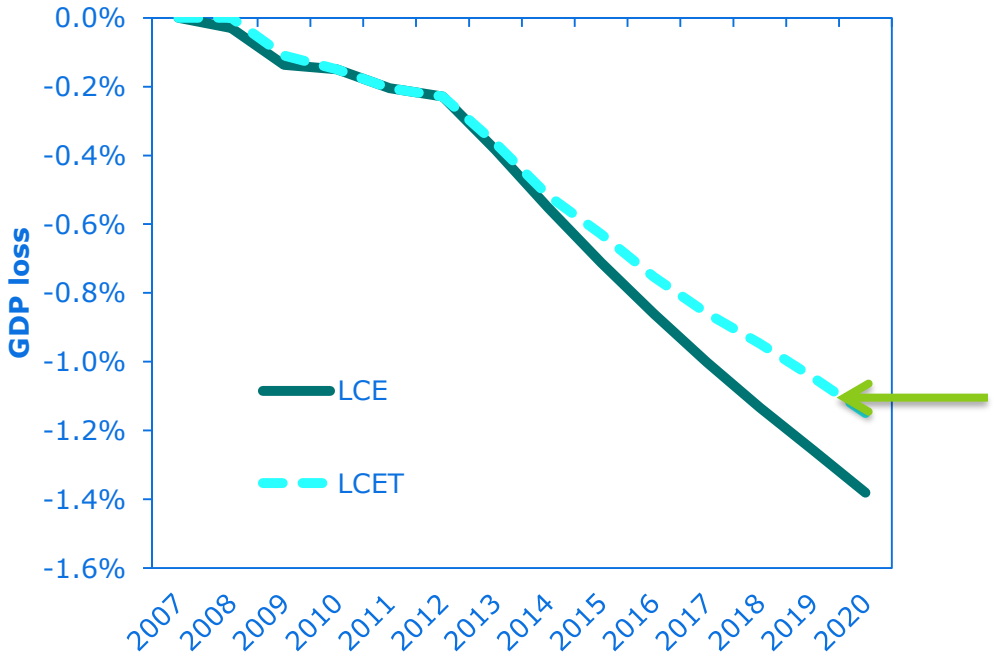
Year	object	Trade volume (Mill/Kilo ton)	Trade price (yuan/ton)	Trade value (million yuan)
2015	CO_2	7.07	156	1100
	SO_2	9.86	1600	15.8
	NO_X	6.92	20000	138.4
2020	CO_2	21.51	191	4116
	SO_2	20.08	1600	32.1
	NO_X	33.66	20000	673.2

Model value

Trading between GOV-enterprise

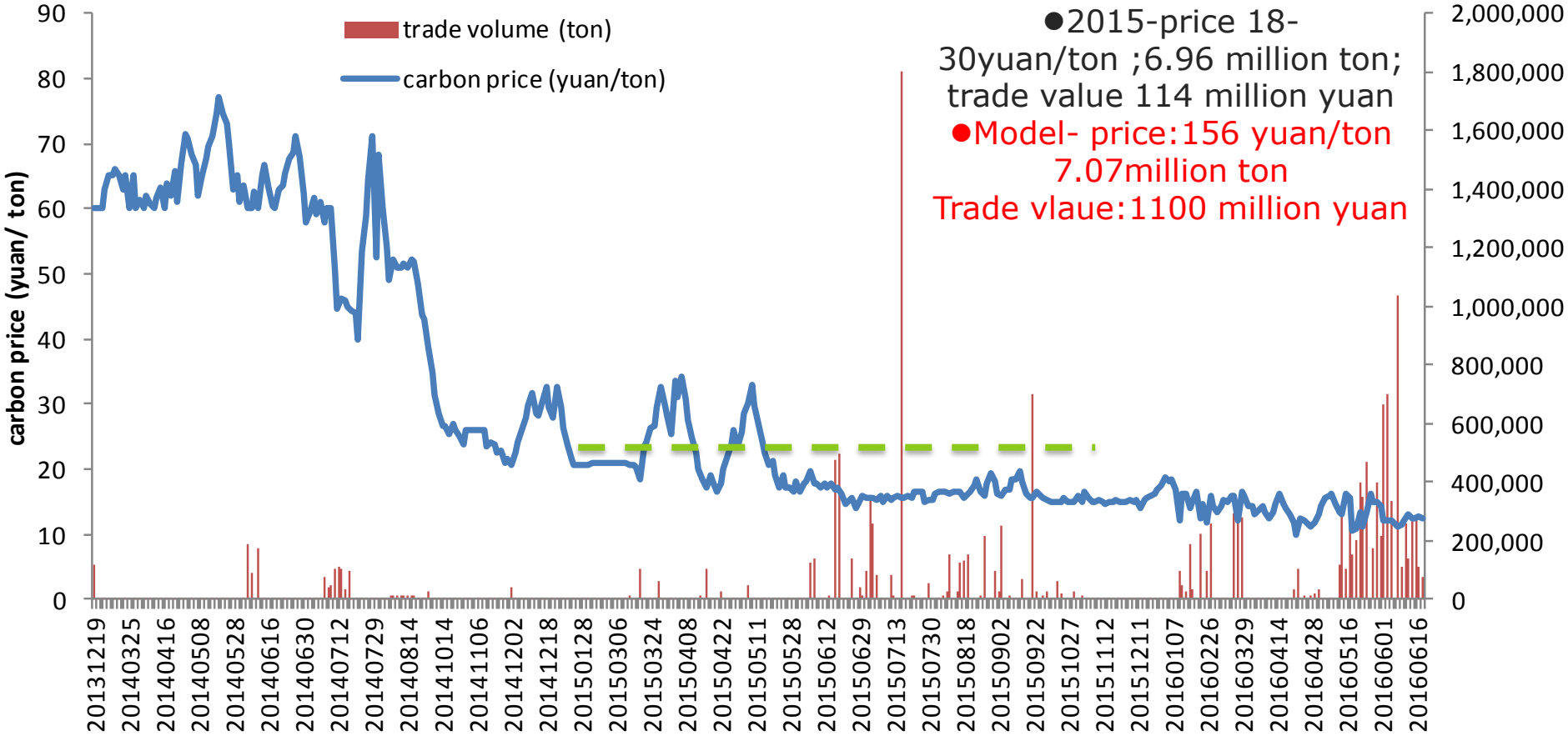
- Due to different abatement costs in each sector, companies choose to sell or buy credits through ETS.
- When CO2 is traded, the embedded trade of SO2 and NOx is 20.1 and 33.7 thousand tons.
- The total trade value of air pollutants is projected at 705 million yuan (104 million US$) in 2020.
- This provides a possibility for an air pollutants emission trading market.

Impact on GDP



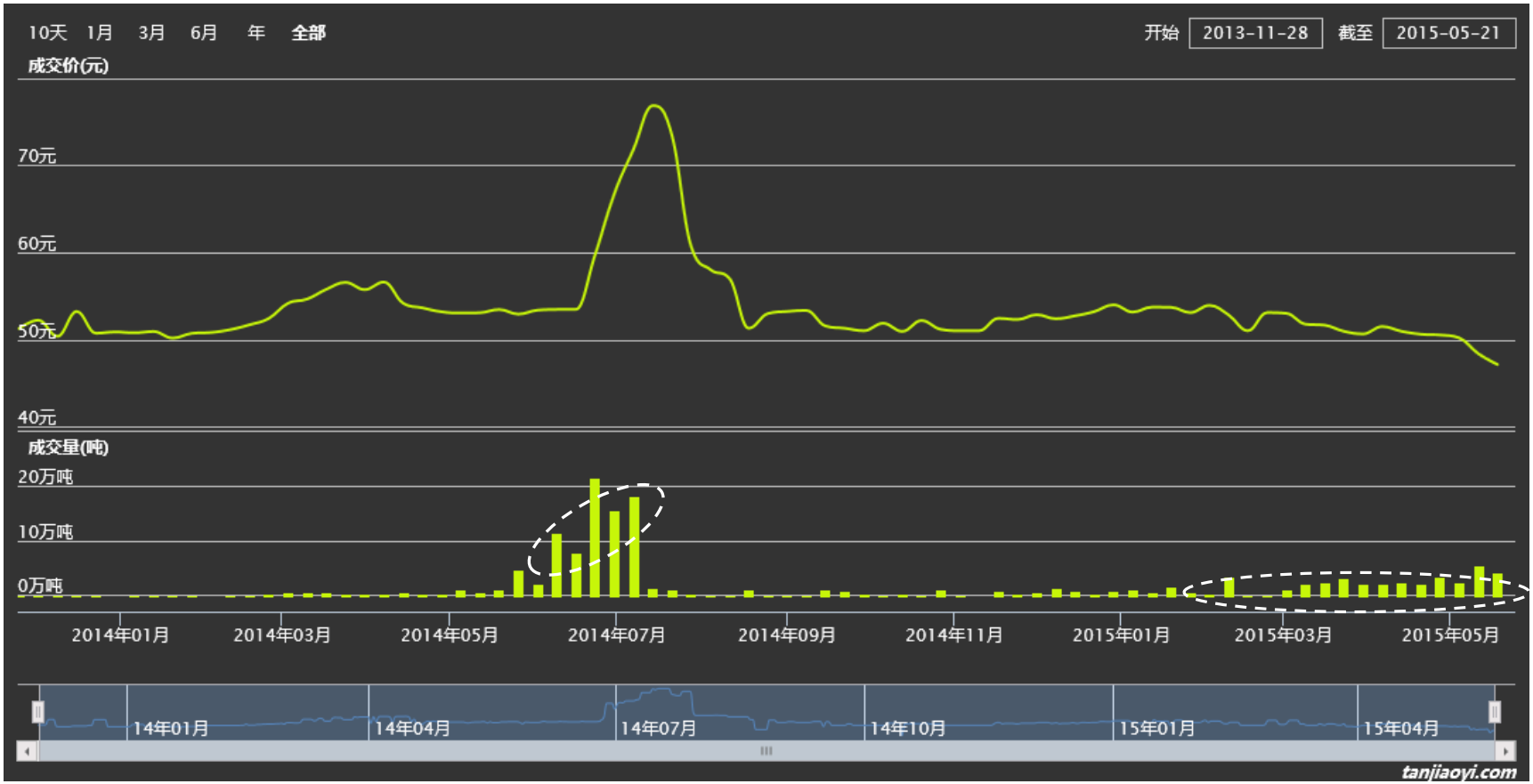
- **Compared with command and control policy, trading market can save the GDP loss.**
- **A more appropriate design of climate policy and air pollutant policy can reduce the GDP loss.**

The actual market of Guangdong pilot

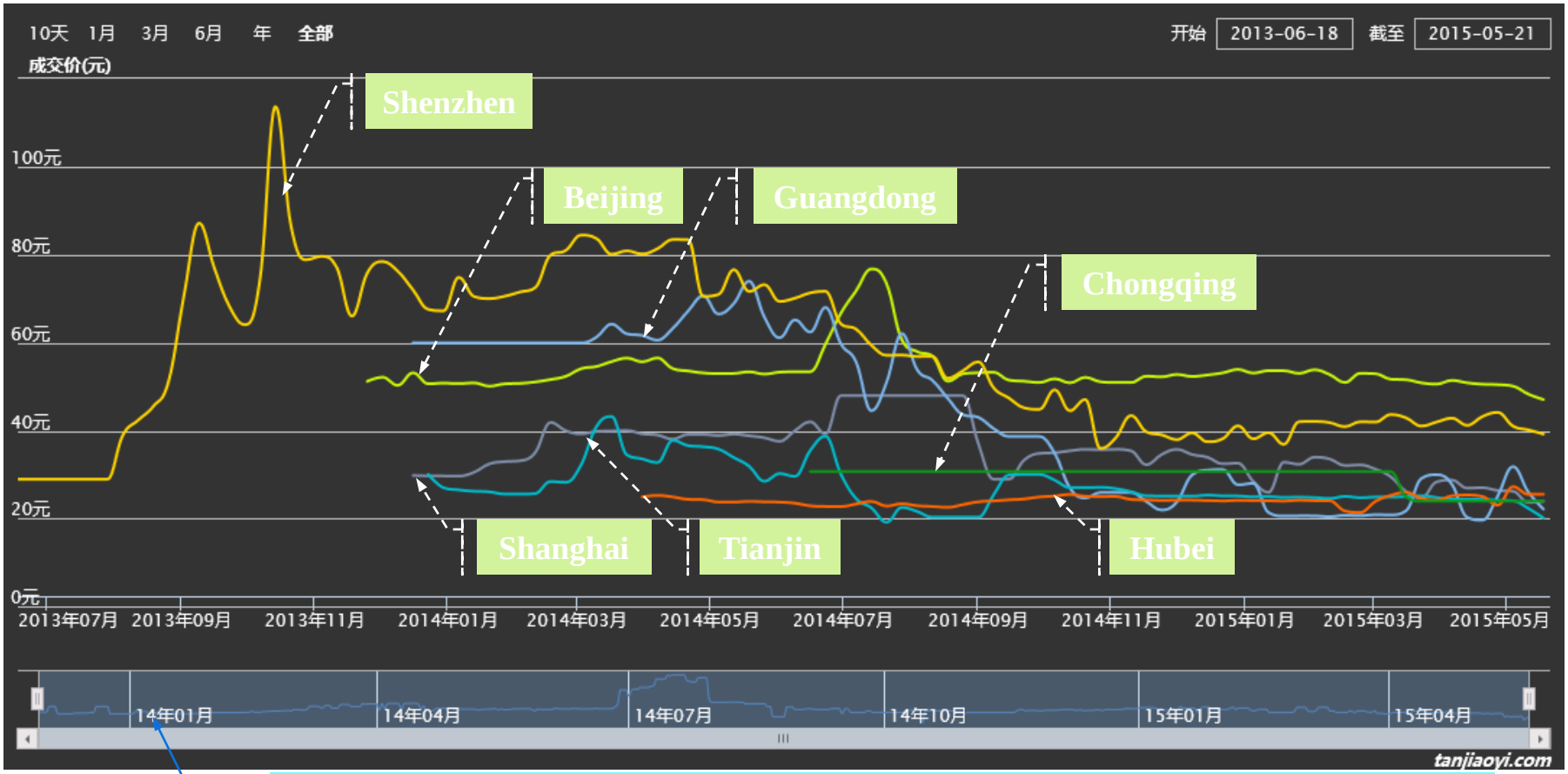


- Decrease in GDP growth rate reduces industrial production, which leads to excess allowances
- The firms are unfamiliar with the carbon market regulations, which minimises trading volume
- The carbon price does not reflect the supply and demand of firms' allowances
- The carbon market is distorted

The market of Beijing pilot



Credit prices of the pilot markets

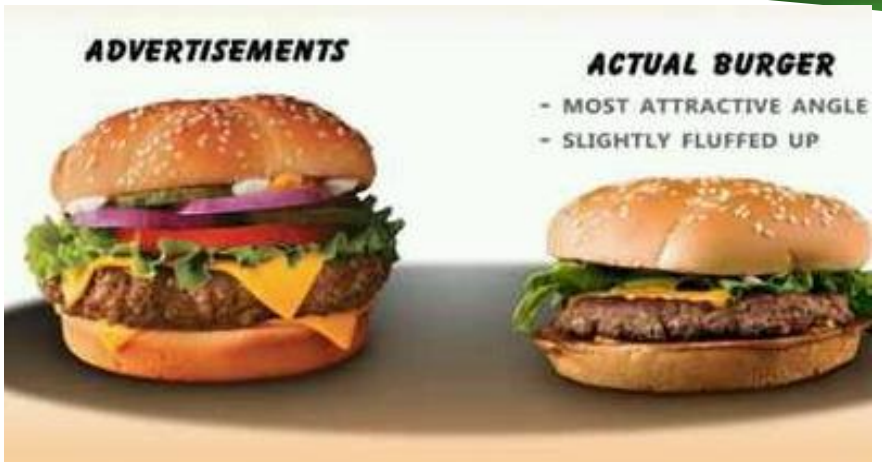


Different carbon price in different market, due to changes in management and sector.

From the ideal model to realistic carbon market

- Model-> Compared with command-and-control policy:
  - ETS can reduce the abatement cost with all sectors, although there is a slight increase in SO2 emissions
  - All sectors choose to participate in trading when there is an abatement cost difference
  - All sectors benefit, carbon market optimises mitigation allocation

From the ideal model to realistic carbon market



- There is a significant difference between the ideal model and the realistic carbon market.

From the ideal model to realistic carbon market

- Realistic carbon market:
  - Information is incomplete
  - Enterprises do not response to policy
  - Carbon price is not transmitted

- Through interview and investigation, some firms have sold the allowance to earn money, whilst some have cancelled after verification and others were not interested.
- In this compliance process, each firm will benefit in comparison with the command-and-control policy.
- The market will protect firms from financial loss.

Discussion and conclusions

- **Indicates noticeable co-benefits of carbon policy for carbon emissions and air pollution**
- **ETS policy is more flexible than command-and-control policy, which will make it more attractive to firms**
- **The efficiency of the market can be improved by:**
  - **Solving policy coordination (Cap setting)**
  - **increasing the enterprise capacity and by improving carbon asset management**
  - **Increasing awareness of government regulations and information public**
  - **Ensuring that the carbon price reflects the supply and demand of firms' allowances**
- **Overall, an ETS would create a carbon price. CO_2, air pollutant, energy saving market.**
- **Promote more investment for technology, attract financing and bring various incentives to different stakeholders->National market->Link to other ETS**

Thanks for your attention! welcome your questions and comments !