National Emission Trading In China: How Would Economic Impacts Disperse Across Provinces And Sectors?

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BACKGROUND

❖ **China's Nationally Determined Contribution (NDC) under the Paris Agreement** -- *Reduce CO_2 intensity by 60-65% by 2030 from 2005 levels*

❖ **Carbon pricing a key policy instrument--** *several countries, including China, have considered carbon pricing instruments (carbon tax, emission trading) to achieve their NDCs*

❖ **National emission trading after several pilots in China** – *after the seven pilots of domestic emission trading, China has launched a national emission trading scheme in 2017.*

❖ **At present, the national ETS is limited to the power sector only-** *It is expected to be expanded to other emission-intensive industries (e.g., iron and steel, cement) in the future.*

❖ **The relative competitiveness in various provinces and sector would change-** *under the national ETS, which may lead to the relocation of capital and investment among different regions ,specifically for the energy-intensive and emission-intensive ones.*

RESEARCH TARGETS

❖ The economy-wide impacts of the national ETS, and especially focuses on the distribution effect among different provinces and economic sectors.

❖ It investigates how much each province will reduce its GHG emissions by 2030 to meet the NDC; and how the provinces would trade their emission allowances under alternative schemes for initial allocations of emission allowances.

❖ It assesses the economic costs (impacts on GDP), household consumption and welfare, investment, commodity prices, and inter-regional/international trade of goods and services.

METHODOLOGY
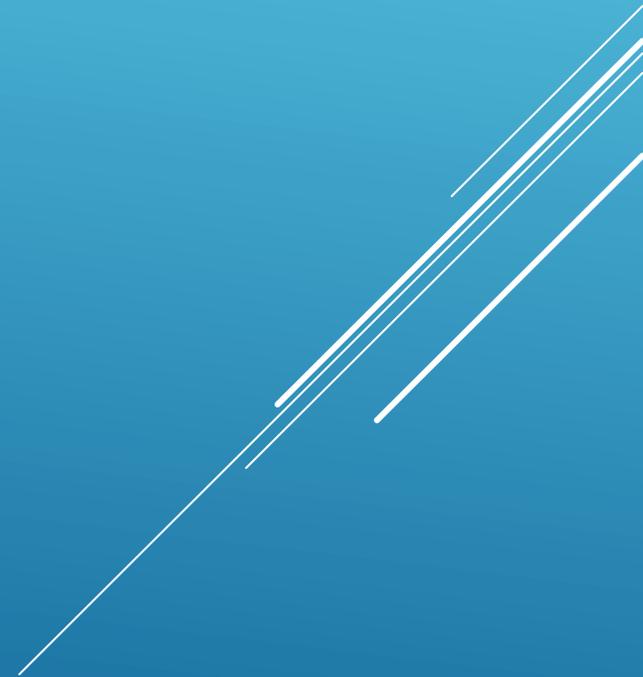
MUTI-REGIONAL DYNAMIC CGE MODEL

❖ China Multi-Regional Energy-Environment-Economy CGE Model (CMRE3-CGE) is a multi-regional dynamic CGE model；

❖ The Whole Economy is divided into 31 provincial regions, and there are 1 provincial government, 16 production sectors (including 5 energy sectors and 11 non-energy sectors), 1 representative household and 1 enterprise in each region；

❖ All 31 provincial regions form a national wide market through labor migration, capital flow and commodity trading；

❖ There is a central government at the national level in this model；

❖ CMRE3-CGE comprises six modules: production, trade, institution, labor and capital flow, carbon tax and carbon emission trading, equilibrium and macro-closure, as well as recursive dynamic mechanism.

ANALYTICAL FRAMEWORK
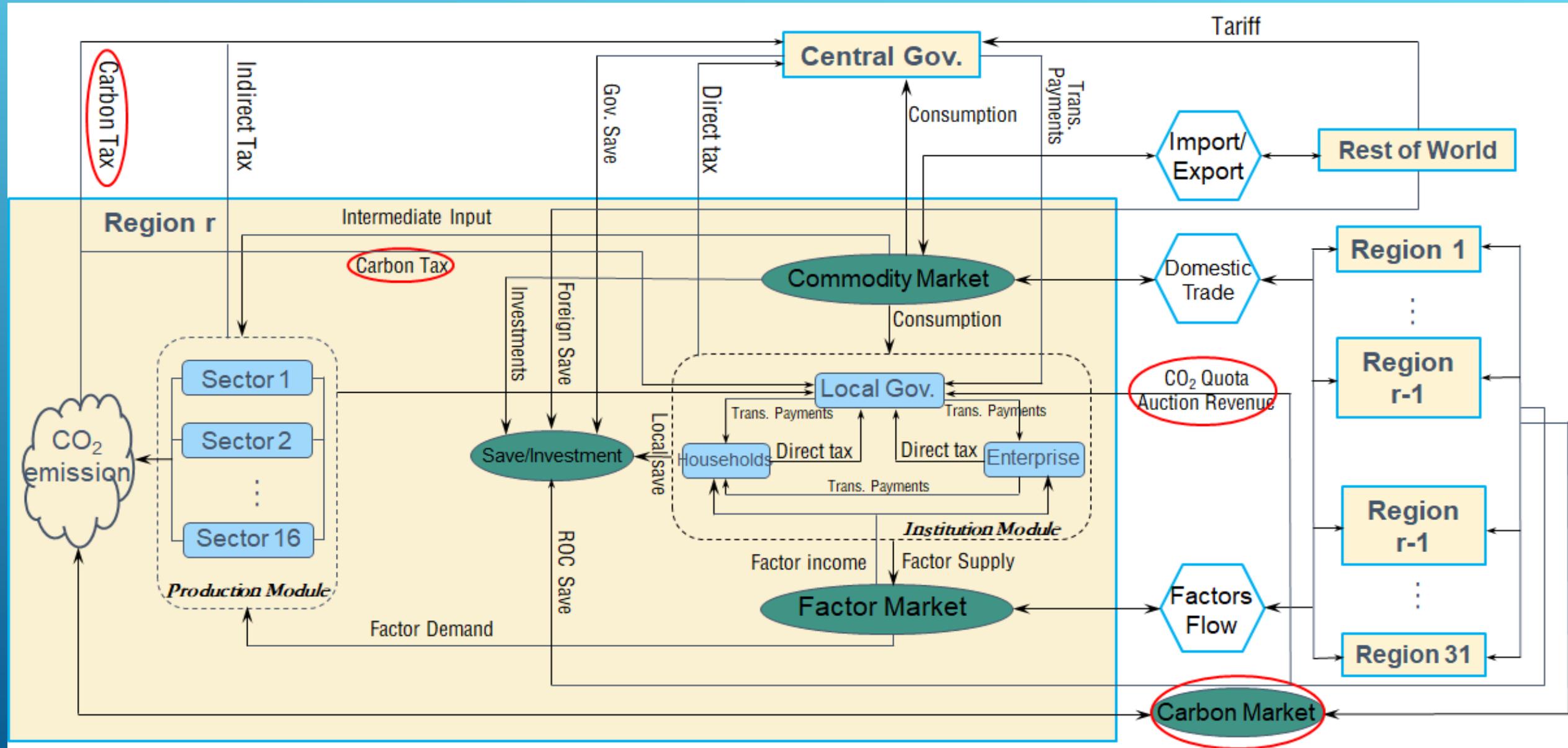
31 PROVINCIAL REGIONS

No.	Name	Abbr.	No.	Name	Abbr.	No.	Name	Abbr.	No.	Name	Abbr.
1	Anhui	AHU	9	Hainan	HAN	17	Jilin	JLI	25	Shanxi	SHX
2	Beijing	BJI	10	Hebei	HEB	18	Liao Ling	NLI	26	Sicuan	SCU
3	Chong qing	CQI	11	Heilongjiang	HLJ	19	Nei menggu	LMG	27	Tianjin	TJI
4	Fujian	FJI	12	Henan	HNA	20	Ningxia	NXI	28	Xin Jiang	XJI
5	Gansu	GSU	13	Hubei	HUB	21	Qing Hai	QHA	29	Xizang	XZA
6	Guang dong	GDO	14	Hunan	HUN	22	Shann Xi	SAX	30	Yun Nan	YNA
7	Guangxi	GXI	15	Jiangsu	JSU	23	Shan dong	SDO	31	Zhe Jiang	ZJI
8	Guizhou	GZH	16	Jiangxi	JXI	24	Shang hai	SHA			

16 PRODUCTION SECTORS

No.	Sector Name	Abbr.	In China IO table with 42 Sectors
1	Agriculture, Forestry, Animal Husbandry and Fishery	AGRI	1
2	Mining and washing of coal	COAL	2
3	Extraction of petroleum and natural gas	OILNG	3
4	Mining and processing of metal and nonmetal	MINE	4-5
5	Food and tobacco, Textile, leather, fur, feather, timber and furniture, paper, printing	FTPMF	6-10
6	Processing of petroleum, coking, processing of nuclear fuel	PETRO	11
7	Manufacture of chemical products	CHEMI	12
8	Manufacture of non-metallic mineral products	NMETA	13
9	Smelting and processing of metals	METAL	14
10	Other manufacture	OTHMF	15-24
11	Production and distribution of electric power and heat power	ELECT	25
12	Production and distribution of gas	GAS	26
13	Production and distribution of tap water	WATER	27
14	Construction	CONST	28
15	Transport, storage, and postal services	TRANS	30
16	Services	SERVI	29, 31-42

STRUCTURE OF PRODUCTION FUNCTION IN THE CGE MODEL
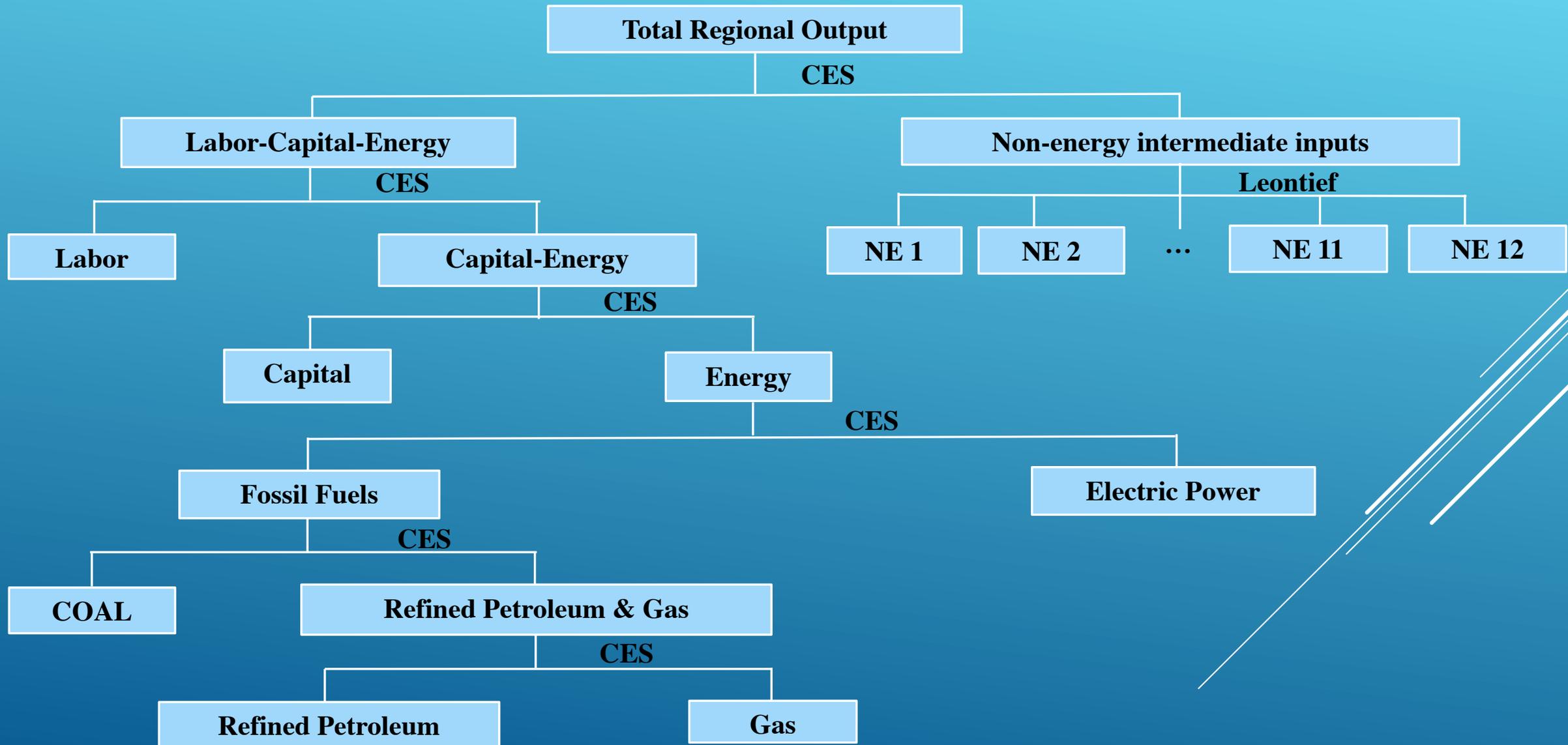
DESCRIPTION OF INTERNATIONAL TRADE AND INTER-PROVINCIAL TRADE

The Structure of MRIO table

			Intermediate output								Final consumption			Export	Total Output
			Region1			...	Region 31				Region1	...	Region 31		
			Sector1	...	Sector 16		Sector1	...	Sector16						
Inter. input	Region 1	Sector 1	...	...	...	...	...	...	...		...	...	...	...	...
		...	...	...	...	...	...	...	...		...	...	...	...	...
		Sector 16	...	...	...	...	...	...	...		...	...	...	...	...
	...		...		...		...				...	...	...	...	...
	Region 31	Sector 1	...	...	...	...	...	...	...		...	...	...	...	...
		...	...	...	...	...	...	...	...		...	...	...	...	...
		Sector 16	...	...	...	...	...	...	...		...	...	...	...	...
	Import		...	...	...	...	...	...	...		...	...	...		
Value-added			...	...	...	...	...	...	...						
Total input			...	...	...	...	...	...	...						
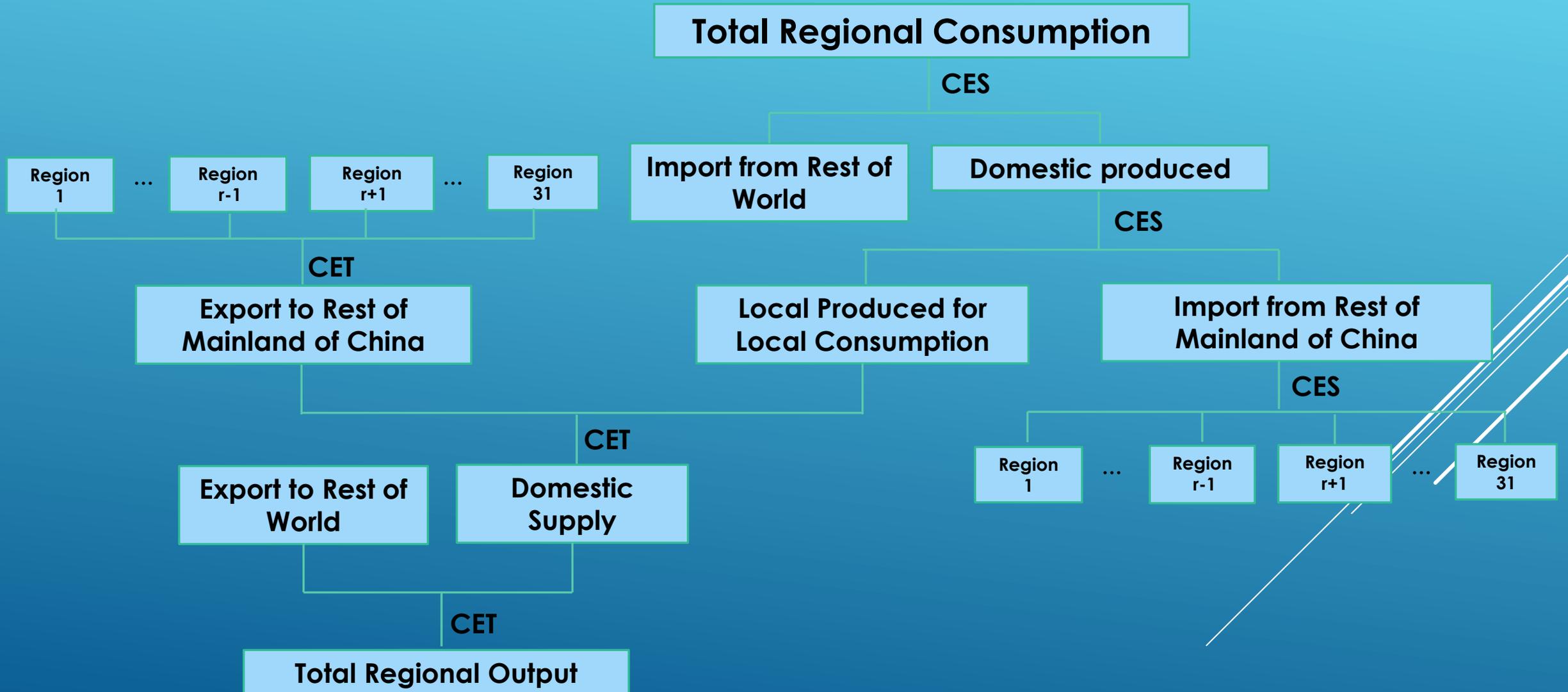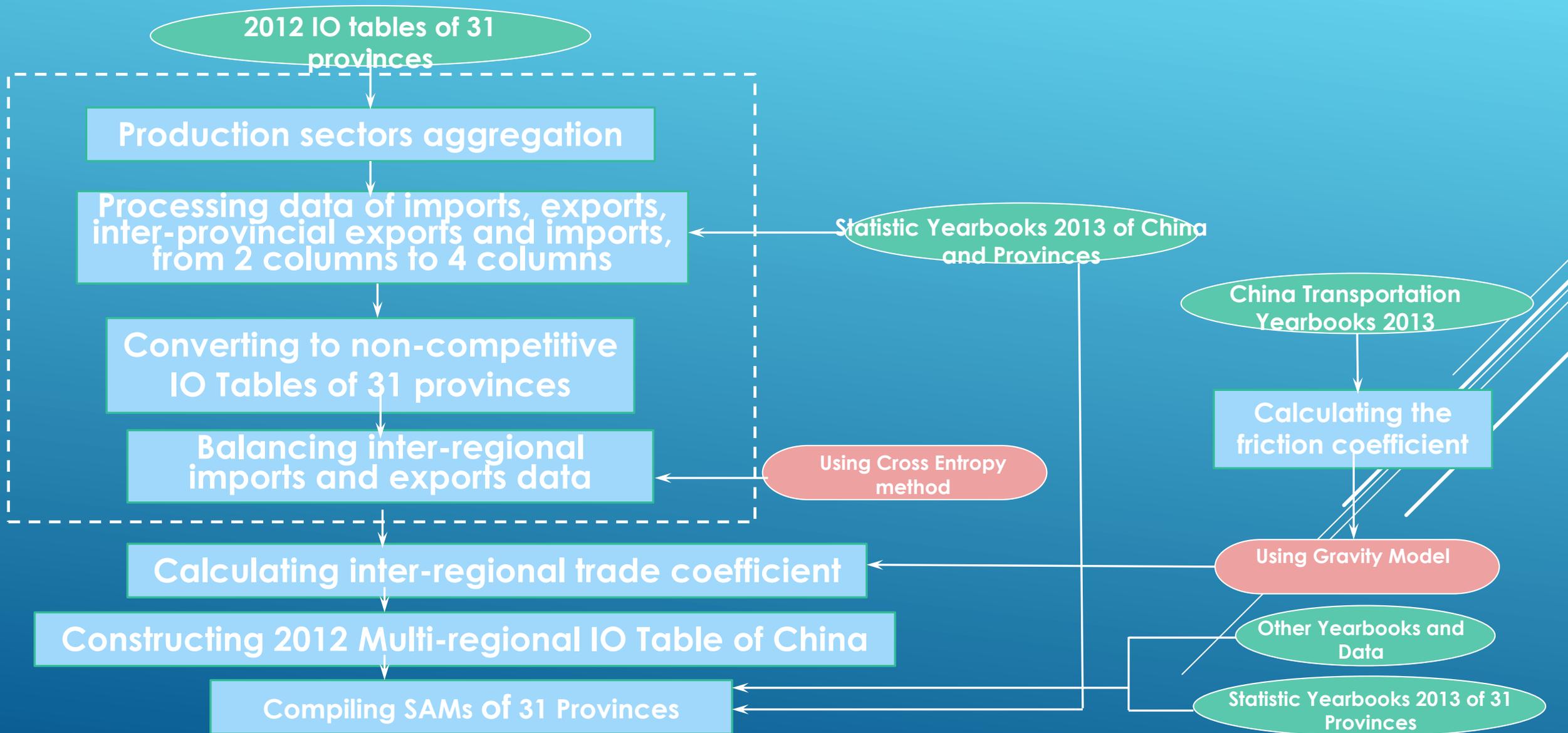
The structure of SAM for each province

	Activity	Commodity	Factors	Households	Government	Enterprise	ROMC	ROW	Invest-Saving	Total
Activity		**16X16**					**16X30**	**16X1**		Total Output
Commodity	**16X16**			**16X2**	**16X2**				**16X1**	Total Demand
Factors	**2X16**									Income
Households			**2X2**		**2X2**		**2X30**			Income
Government	**2X16**	**1X16**		**2X2**	**2X2**	**2X1**				Income
Enterprise			**1X2**		**1X2**					Income
Rest of Mainland of China		**30X16**	**30X2**	**30X2**						Import from ROMC
Rest of World		**1X16**								Import from ROW
Invest-Saving				**1X2**	**1X2**	**1X1**	**1X30**	**1X1**	**1X1**	Total Saving
Total	Total Input	Total Supply	Factor income allocation	Expenditure	Expenditure	Expenditure	Export to ROMC	Export to ROW	Total Investment	

METHOD OF CARBON MARKET SIMULATION

Carbon Emission Permits

$$QTPermit_t = (1 - mtrate_t) \cdot QTEMISD0_t$$

In this model, the total carbon emission permits will be allocated to different ETS participants in two ways: Grandfathering and Auctioning.

METHOD OF CARBON MARKET SIMULATION

Modeling of ETS with grandfathering allocation

Emission-based grandfathering

$$QFPermit_{i,r,t} = \frac{QEMISD0_{i,r,t}}{QTEMISD0_t} \times QTPermit_t$$

Output-based grandfathering

$$QFPermit_{i,r,t} = \frac{QAD0_{i,r,t}}{QTAD0_t} \times QTPermit_t$$

METHOD OF CARBON MARKET SIMULATION

Modeling of ETS **with** *grandfathering allocation*

CO$_2$ emission of each industry:

$$QEMIS_{i,r,t} = QFPermit_{i,r,t} + TradingPermit_{i,r,t}$$

$TradingPermit_{i,r,t}$ denote carbon emission permits sold or purchased of industry i in ETS market, it will be positive when purchasing additional permits in ETS market and negative when selling redundant permits for profits in ETS market.

$$\sum_{r}\sum_{i} TradingPermit_{i,r,t} = 0$$

METHOD OF CARBON MARKET SIMULATION

Modeling of ETS with grandfathering allocation

The expenditure or income in the ETS market

$$carbon\exp_{i,r,t} = pcarbon_t \times TradingPermit_{i,r,t}$$

$carbon\exp_{r,i,t}$ *is the expenditure (positive) or income (negative) of industry i in the ETS market.*

The cost equation at the first tier of production function need subtract the value of free permits

$$PA_{i,r,t} \cdot QA_{i,r,t}(1 - tcgind_{i,r} - t\lg ind_{i,r}) = PVA_{i,r,t} \cdot QVA_{i,r,t} + PINTA_{i,r,t} \cdot QINTA_{i,r,t} - pcarbon_t \cdot QFPermit_{i,r,t}$$

METHOD OF CARBON MARKET SIMULATION

Modeling of ETS with Auctioning allocation

Total auction permits should equal to the total carbon mission permits at each period

$$QTAPermit_t = QTPermit_t$$

$$QTAPermit_t = \sum_r \sum_i QAPermit_{i,r,t}$$

METHOD OF CARBON MARKET SIMULATION

Modeling of ETS with Auctioning allocation

For each industry, their CO_2 emission should equal to their permits purchased at the auctioning market.

$$QEMIS_{i,r,t} = QAPermit_{i,r,t}$$

$$carbon \exp_{i,r,t} = pcarbon_t \times QAPermit_{i,r,t}$$

Under the auctioning allocation, the income of permits auctioning of each province will be added to the revenue of local government in this model.

METHOD OF CARBON MARKET SIMULATION

The Production function should be adjusted under both Grandfathering and Auctioning

$$\frac{(1+ pcarbon \cdot coef_{coal}) \cdot PEcoal_{i,r}}{PEoilgas_{i,r}} = \frac{\delta_{i,r}^{ef}}{(1-\delta_{i,r}^{ef})} \cdot \left(\frac{QEoilgas_{i.r}}{QEcoal_{i,r}} \right)^{1-\rho_{i,r}^{ef}}$$

$$PEF_{i,r} \cdot QEF_{i,r} = (1+ pcarbon_t \cdot coef_{coal}) \cdot PEcoal_{i,r} \cdot QEcoal_{i,r} + PEoilgas_{i,r} \cdot QEoilgas_{i,r}$$

$$\frac{(1+ pcarbon_t \cdot coef_{gas}) \cdot PEgas_{i,r}}{(1+ pcarbon_t \cdot coef_{oil}) \cdot PEoil_{i,r}} = \frac{\delta_{i,r}^{pg}}{(1-\delta_{i,r}^{pg})} \cdot \left(\frac{QEoil_{i,r}}{QEgas_{i,r}} \right)^{1-\rho_{i,r}^{pg}}$$

$$PEoilgas_{i,r} \cdot QEoilgas_{i,r} = (1+ pcarbon_t \cdot coef_{oil}) \cdot PEoil_{i,r} \cdot QEoil_{i,r} + (1+ pcarbon_t \cdot coef_{gas}) \cdot PEgas_{i,r} \cdot QEgas_{i,r}$$

DYNAMIC MECHANISM

❖ The model is made dynamic through population growth rate (i.e., labor supply growth rate) ,TFP and investment.

❖ Demand for the total capital of current time period is determined by the previous time period's capital stock, depreciation and new-added investment.

❖ The new capital stock resulting from previous investment is allocated across sectors in proportion to each sector's share in aggregate capital income, and these proportions are adjusted by the ratio of each sector's profit rate to the average profit rate for the whole economy. This is similar to the method used by James Thurlow (2004). *(James Thurlow, 2004. A Dynamic Computable General Equilibrium (CGE) Model for South Africa: Extending the Static IFPRI Model. TIPS Working Paper Series (WP1-2004))*

❖ Autonomous Energy Efficiency Improvement (AEEI) in CGE model is considered in this study, and is assumed to be 1% per year following the common assumptions in CGE model.

SIMULATION RESULTS
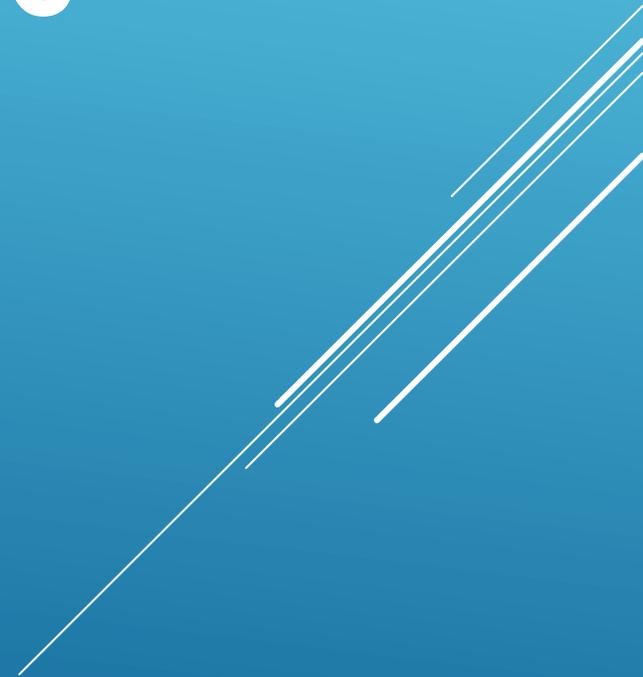
POLICY SCENARIOS

❖ **Baseline: Not meeting NDC, No ETS**

❖ We considered two scenarios for the allocation of allowances: free allocation (or grandfathering) and auction.

❖ Under the free allocation, we considered two criteria (i) baseline emissions of the emitters (sectors), (ii) baseline sectoral outputs.

❖ Under auctioning, we considered two schemes to recycle auction revenues to the economy: (i) provincial government consumption and investment, and (ii) recycling to households as a lump-sum rebate.

❖ 100% coverage of production sectors at all scenarios.

EMISSION ALLOWANCES BY PROVINCE OF CHINA IN 2030 – GRANDFATHERING
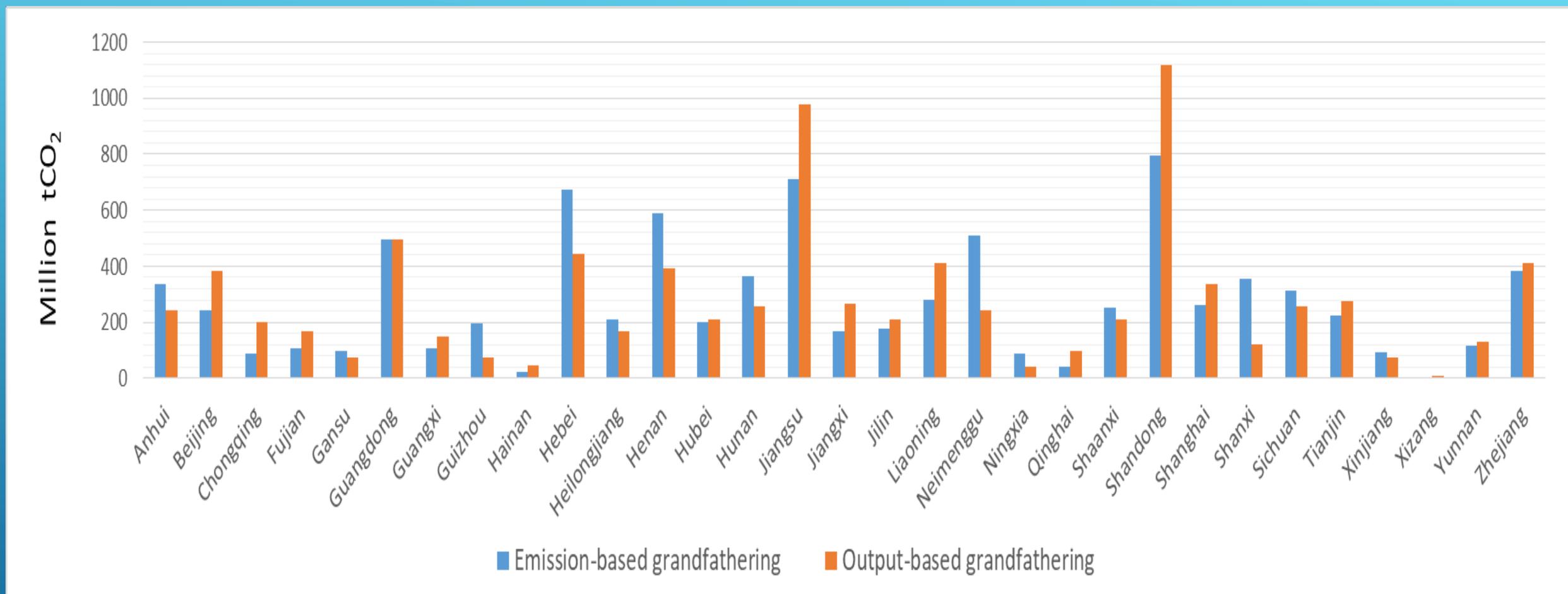
❖ To meet China's NDC, the total allowances in 2030 are estimated to be 8,502 million tons CO_2.

❖ Output- based grandfathering causes more allowance allocation in 18 provinces; emission-based grandfathering causes higher allowance allocation in 13 provinces.

EMISSION ALLOWANCES BY INDUSTRY OF CHINA IN 2030 – GRANDFATHERING
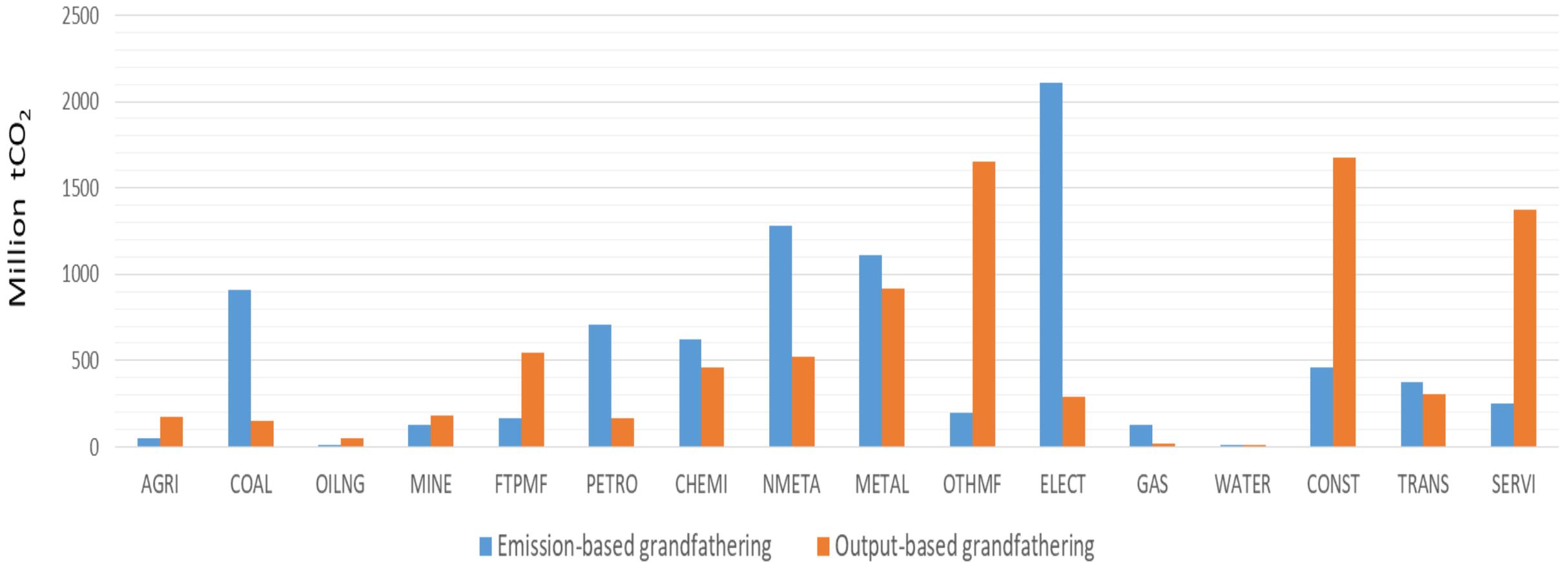
❖ **Most of Energy-intensive industries will have higher allowance under emission-based grandfathering.**

❖ **7 industries(AGRI,OLING,MINE,FTPMF,OTHMF,CONST,SERVI) will have higher allowance under output-based grandfathering.**

Allowances across the sectors in each province in 2030(million tCO2): Emission-based grandfathering

| Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	1.7	3.5	0.0	1.4	3.8	2.7	17.5	108.5	53.7	4.9	99.2	5.5	0.0	20.4	8.9	7.1
Beijing	0.4	190.3	0.0	0.4	0.6	1.5	0.9	3.4	0.2	1.7	20.3	0.2	0.0	3.1	14.3	6.9
Chongqing	0.1	13.5	0.1	3.0	0.9	1.5	4.9	17.6	20.0	2.3	10.9	0.7	0.0	5.2	4.4	1.3
Fujian	3.7	2.7	0.0	2.9	2.9	2.3	2.3	21.1	16.6	1.4	25.0	3.7	0.0	6.5	15.3	3.0
Gansu	1.0	6.1	0.1	1.6	1.2	2.2	3.5	15.8	8.2	1.6	37.0	0.0	0.0	9.2	4.8	4.2
Guangdong	0.9	0.0	0.0	2.0	8.2	27.0	10.6	113.3	15.6	4.8	185.8	35.5	0.0	35.7	21.0	34.2
Guangxi	0.5	0.0	0.0	0.9	1.3	1.6	4.8	22.9	25.3	2.0	22.4	1.2	0.0	13.5	5.9	2.6
Guizhou	3.8	57.4	0.0	0.2	1.4	9.0	4.8	47.1	22.4	0.2	30.4	1.4	0.0	8.0	5.9	2.5
Hainan	0.9	0.0	0.0	0.1	0.1	4.2	0.5	1.8	0.2	0.1	5.5	0.1	0.0	2.6	4.2	1.7
Hebei	1.9	4.8	0.3	23.5	14.1	137.6	50.3	99.4	199.1	13.6	76.6	3.1	0.0	18.3	20.3	8.6
Heilongjiang	3.5	16.0	0.7	2.5	8.3	23.7	5.2	22.5	17.9	7.9	65.9	3.8	0.2	7.3	14.0	13.0
Henan	0.9	75.1	0.0	2.6	2.3	63.9	32.1	39.8	38.4	8.0	290.4	5.6	0.1	7.8	14.8	7.7
Hubei	1.5	0.6	0.0	0.7	5.3	2.2	32.6	53.7	8.6	7.2	49.8	0.9	0.0	13.1	16.7	7.3
Hunan	2.1	47.9	0.0	7.5	10.5	26.5	11.6	85.5	40.1	8.0	91.4	2.8	0.0	11.4	8.6	8.5
Jiangsu	1.1	14.9	0.1	15.0	29.0	34.4	47.2	49.6	115.1	28.1	257.5	21.9	0.0	65.9	15.3	14.6
Jiangxi	0.1	17.1	0.0	6.7	1.5	3.6	4.9	61.8	40.8	2.7	7.4	2.0	0.0	15.6	2.6	2.8
Jilin	6.7	2.0	0.1	1.4	10.5	8.2	27.9	44.7	4.2	6.4	32.1	0.6	0.1	8.4	6.1	19.9
Liaoning	1.6	0.7	0.0	16.1	8.1	12.7	14.0	66.6	48.0	18.9	33.9	3.1	0.1	29.6	15.4	9.2
Neimenggu	4.1	231.0	0.0	15.4	5.9	33.9	49.9	24.4	42.9	10.2	29.4	5.2	0.3	26.8	24.8	6.7
Ningxia	0.4	15.6	0.0	0.0	1.5	9.0	10.2	13.8	3.6	0.2	21.4	0.0	0.0	5.2	3.2	2.3
Qinghai	0.0	8.0	0.0	0.1	0.0	2.9	0.2	15.5	0.3	0.0	14.2	0.1	0.0	0.3	1.4	0.4
Shaanxi	4.1	35.4	1.7	1.3	5.0	50.1	9.1	36.6	25.7	1.8	38.3	0.8	0.0	22.0	14.8	7.2
Shandong	0.1	15.3	2.1	6.3	8.7	58.4	180.8	122.3	91.7	15.8	230.9	8.6	0.0	15.6	28.4	9.5
Shanghai	0.5	0.0	0.0	0.0	1.4	2.3	17.1	5.2	68.2	4.9	77.3	7.9	0.0	5.7	44.0	25.8
Shanxi	0.5	38.4	0.8	0.3	1.3	121.7	15.8	39.3	36.2	3.3	67.0	1.7	0.0	15.0	10.0	2.7
Sichuan	2.8	18.7	0.3	7.7	11.4	18.0	23.5	46.6	36.3	9.9	98.6	4.1	0.3	20.0	6.6	9.0
Tianjin	0.8	89.4	0.1	5.9	2.0	4.6	6.4	10.6	60.6	2.7	12.3	1.5	0.0	3.1	15.4	8.0
Xinjiang	1.2	1.1	0.1	1.6	0.2	19.8	5.0	12.1	12.3	0.4	15.0	1.2	0.0	7.2	11.8	6.3
Xizang	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.4
Yunnan	0.6	5.9	0.0	1.3	1.2	15.3	11.8	21.8	18.9	0.9	20.4	2.5	0.0	5.6	3.6	6.2
Zhejiang	0.2	0.1	0.0	1.3	15.8	5.7	18.4	58.5	35.7	25.2	140.3	3.4	0.0	54.8	12.4	12.7

Allowances across the sectors in each province in 2030(million tCO2) : output-based grandfathering

Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	6.8	0.9	0.0	5.5	13.4	0.5	9.9	16.3	32.3	52.7	7.8	1.2	0.6	51.8	6.4	38.5
Beijing	2.0	73.0	0.0	1.0	6.8	3.5	4.6	7.9	1.9	43.8	91.8	1.4	0.3	43.6	13.5	88.6
Chongqing	3.4	1.5	0.5	4.8	7.7	0.5	8.8	14.6	24.1	47.9	3.1	0.3	0.5	49.6	5.8	26.3
Fujian	5.1	0.2	0.0	2.3	18.4	1.6	4.3	9.1	12.7	24.6	3.7	0.5	0.1	44.6	8.2	31.3
Gansu	2.5	0.5	0.2	1.3	1.9	2.9	2.2	3.7	14.8	5.8	2.8	0.1	0.2	21.5	2.6	10.5
Guangdong	4.3	0.0	0.4	4.4	29.8	15.2	24.5	32.5	17.5	101.1	16.2	3.1	1.3	123.5	17.1	106.5
Guangxi	3.6	0.0	0.0	2.5	8.8	2.2	3.8	10.1	17.7	21.1	3.8	0.2	0.2	45.8	6.8	23.4
Guizhou	2.9	3.4	0.0	0.6	3.6	0.6	2.0	4.1	6.6	2.4	4.2	0.1	0.1	21.2	7.2	14.1
Hainan	2.1	0.0	0.4	0.9	0.9	4.6	1.3	3.6	0.5	2.5	0.8	0.1	0.1	15.7	2.9	9.6
Hebei	11.9	0.4	0.3	36.6	19.6	11.1	21.0	25.3	94.6	64.6	8.8	0.4	1.0	86.5	18.4	43.2
Heilongjiang	9.8	1.1	6.0	5.4	14.5	5.5	7.1	8.1	8.0	13.1	4.5	0.5	0.5	43.7	9.5	32.5
Henan	11.9	3.8	0.1	15.2	33.1	5.0	14.9	46.7	41.1	88.7	10.6	0.7	0.6	64.1	10.8	46.5
Hubei	10.1	0.1	0.0	2.5	12.6	1.2	10.5	10.0	10.7	37.7	5.4	0.3	0.0	48.5	9.8	49.5
Hunan	9.2	3.0	0.0	5.6	14.0	6.1	8.6	19.0	22.1	39.7	5.4	0.3	0.3	67.8	9.1	45.2
Jiangsu	8.9	1.3	0.7	4.9	58.9	9.8	63.3	43.7	140.3	277.5	19.9	4.1	0.6	161.7	21.8	162.1
Jiangxi	4.8	3.0	0.0	12.9	13.2	0.9	13.5	25.1	60.2	47.2	5.7	0.2	0.4	41.7	6.3	29.8
Jilin	7.1	0.8	1.3	4.3	17.6	2.6	10.3	15.6	8.8	46.2	3.4	0.2	0.7	48.3	7.2	38.0
Liaoning	8.1	0.2	0.2	17.9	23.1	15.2	17.1	27.1	49.3	84.8	5.8	0.4	0.3	83.9	16.1	61.8
Neimenggu	13.4	17.6	0.1	14.4	18.6	2.4	13.0	13.0	36.7	27.4	7.6	0.4	0.3	54.7	8.8	12.7
Ningxia	1.3	2.0	0.0	0.1	1.7	2.1	2.6	2.7	6.5	1.9	3.0	0.1	0.1	10.2	2.3	5.9
Qinghai	0.6	5.9	3.2	2.1	0.5	3.2	3.4	43.7	8.8	0.6	11.5	0.0	0.0	8.0	1.2	7.4
Shaanxi	8.9	8.9	14.4	2.8	9.7	9.8	5.3	12.9	21.8	10.4	5.2	0.3	0.4	58.9	5.7	34.0
Shandong	8.4	3.9	7.1	17.9	126.5	34.9	133.3	63.5	112.5	324.6	22.5	1.0	0.5	119.1	26.5	113.8
Shanghai	0.7	0.0	0.1	0.0	9.2	4.6	16.3	6.0	22.5	78.9	7.2	0.8	0.4	54.2	34.5	101.6
Shanxi	3.2	6.4	1.3	1.2	2.5	3.4	4.0	3.3	20.4	16.7	3.8	0.2	0.1	33.4	7.2	16.3
Sichuan	11.1	2.2	1.1	7.0	21.8	1.9	13.4	13.7	19.4	46.9	7.2	0.8	0.9	55.0	5.4	49.0
Tianjin	1.0	9.3	4.7	4.6	12.1	4.5	8.8	10.1	49.9	45.0	3.4	0.3	0.8	54.4	15.3	49.8
Xinjiang	3.2	0.5	7.9	2.3	0.6	4.6	3.3	3.6	7.0	2.2	1.6	0.2	0.0	23.7	3.8	9.5
Xizang	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.3	2.0
Yunnan	3.9	1.2	0.0	2.2	7.5	1.1	4.9	7.1	13.7	5.6	4.2	0.2	0.2	51.1	4.2	25.0
Zhejiang	5.8	0.0	0.0	1.3	39.8	7.1	23.6	17.5	31.1	87.0	11.9	0.9	0.7	87.2	11.7	88.0

POLICY IMPLICATION

❖ **While the emission-based allocation rule is preferable to emission-intensive sectors, the output-based allocation rule is preferable to less emission-intensive sectors.**

❖ **If an economy is highly based on fossil fuel industries and the government prefers not to penalize too much these industries, it may employ the emission-based allocation rule.**

❖ **If the government wants to reward sectors that contribute to the economy with a lower carbon footprint, it might prefer the output-based allocation rule.**

EMISSION ALLOWANCES BY PROVINCE OF CHINA IN 2030 – AUCTIONING
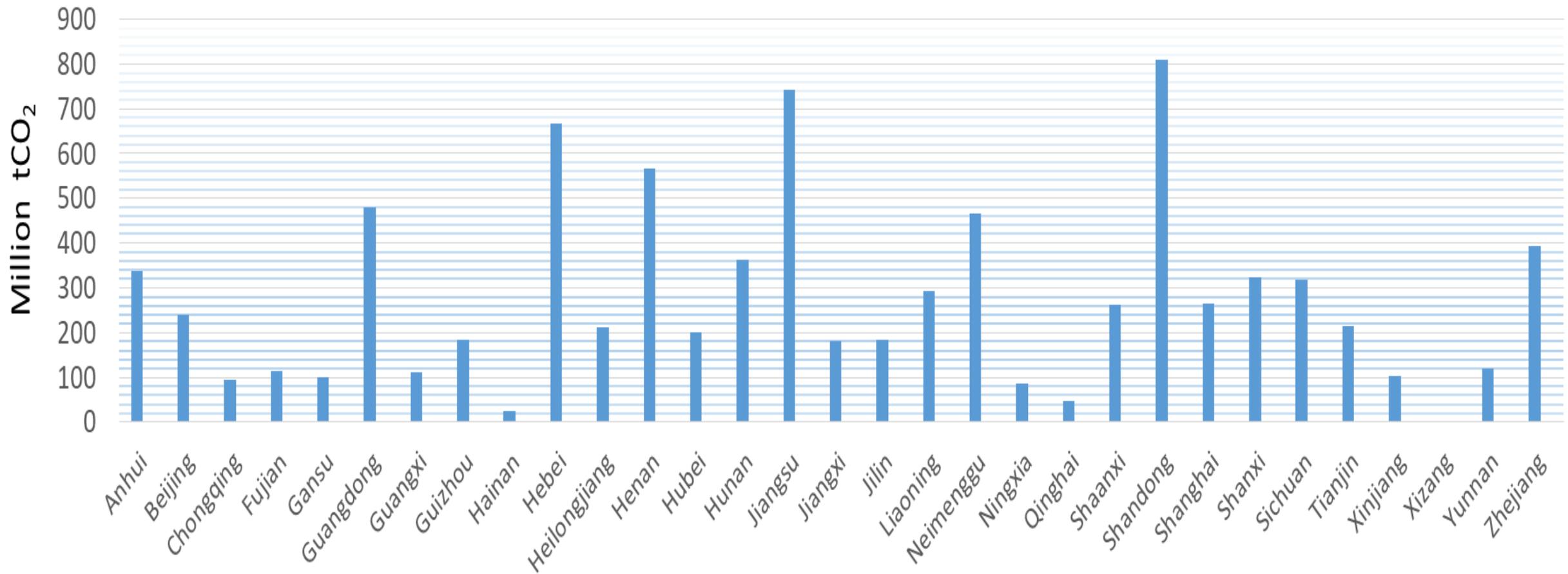
❖ **The five provinces that purchase the highest number of allowances are (in decending order): Shandong, Jiangsu, Hebei, Henan, Guangdong.**

❖ **Xizang, Hainan, Qinghai, Ningxia and Chongqing are the ones purchasing the lowest number of emission permits.**

EMISSION ALLOWANCES BY INDUSTRY OF CHINA IN 2030 – AUCTIONING
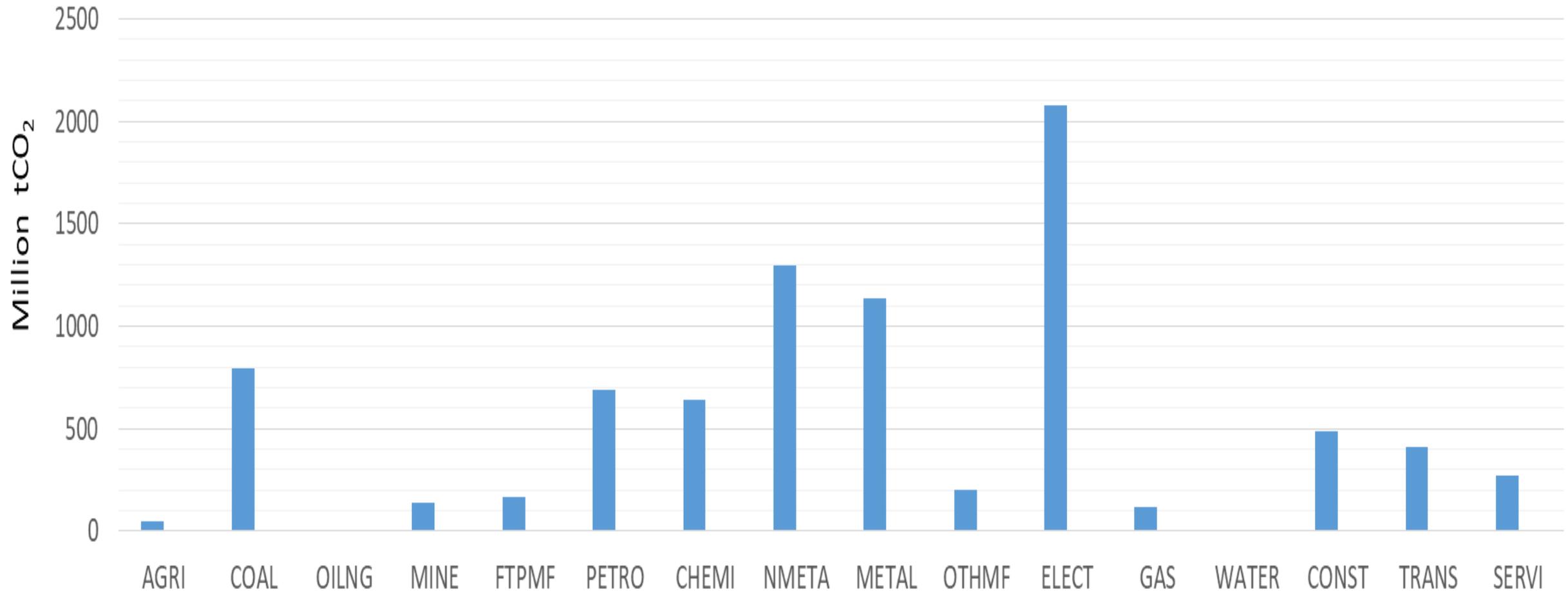
❖ **The electricity sector purchases the highest amounts of emission allowances followed by other emission-intensive sectors, such as non-metallic minerals, metal, petroleum refinery and the coal sectors.**

Permits acquired by emitters under auctioning in 2030 (million tCO2)

| Province`	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	1.8	3.2	0.0	1.5	3.9	2.8	17.7	105.5	54.5	5.1	97.7	5.4	0.0	21.4	9.9	7.6
Beijing	0.5	176.2	0.0	0.5	0.6	1.8	1.0	3.9	0.3	1.9	24.3	0.3	0.0	3.5	15.9	7.9
Chongqing	0.1	13.7	0.1	3.3	1.0	1.7	5.5	19.3	21.9	2.5	11.6	0.8	0.0	5.8	4.9	1.4
Fujian	4.1	2.3	0.0	3.0	3.0	2.5	2.4	21.3	17.2	1.5	25.0	3.6	0.0	6.8	16.8	3.2
Gansu	1.1	5.7	0.1	1.7	1.2	2.4	3.7	16.3	8.8	1.7	37.0	0.0	0.0	9.6	5.2	4.5
Guangdong	1.0	0.0	0.0	2.2	8.2	29.1	11.5	110.4	15.6	5.0	173.4	28.0	0.0	36.3	23.1	37.4
Guangxi	0.5	0.0	0.0	1.0	1.4	1.8	5.1	24.4	27.0	2.2	23.0	1.2	0.0	14.4	6.7	2.9
Guizhou	3.8	48.2	0.0	0.2	1.4	8.2	4.8	45.7	22.7	0.2	29.8	1.3	0.0	8.5	6.3	2.6
Hainan	0.9	0.0	0.0	0.1	0.1	4.7	0.6	1.9	0.2	0.1	5.7	0.1	0.0	2.8	4.7	1.9
Hebei	2.1	4.9	0.3	24.9	14.2	134.2	50.1	97.4	199.5	13.8	72.8	2.9	0.0	18.9	22.2	9.1
Heilongjiang	3.8	15.2	0.7	2.6	8.4	23.3	5.6	22.2	18.3	7.9	64.7	3.6	0.2	7.5	15.1	13.9
Henan	1.0	61.2	0.0	2.8	2.3	60.6	31.5	41.0	38.9	8.1	281.8	5.6	0.1	8.1	16.0	8.2
Hubei	1.7	0.5	0.0	0.7	5.4	2.2	31.9	52.5	9.0	7.4	48.0	0.9	0.0	13.4	18.7	8.0
Hunan	2.2	41.9	0.0	7.6	10.7	26.7	11.9	86.7	41.2	8.3	91.1	2.8	0.0	11.8	9.3	9.1
Jiangsu	1.2	13.3	0.2	15.3	30.5	36.2	49.6	52.5	121.8	29.9	267.0	21.8	0.0	69.7	17.1	16.1
Jiangxi	0.1	17.1	0.0	7.2	1.7	3.9	5.4	65.8	43.8	2.9	7.8	2.1	0.0	17.0	2.9	3.0
Jilin	7.2	2.2	0.1	1.5	10.8	8.5	28.5	45.8	4.5	6.7	31.6	0.7	0.1	9.0	6.7	21.1
Liaoning	1.7	0.8	0.0	17.0	8.3	13.8	15.0	68.2	50.6	19.8	34.0	3.1	0.2	31.9	17.3	10.0
Neimenggu	4.3	188.0	0.0	15.6	5.9	29.6	49.0	25.2	44.1	10.2	29.0	4.2	0.3	27.8	25.7	7.0
Ningxia	0.5	13.5	0.0	0.0	1.5	9.1	10.0	14.1	3.8	0.3	21.3	0.0	0.0	5.5	3.4	2.4
Qinghai	0.0	8.7	0.0	0.2	0.0	3.2	0.2	17.1	0.3	0.0	15.8	0.1	0.0	0.3	1.6	0.4
Shaanxi	4.4	33.6	1.8	1.4	5.2	52.0	9.5	38.8	27.1	1.9	38.5	0.9	0.0	23.5	15.9	7.7
Shandong	0.2	14.8	2.1	6.8	8.9	60.6	185.6	126.6	95.7	16.5	225.5	8.3	0.0	16.8	31.7	10.4
Shanghai	0.5	0.0	0.0	0.0	1.5	2.4	18.5	5.6	65.2	5.2	75.4	7.7	0.0	6.0	48.7	28.6
Shanxi	0.5	33.2	0.8	0.3	1.2	104.5	15.4	36.8	36.7	3.3	61.3	1.5	0.0	15.1	10.4	2.8
Sichuan	2.9	17.8	0.3	8.0	11.5	17.8	24.2	47.5	37.9	10.2	98.2	4.1	0.3	20.8	7.3	9.5
Tianjin	0.8	73.2	0.1	6.2	2.1	5.0	6.9	11.1	62.4	2.9	12.3	1.6	0.0	3.2	17.4	8.7
Xinjiang	1.3	1.1	0.2	1.8	0.2	21.1	5.5	12.7	13.3	0.4	15.5	1.2	0.0	7.7	12.9	6.8
Xizang	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.5
Yunnan	0.7	5.9	0.0	1.4	1.3	14.8	12.3	22.9	20.1	1.0	21.3	2.4	0.0	6.2	3.9	6.6
Zhejiang	0.2	0.1	0.0	1.3	16.3	6.1	19.5	60.1	36.6	25.9	140.2	3.4	0.0	56.8	13.8	13.9

ALLOWANCE TRADING BY PROVINCE OF CHINA IN 2030 – GRANDFATHERING

The market-clearing permit price under the output-based allocation rule would be 164RMB/tCO$_2$,whereas it would be 263RMB/TCO$_2$ under the emission-based allocation rule.

Legend: ■ Emission-based grandfathering ■ Output-based grandfathering
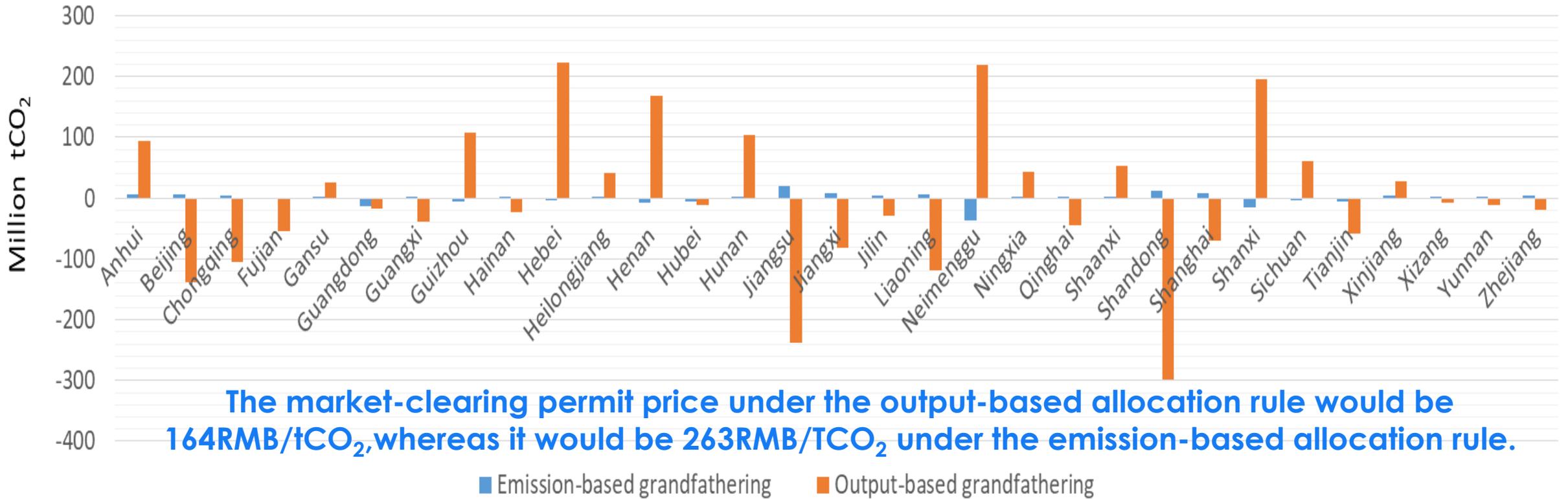
❖ *Note: +ve sign refers to purchasing of allowances, -ve sign refers to the selling of allowances.*

❖ **The size of the emission market is much larger under the output-based allocation rule as compared to the emission-based allocation rule.**

❖ **The direction and magnitude of emissions trade of a province are highly sensitive to the grandfathering criteria for initial allowance allocation.**

# ALLOWANCE TRADING BY SECTOR OF CHINA IN 2030 – GRANDFATHERING
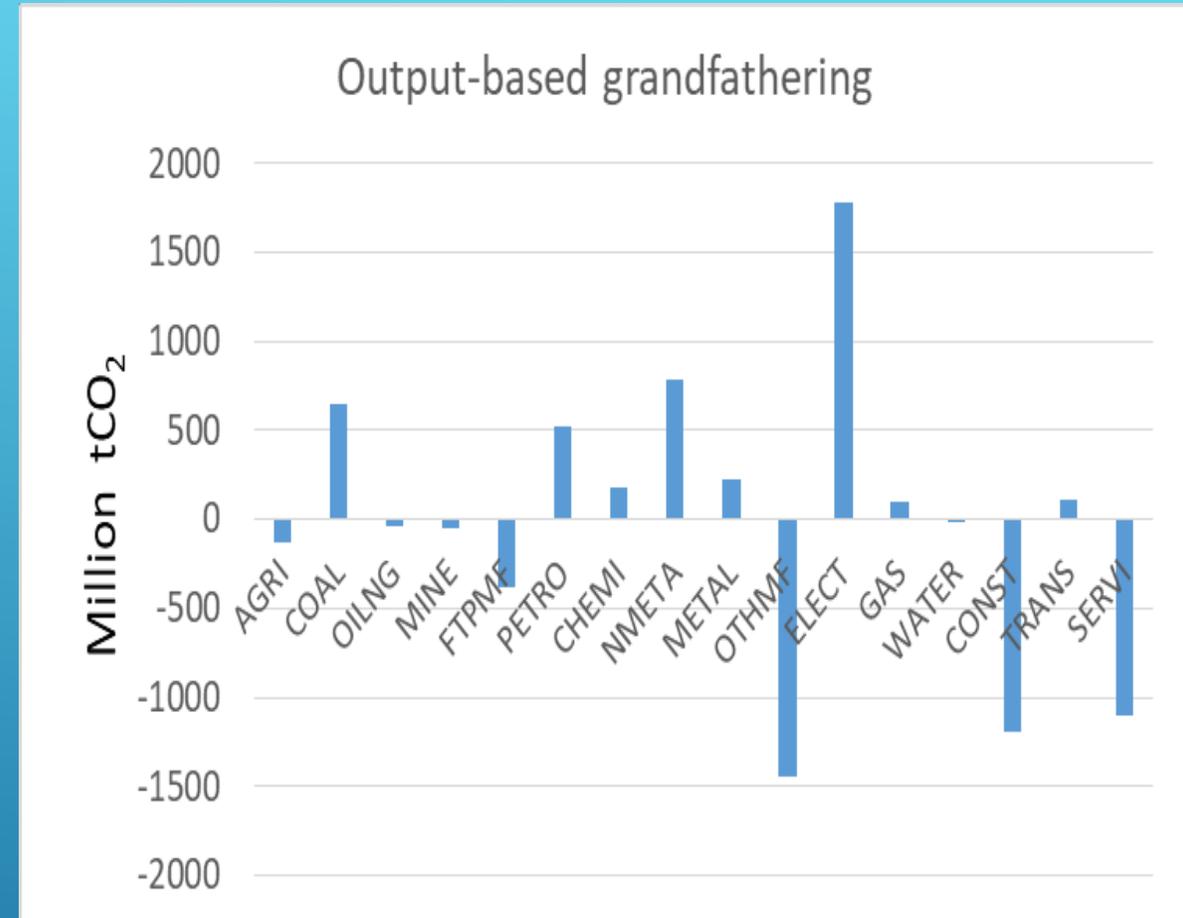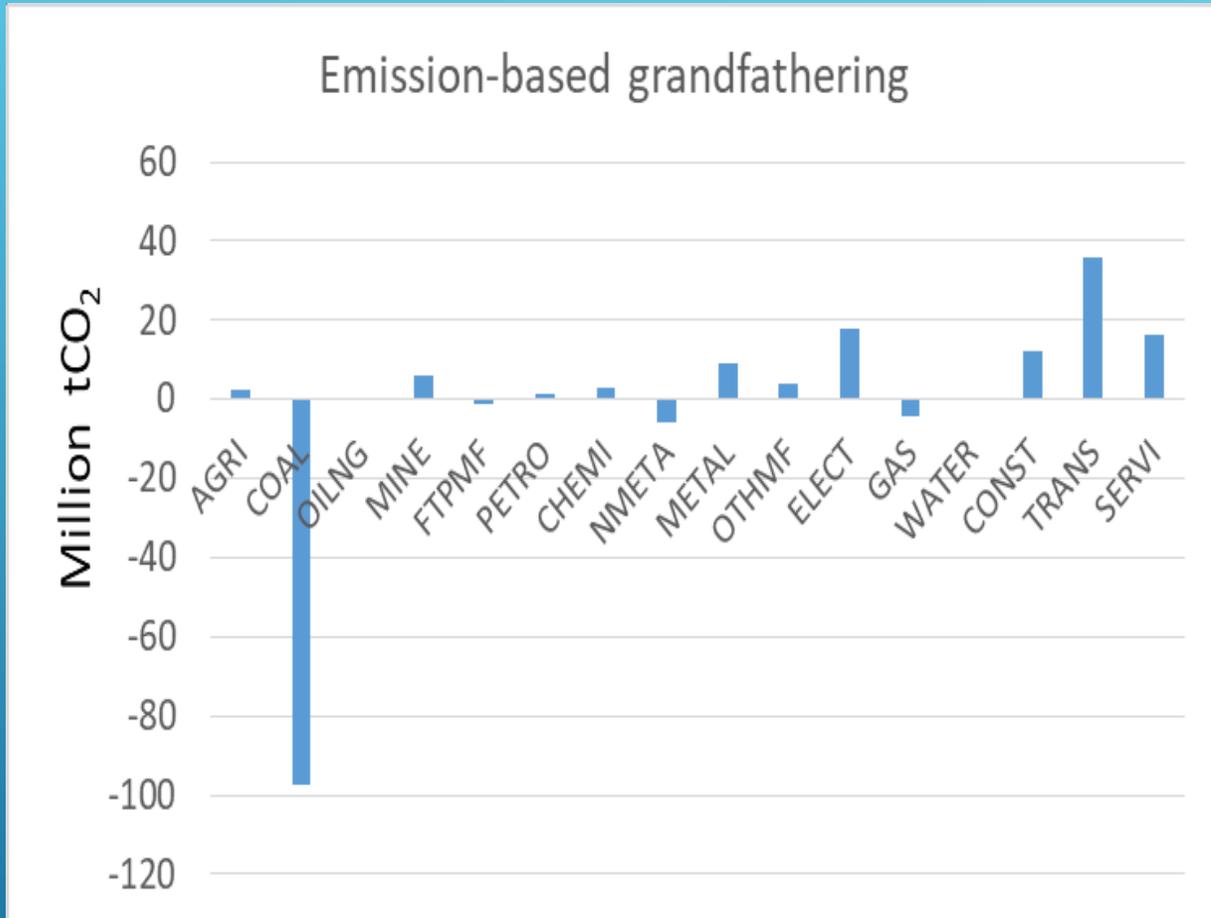
❖ **Electricity sector is an important buyer of allowance under the two grandfathering rules .**

❖ **Coal,other manufacturing, service,construction as important participants change the direction of allowance trading under the two grandfathering rules.**

Emission trading in 2030 - allowances are allocated through emission-based grandfathering (Millions tCO2)

Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	0.14	-0.71	0.00	0.10	0.02	0.04	-0.12	0.62	-0.22	0.19	3.71	0.16	0.00	0.65	1.07	0.44
Beijing	0.05	-0.74	0.00	0.06	0.06	0.14	0.11	0.42	0.03	0.20	2.37	0.02	0.00	0.36	1.54	0.74
Chongqing	0.01	-0.41	0.01	0.29	0.06	0.08	0.34	1.09	1.38	0.18	0.66	0.02	0.00	0.55	0.37	0.10
Fujian	0.28	-0.68	0.00	0.09	-0.03	0.08	-0.03	-1.14	-0.11	0.06	-0.99	-0.16	0.00	0.04	1.27	0.17
Gansu	0.07	-0.70	0.00	0.03	-0.01	0.18	0.15	0.29	0.44	0.05	0.01	0.00	0.00	0.27	0.33	0.14
Guangdong	0.06	0.00	0.00	0.17	-0.40	1.61	0.65	-7.82	-0.77	0.09	-9.14	-2.06	0.00	-0.97	1.99	2.69
Guangxi	0.04	0.00	0.00	0.09	0.04	0.12	-0.04	0.13	0.58	0.13	0.28	0.07	0.00	0.60	0.72	0.28
Guizhou	-0.11	-7.61	0.00	0.01	-0.04	0.16	-0.02	1.11	0.44	0.01	0.25	-0.07	0.00	0.36	0.52	0.19
Hainan	0.01	0.00	-0.01	0.01	0.00	0.40	0.04	0.06	0.01	0.00	-0.04	0.00	0.00	0.13	0.44	0.15
Hebei	0.21	-0.72	0.01	2.21	-0.36	-1.89	-0.86	-3.01	-2.37	0.00	0.21	-0.23	0.00	0.42	1.94	0.31
Heilongjiang	0.25	-1.87	0.04	0.12	-0.17	-0.82	0.35	-0.47	0.42	-0.19	0.86	-0.21	0.00	0.07	1.09	0.65
Henan	0.07	-11.87	0.00	0.30	0.00	-1.06	-1.61	-0.03	-0.40	0.14	5.69	-0.03	0.01	0.27	1.33	0.52
Hubei	0.18	-0.14	0.00	-0.01	-0.26	-0.15	-2.16	-2.94	-0.20	-0.18	-2.01	-0.01	0.00	-0.44	1.63	0.53
Hunan	0.13	-5.10	0.00	0.10	-0.05	1.48	0.15	0.83	0.63	0.23	2.77	-0.02	0.00	0.39	0.88	0.56
Jiangsu	0.09	-1.59	0.01	0.12	0.32	0.47	0.32	0.82	3.49	1.24	9.00	0.62	0.00	2.18	1.65	1.21
Jiangxi	0.01	-0.75	0.00	0.40	0.09	0.19	0.36	3.04	1.87	0.16	0.33	0.04	0.00	1.13	0.31	0.15
Jilin	0.31	-0.27	0.01	0.07	0.08	0.21	0.11	0.74	0.20	0.18	0.43	-0.02	0.00	0.44	0.65	0.77
Liaoning	0.06	-0.10	0.00	0.47	-0.07	0.70	0.62	-0.68	1.35	0.40	0.26	-0.07	0.00	1.80	1.70	0.60
Neimenggu	0.10	-33.88	0.00	-0.18	-0.18	-1.30	-1.30	-0.10	0.16	-0.23	-0.80	-0.80	0.00	0.47	1.57	0.08
Ningxia	0.05	-2.19	0.00	0.00	-0.02	0.11	0.16	0.51	0.26	0.01	0.71	0.00	0.00	0.24	0.24	0.09
Qinghai	0.00	0.05	0.00	0.01	0.00	0.24	0.01	0.48	0.03	0.00	0.66	0.00	0.00	0.03	0.07	0.02
Shaanxi	0.21	-5.63	0.09	0.07	0.02	0.21	0.15	1.20	0.59	0.08	1.01	-0.02	0.00	0.92	0.73	0.37
Shandong	0.01	-2.01	0.13	0.50	0.06	1.28	3.35	1.15	1.85	0.64	0.70	-0.46	0.00	1.17	3.16	0.78
Shanghai	0.02	0.00	0.00	0.00	0.05	0.06	1.46	0.17	-2.54	0.33	0.68	-0.43	0.00	0.21	5.20	2.60
Shanxi	-0.02	-8.25	0.07	0.00	-0.10	-2.16	-0.77	-1.91	0.12	-0.07	-3.11	-0.20	0.00	-0.24	0.52	0.03
Sichuan	0.01	-2.43	0.01	0.17	-0.32	-0.59	0.04	-0.92	0.65	0.02	-0.33	-0.25	0.02	0.26	0.62	0.30
Tianjin	0.02	-8.93	0.01	0.30	0.01	0.32	0.30	0.14	0.30	0.13	0.08	0.00	0.00	0.05	1.90	0.44
Xinjiang	0.13	-0.07	0.01	0.14	0.00	1.01	0.44	0.17	0.64	0.02	0.13	-0.03	0.00	0.34	1.07	0.40
Xizang	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02
Yunnan	0.03	-0.56	0.00	0.10	0.02	0.26	0.23	0.45	0.64	0.03	0.56	-0.01	0.00	0.64	0.34	0.32
Zhejiang	0.02	-0.03	0.00	0.04	-0.04	0.17	0.60	-0.48	-0.38	-0.09	2.86	-0.12	0.00	-0.12	1.22	0.85

Emission trading in 2030 - allowances are allocated through output-based grandfathering (Millions tCO2)

| Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	-4.9	2.2	0.0	-4.0	-9.6	2.3	7.9	89.5	22.5	-47.6	90.2	4.3	-0.6	-30.4	3.5	-31.0
Beijing	-1.6	108.7	0.0	-0.5	-6.2	-1.6	-3.6	-3.9	-1.6	-41.9	-66.6	-1.1	-0.3	-40.2	2.5	-80.8
Chongqing	-3.4	12.2	-0.4	-1.5	-6.8	1.2	-3.4	4.8	-2.1	-45.4	8.4	0.5	-0.5	-43.8	-0.9	-24.9
Fujian	-1.0	2.1	0.0	0.8	-15.4	0.9	-1.9	12.1	4.4	-23.0	21.2	3.1	-0.1	-37.8	8.6	-28.1
Gansu	-1.4	5.2	-0.1	0.4	-0.7	-0.5	1.5	12.5	-5.9	-4.1	34.1	0.0	-0.2	-11.9	2.6	-6.0
Guangdong	-3.3	0.0	-0.3	-2.2	-21.7	14.2	-13.0	77.8	-1.9	-96.1	156.1	24.7	-1.2	-87.3	6.0	-69.5
Guangxi	-3.1	0.0	0.0	-1.4	-7.4	-0.5	1.3	14.3	9.3	-18.9	19.1	1.0	-0.2	-31.3	-0.1	-20.5
Guizhou	0.8	44.0	0.0	-0.4	-2.2	7.4	2.7	41.3	16.0	-2.2	25.4	1.2	-0.1	-12.7	-0.9	-11.5
Hainan	-1.2	0.0	-0.4	-0.8	-0.8	0.2	-0.7	-1.7	-0.2	-2.4	4.9	0.0	-0.1	-12.9	1.8	-7.7
Hebei	-9.8	4.2	0.1	-11.5	-5.6	122.8	29.1	72.4	105.6	-50.9	63.5	2.5	-0.9	-67.7	3.5	-34.4
Heilongjiang	-6.0	13.9	-5.3	-2.8	-6.2	17.6	-1.5	14.1	10.3	-5.3	59.7	3.1	-0.3	-36.3	5.6	-18.9
Henan	-11.0	56.2	0.0	-12.4	-30.8	55.0	16.2	-5.7	-2.4	-80.7	269.6	4.8	-0.5	-56.1	5.2	-38.4
Hubei	-8.4	0.4	0.0	-1.8	-7.3	1.0	21.1	42.0	-1.8	-30.4	42.2	0.6	0.0	-35.2	8.7	-41.6
Hunan	-7.1	38.3	0.0	1.9	-3.4	20.7	3.2	67.3	18.9	-31.4	85.0	2.4	-0.3	-56.1	0.2	-36.2
Jiangsu	-7.7	11.9	-0.6	10.4	-28.6	26.3	-13.8	9.0	-18.1	-247.8	247.1	17.7	-0.6	-91.9	-4.9	-146.4
Jiangxi	-4.6	14.3	0.0	-5.5	-11.5	3.0	-8.0	41.3	-15.7	-44.4	2.1	1.8	-0.4	-24.7	-3.4	-26.8
Jilin	0.1	1.5	-1.2	-2.8	-6.8	5.8	18.1	30.3	-4.3	-39.5	27.9	0.4	-0.6	-39.4	-0.5	-17.0
Liaoning	-6.4	0.6	-0.2	-0.8	-14.8	-1.3	-2.1	41.4	1.5	-65.0	28.2	2.7	-0.2	-51.9	1.3	-51.9
Neimenggu	-9.2	167.4	0.0	1.1	-12.8	26.7	35.6	12.1	7.2	-17.2	21.3	3.7	0.0	-27.0	16.8	-5.8
Ningxia	-0.8	11.5	0.0	0.0	-0.2	7.0	7.4	11.5	-2.7	-1.7	18.3	-0.1	-0.1	-4.7	1.1	-3.5
Qinghai	-0.6	4.2	-3.1	-1.9	-0.5	0.4	-3.2	-23.4	-8.5	-0.6	6.7	0.0	0.0	-7.7	0.5	-6.9
Shaanxi	-4.5	24.5	-12.6	-1.4	-4.5	42.0	4.2	26.1	5.4	-8.5	32.9	0.6	-0.4	-35.5	10.1	-26.3
Shandong	-8.3	10.8	-4.9	-11.0	-117.7	26.7	55.2	64.2	-15.6	-308.2	204.8	7.2	-0.5	-102.3	5.4	-103.5
Shanghai	-0.1	0.0	-0.1	0.0	-7.7	-2.1	2.4	-0.4	43.5	-73.8	68.3	6.9	-0.4	-48.2	14.7	-73.1
Shanxi	-2.7	26.3	-0.5	-0.9	-1.3	98.9	11.2	33.2	16.2	-13.4	56.5	1.3	-0.1	-18.4	3.1	-13.6
Sichuan	-8.2	15.4	-0.7	1.0	-10.4	15.7	10.7	33.6	18.3	-36.8	90.5	3.3	-0.6	-34.3	1.9	-39.7
Tianjin	-0.2	65.3	-4.6	1.7	-10.0	0.6	-1.8	1.1	13.0	-42.1	8.9	1.3	-0.8	-51.3	2.2	-41.2
Xinjiang	-1.9	0.6	-7.8	-0.5	-0.3	16.6	2.3	9.1	6.3	-1.8	13.9	1.0	0.0	-15.9	9.1	-2.7
Xizang	-0.3	0.0	0.0	-0.2	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.8	-0.1	-1.5
Yunnan	-3.3	4.7	0.0	-0.8	-6.3	13.6	7.4	15.9	6.4	-4.6	17.1	2.2	-0.2	-44.9	-0.2	-18.4
Zhejiang	-5.6	0.0	0.0	0.0	-23.5	-1.0	-4.0	42.5	5.6	-61.2	127.9	2.6	-0.7	-30.5	2.1	-74.3

EMISSION REDUCTIONS IN 2030 FROM THE BASELINE (% CHANGE)-BY PROVINCE
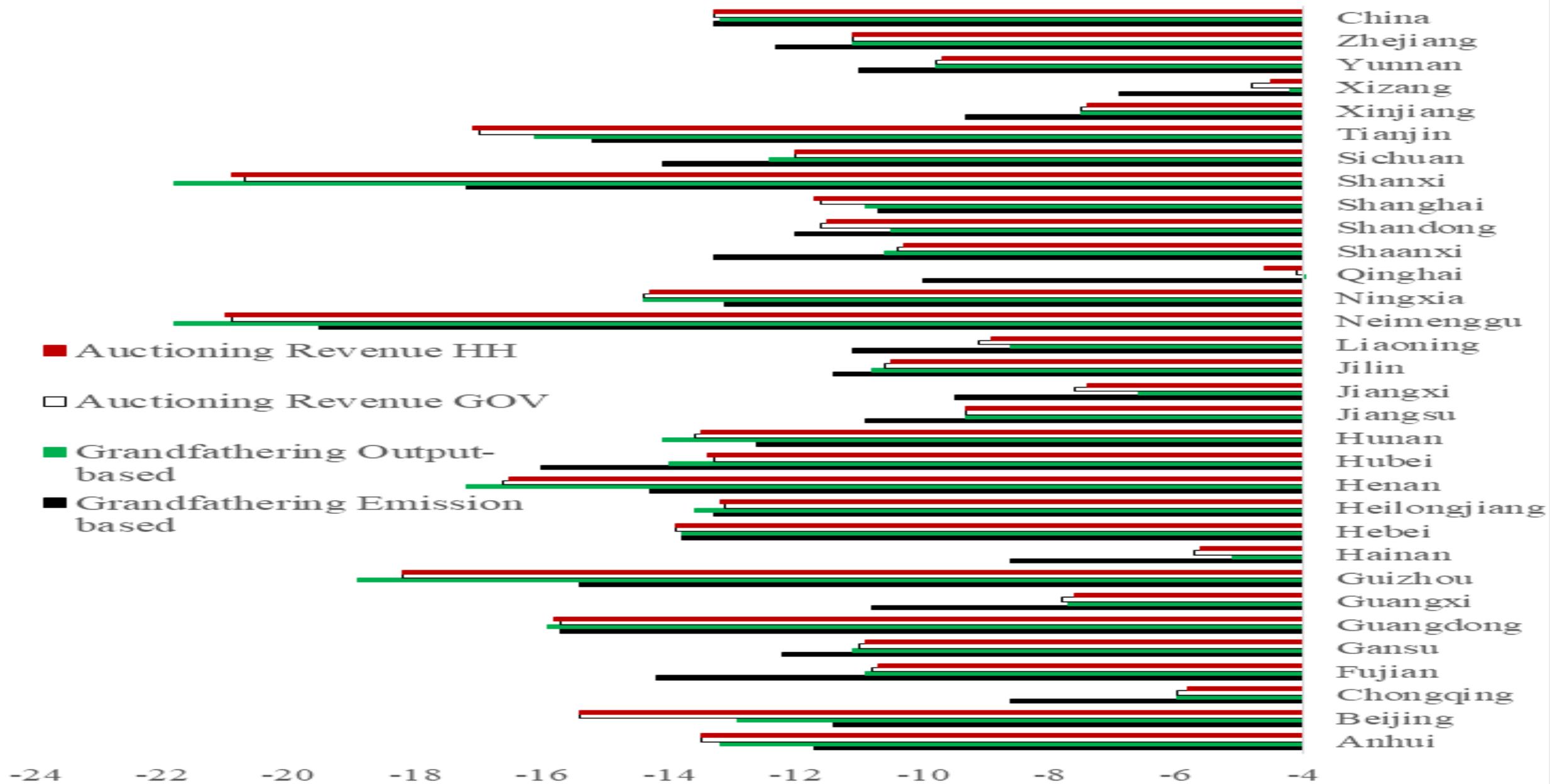
EMISSION REDUCTIONS IN 2030 FROM THE BASELINE (% CHANGE)-BY SECTOR
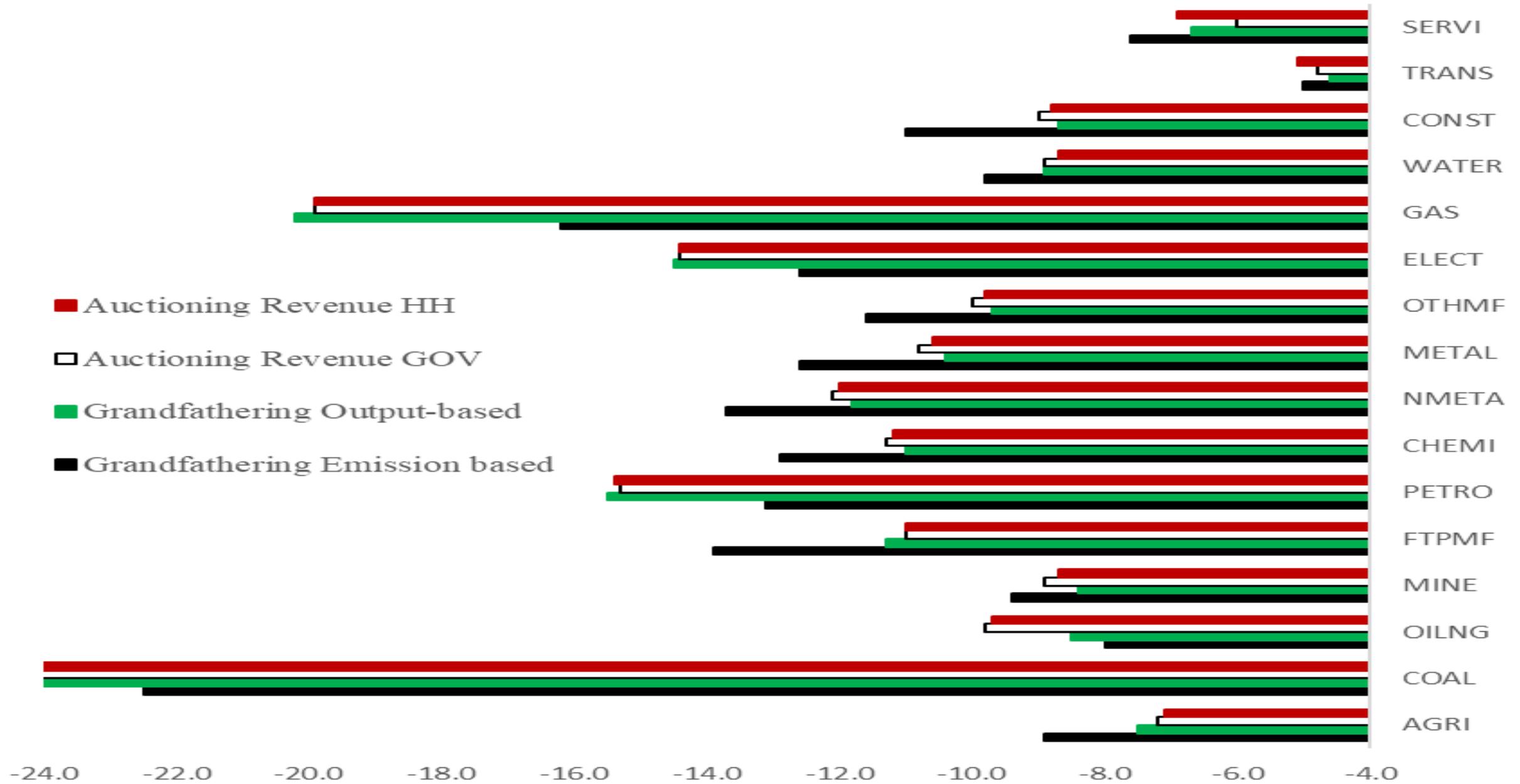
CHANGE IN PROVINCIAL GDP IN 2030 FROM THE BASELINE (%)
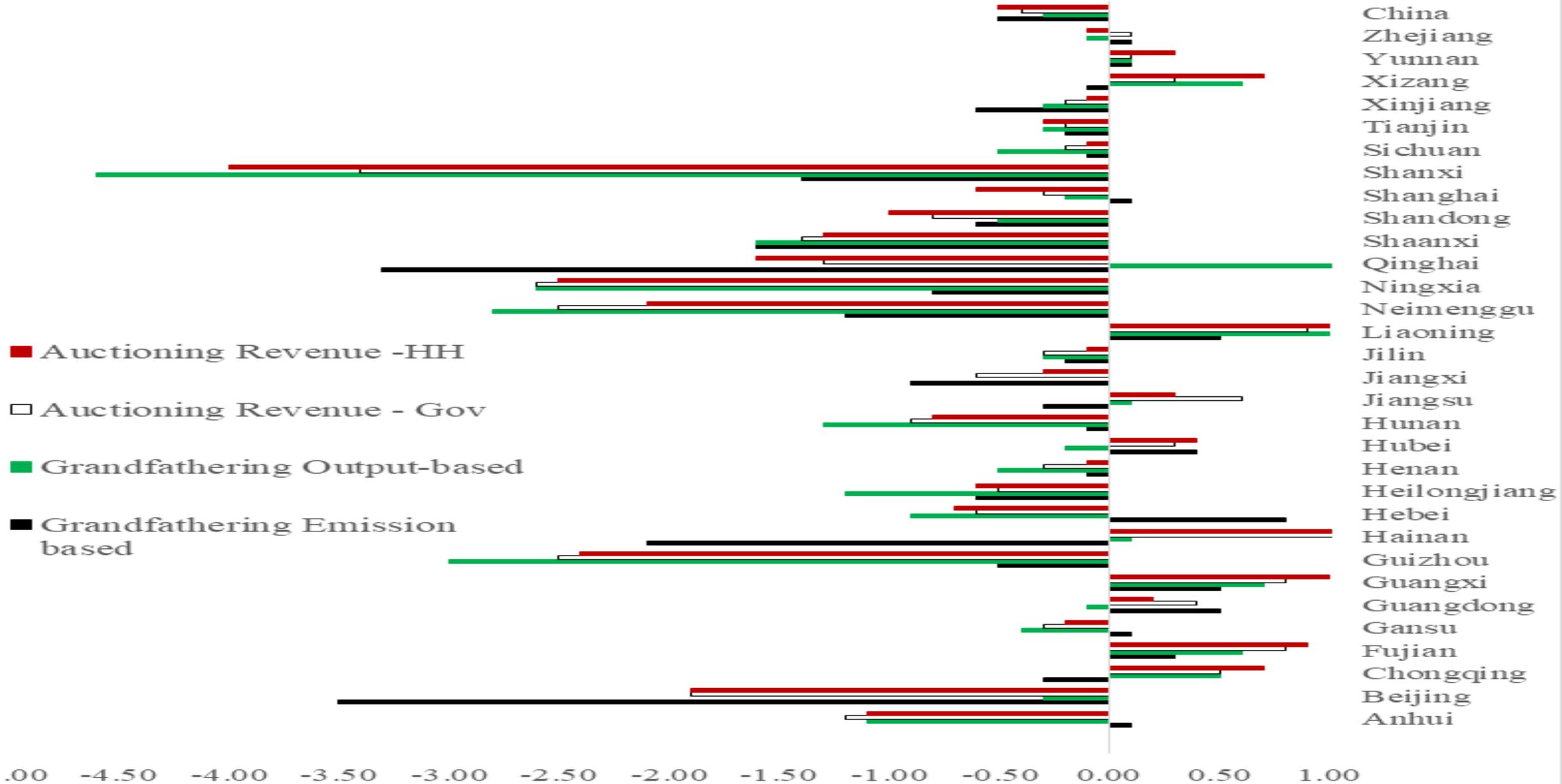
CHANGE IN SECTORAL OUTPUTS IN 2030 FROM THE BASELINE (%)
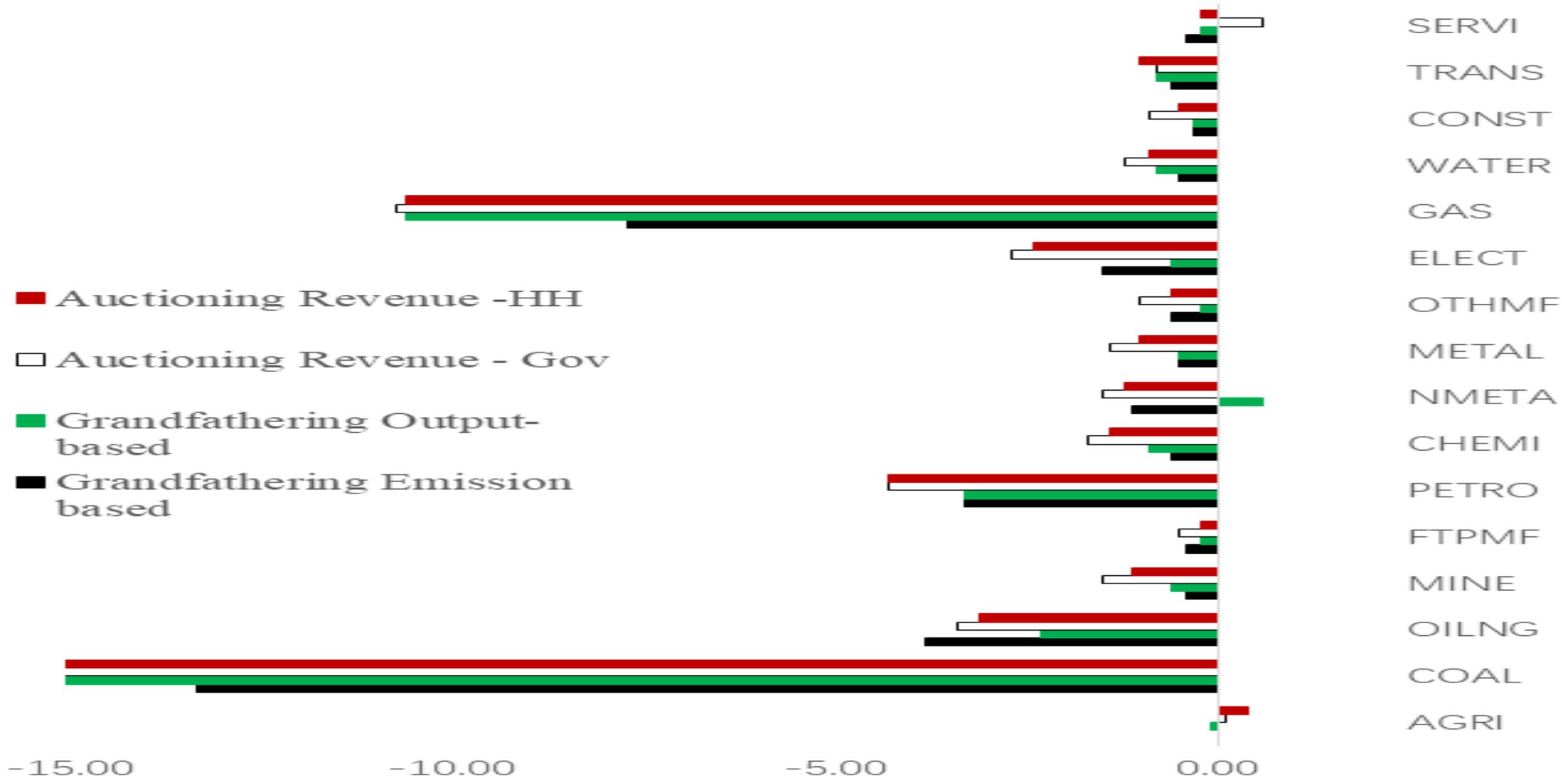
Impacts on sectoral outputs of China in 2030 (% change from the baseline) under the emission-based grandfathering

Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	0.09	-18.00	-	-0.46	-0.17	-3.06	-0.31	-0.68	-0.54	-0.65	-1.82	-7.30	-0.56	-0.31	-0.28	-0.47
Beijing	-0.78	-13.21	-4.85	1.46	-0.15	-3.11	0.02	0.35	0.56	0.03	-0.56	-4.00	-0.60	-0.25	-1.38	-0.38
Chongqing	-0.13	-8.95	0.58	-0.45	-0.39	-1.32	-0.30	-0.43	-0.38	-0.37	-1.04	-4.46	-0.52	-0.37	-0.54	-0.46
Fujian	0.06	-19.91	-	0.44	0.07	-2.81	0.16	0.14	0.02	-0.12	-0.93	-8.06	-0.08	-0.17	-0.18	-0.16
Gansu	0.05	-12.60	-1.16	-0.25	-0.05	-2.66	0.00	-0.21	-0.28	-0.20	-1.23	-8.33	-0.13	-0.23	-0.21	-0.15
Guangdong	0.57	-	-3.77	0.16	0.01	-3.68	0.01	-0.04	-0.01	0.04	-1.09	-10.76	0.16	-0.30	-0.09	-0.12
Guangxi	0.61	-16.29	-	0.09	-0.13	-1.82	0.10	-0.12	-0.11	-0.19	-1.11	-2.90	-0.22	-0.23	-0.05	-0.08
Guizhou	-0.12	-13.57	-	-0.28	-0.76	-2.86	-0.11	-0.17	0.07	-0.48	-0.82	-10.16	-0.39	-0.23	-0.48	-0.31
Hainan	-0.10	-	-	-0.58	0.01	-3.05	-0.57	-0.32	-0.03	-0.44	-1.08	-5.98	-0.74	-0.34	-0.61	-0.53
Hebei	0.34	-11.14	4.93	-0.23	0.11	-2.95	0.03	-0.42	-0.27	-0.43	-1.30	-8.24	-0.49	-0.38	-0.06	-0.09
Heilongjiang	-0.14	-12.35	-4.31	-1.02	-0.56	-3.21	-0.76	-0.73	-0.63	-0.48	-1.56	-7.64	-1.05	-0.46	-0.70	-0.81
Henan	0.20	-12.78	5.84	-0.31	-0.03	-3.32	-0.01	-0.30	-0.31	-0.47	-1.31	-5.94	-0.19	-0.31	-0.19	-0.17
Hubei	0.32	-14.72	-0.72	0.15	0.26	-2.57	-0.06	-0.20	-0.11	-0.19	-1.12	-5.43	1.10	-0.26	-0.13	-0.15
Hunan	0.07	-13.26	-	0.15	0.00	-4.04	0.05	-0.26	-0.14	-0.34	-1.80	-6.44	-0.25	-0.35	-0.25	-0.28
Jiangsu	0.36	-13.02	-1.40	-0.82	-0.53	-2.72	-0.68	-0.51	-0.61	-0.65	-1.81	-7.01	-0.49	-0.39	-0.47	-0.49
Jiangxi	-0.48	-10.84	-	-1.09	-0.55	-1.99	-0.86	-1.32	-1.24	-1.27	-1.97	-5.28	-1.02	-0.49	-1.24	-0.86
Jilin	-0.13	-12.26	0.77	-0.62	-0.45	-2.51	-0.46	-0.69	-0.72	-0.74	-1.89	-9.07	-0.56	-0.48	-0.70	-0.54
Liaoning	0.47	-12.86	-2.65	0.13	0.04	-2.84	0.14	0.02	-0.16	-0.17	-1.17	-4.63	-0.07	-0.28	-0.12	-0.16
Neimenggu	-1.11	-14.63	2.41	-0.45	-0.97	-4.64	-0.97	-0.28	-0.59	-0.99	-2.20	-18.86	-0.99	-0.13	-0.44	-0.57
Ningxia	-0.58	-14.93	3.66	0.57	-0.40	-2.33	-0.81	-0.20	0.21	-0.40	-0.60	-8.96	-0.53	-0.28	-0.63	-0.89
Qinghai	-1.53	-10.60	-6.98	-6.53	-4.59	-5.32	-5.16	-8.85	-1.11	-2.70	-7.32	-7.76	-5.44	-0.46	-3.68	-4.50
Shaanxi	-0.62	-15.57	-2.48	0.37	-0.64	-3.33	-0.73	-0.05	-0.33	-0.34	-2.05	-8.53	-0.82	-0.17	-0.72	-0.93
Shandong	0.18	-13.36	-5.22	-1.22	-0.93	-3.59	-1.18	-0.57	-1.00	-1.03	-2.19	-7.43	-1.00	-0.53	-0.87	-0.77
Shanghai	-0.05	-	-	-6.23	-0.35	-3.25	-0.46	-0.11	-0.96	-0.32	-1.43	-8.11	-0.46	-0.38	-0.95	-0.37
Shanxi	-0.71	-12.86	-2.69	-0.64	-0.69	-3.09	-0.48	-0.54	-0.84	-0.34	-2.13	-10.34	-0.97	-0.40	-1.64	-1.29
Sichuan	0.00	-11.56	-0.52	-0.26	-0.21	-3.59	-0.28	-0.23	-0.42	-0.46	-1.90	-4.98	-0.48	-0.26	-0.37	-0.38
Tianjin	0.20	-13.11	-2.65	0.00	-0.49	-3.37	-0.61	-0.25	-0.33	-0.54	-1.79	-7.88	-0.73	-0.38	-0.73	-0.57
Xinjiang	0.28	-9.45	-3.31	0.31	0.13	-3.92	-0.23	0.07	0.07	-0.20	-1.13	-8.03	-0.32	-0.08	-0.39	-0.10
Xizang	0.19	-	-	-0.78	-0.28		1.57	2.96	-0.49	-0.13	-0.48	-	-0.23	-0.32	-0.16	-0.16
Yunnan	0.42	-10.40	-	0.12	-0.39	-2.91	-0.36	-0.24	-0.05	-0.40	-1.05	-8.43	-0.40	-0.26	-0.44	-0.21
Zhejiang	0.08	-38.13	-	-0.14	-0.33	-3.10	-0.07	0.28	-0.07	-0.27	-1.01	-7.90	-0.28	-0.29	-0.23	-0.27

Impacts on sectoral outputs of China in 2030 (% change from the baseline) under the output-based grandfathering

Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	-0.2	-11.9	-	-1.7	-0.4	-4.6	-2.0	-7.0	-1.5	-1.0	-8.8	-11.1	-1.9	-0.6	-0.9	-1.0
Beijing	-0.2	-16.7	-0.7	1.7	0.8	5.1	3.2	4.6	5.4	1.2	9.9	4.2	1.9	0.2	-1.0	0.8
Chongqing	0.9	-6.4	3.9	1.4	0.7	0.1	1.2	1.7	0.8	0.6	-3.9	0.7	0.6	0.0	0.6	0.4
Fujian	0.4	-18.0	-	0.3	0.6	-1.2	0.8	0.3	0.1	0.4	-2.0	-9.2	0.4	0.0	-0.1	0.2
Gansu	-0.4	-11.0	1.0	-1.1	-0.6	0.3	-0.8	-2.1	-0.1	-0.5	-4.5	-3.6	-1.2	-0.4	-0.6	-0.4
Guangdong	0.7		-1.6	-0.4	0.2	-2.3	0.5	-1.7	0.3	0.7	-9.1	-25.7	-0.9	-0.3	-0.4	-0.1
Guangxi	1.0	-7.1	-	0.8	0.5	-0.2	0.8	1.3	0.4	0.2	-3.8	-3.7	0.2	-0.1	0.4	0.3
Guizhou	-1.4	-19.9	-	-3.5	-1.6	-16.3	-3.2	-8.3	-3.7	-1.8	-6.5	-16.5	-3.0	-1.0	-1.8	-1.8
Hainan	0.3	-		0.4	0.9	0.4	1.2	0.8	1.0	0.7	-1.3	-2.6	0.2	0.2	0.2	0.3
Hebei	-0.4	-4.0	-7.8	-2.2	-0.9	-6.9	-2.2	-3.0	-1.8	-1.5	-10.0	-7.9	-2.2	-0.8	-1.4	-1.1
Heilongjiang	-0.4	-9.2	-4.0	-1.5	-1.0	-4.6	-0.9	-2.5	-2.8	-1.6	-7.5	-10.3	-2.0	-0.7	-1.5	-1.3
Henan	0.1	-20.5	-3.3	-0.4	-0.1	-10.6	-1.7	1.1	-0.6	-0.9	-9.3	-7.6	-1.4	-0.4	-1.1	-0.5
Hubei	0.3	-22.2	-0.2	-0.2	0.2	-2.5	-2.7	-3.9	0.6	0.0	-6.8	-5.7	1.1	-0.2	-0.5	-0.2
Hunan	-0.6	-18.3	-	-2.0	-0.8	-8.9	-1.4	-2.7	-1.5	-0.8	-7.4	-8.1	-1.2	-0.7	-1.2	-1.1
Jiangsu	0.8	-16.9	-0.9	-2.8	-0.2	-1.9	0.2	0.9	-0.1	-0.2	-4.1	-10.5	-0.4	-0.2	0.0	-0.1
Jiangxi	0.7	-7.7	-	0.7	0.8	-2.0	1.0	-1.0	0.9	0.3	-2.3	-6.6	-0.1	-0.2	0.2	0.1
Jilin	-0.4	6.8	-1.4	-0.7	-0.8	-3.4	-1.5	-2.0	0.1	-0.2	-7.4	-3.4	-0.9	-0.4	-0.7	-0.6
Liaoning	1.2	6.3	1.7	0.7	0.6	-0.3	1.3	0.6	0.5	0.4	-4.1	-5.9	0.4	-0.1	0.6	0.4
Neimenggu	-1.8	-21.9	0.1	-0.7	-1.3	-17.0	-3.9	0.5	-0.7	-1.6	-3.8	-25.3	-2.3	-0.1	-3.5	-1.2
Ningxia	-2.0	-16.2	-6.1	-2.0	-2.1	-3.7	-6.4	-3.0	-1.0	-1.5	-5.9	-5.2	-2.2	-0.8	-2.1	-2.0
Qinghai	5.2	11.5	13.2	9.2	10.4	7.4	8.3	15.6	3.8	5.1	12.7	0.4	10.9	1.1	7.4	8.6
Shaanxi	-0.5	-9.6	-3.5	0.5	-0.4	-3.5	-1.1	-0.6	-0.1	0.1	-7.8	-3.5	-0.8	-0.1	-1.2	-0.7
Shandong	1.0	-7.3	-4.5	-0.4	-0.2	-2.7	-1.9	-0.6	-0.2	-0.4	-7.0	-9.2	-0.9	-0.3	-0.5	-0.4
Shanghai	-0.2		-2.3		0.1	-1.2	-0.8	2.2	-5.6	0.4	-8.5	-9.0	-0.2	-0.2	-1.4	-0.1
Shanxi	-2.1	-12.2	-6.9	-3.6	-2.5	-20.1	-4.5	-8.3	-3.2	-1.4	-12.2	-13.2	-3.6	-1.2	-4.0	-3.8
Sichuan	-0.2	-8.0	-3.6	-1.1	-0.5	-6.0	-1.1	-1.0	-1.2	-0.7	-5.8	-3.9	-1.0	-0.4	-0.7	-0.5
Tianjin	0.6	-21.1	-3.3	-0.2	-0.1	-2.1	0.6	1.4	0.0	0.2	-4.9	-5.4	0.2	0.0	-0.2	-0.1
Xinjiang	0.2	-4.2	-1.3	0.1	-0.1	-3.8	-0.3	-0.5	-0.2	-0.3	-2.7	-7.1	-0.4	-0.1	-1.0	-0.2
Xizang	0.5	-	-	1.4	1.4		-0.7	-2.4	0.6	0.3	-0.7	-	0.6	0.4	0.9	0.5
Yunnan	0.7	-4.3	-	0.1	0.1	-11.1	-0.4	-0.5	0.2	-0.3	-2.2	-14.8	-0.3	-0.1	-0.2	-0.1
Zhejiang	0.3	-38.3	-	-1.3	-0.2	-1.1	0.1	-0.6	-0.4	-0.3	-6.9	-6.0	-0.5	-0.4	-0.2	-0.2

Impacts on sectoral outputs in 2030 (%) when auction revenue is used by provincial governments

Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	-0.20	-10.35	-	-2.53	-0.60	-4.67	-2.20	-7.52	-2.38	-1.64	-9.28	-12.07	-2.37	-1.12	-1.14	-0.46
Beijing	-0.79	-19.20	3.63	1.41	0.07	1.84	3.11	3.12	2.36	0.29	5.64	1.48	0.98	-0.53	-1.54	1.33
Chongqing	0.86	-6.15	2.52	0.55	0.59	-0.14	0.99	0.96	0.13	0.15	-2.89	0.45	0.35	-0.56	0.32	0.74
Fujian	0.37	-17.18	-	-0.08	0.55	-1.78	0.61	-0.08	-0.38	0.03	-2.50	-9.30	0.63	-0.50	-0.45	0.62
Gansu	-0.08	-10.53	0.73	-1.70	-0.66	-0.81	-1.04	-2.37	-0.85	-0.96	-4.67	-3.66	-1.52	-0.95	-0.80	0.23
Guangdong	1.02	-	0.45	-1.01	-0.07	-3.30	-0.08	-2.41	-0.79	-0.07	-9.18	-25.54	-1.20	-0.91	-0.60	0.98
Guangxi	1.36	-6.39	-	0.94	0.34	-0.97	0.79	0.85	-0.14	-0.12	-3.78	-3.99	-0.13	-0.62	0.10	0.52
Guizhou	-0.95	-19.03	-	-2.81	-0.93	-15.12	-2.90	-8.23	-3.75	-1.85	-6.43	-15.49	-2.69	-1.41	-1.66	-0.73
Hainan	0.50	-	-	0.26	0.66	-1.19	0.71	-0.05	0.10	-0.25	-1.77	-3.06	-0.19	-0.45	-0.30	0.36
Hebei	-0.06	0.37	-8.73	-3.12	-0.70	-7.01	-2.55	-3.60	-2.49	-2.10	-9.66	-7.27	-2.60	-1.41	-0.20	0.87
Heilongjiang	-0.11	-8.61	-2.36	-1.82	-1.06	-4.67	-0.97	-3.04	-3.22	-1.97	-7.34	-9.85	-1.90	-1.28	-1.44	0.24
Henan	0.30	-19.62	-5.00	-0.90	-0.08	-10.11	-1.63	0.49	-0.99	-1.31	-9.16	-7.44	-1.62	-0.87	-0.96	0.59
Hubei	0.33	-20.32	1.89	0.42	0.26	-2.44	-2.51	-3.71	0.80	0.21	-6.64	-5.45	2.09	-0.59	0.48	0.22
Hunan	-0.30	-17.44		-1.90	-0.49	-9.28	-1.09	-2.86	-1.53	-0.93	-7.19	-7.55	-1.18	-1.20	-0.85	-0.06
Jiangsu	1.58	-16.23	-1.04	-3.46	-0.14	-1.89	-0.06	0.10	-0.97	-0.75	-4.45	-10.36	-0.32	-0.86	1.00	1.64
Jiangxi	0.39	-9.04		-1.07	0.39	-2.63	0.11	-2.16	-1.07	-1.02	-2.85	-6.77	-1.01	-0.90	-0.36	0.20
Jilin	-0.28	6.35	-3.40	-1.09	-0.88	-3.52	-1.58	-2.62	-0.46	-0.80	-7.06	-3.14	-1.36	-1.01	-0.82	-0.35
Liaoning	1.11	8.64	1.23	-0.22	0.30	-1.28	0.62	-0.12	-0.29	-0.26	-4.46	-6.39	-0.21	-0.69	0.11	0.45
Neimenggu	-1.28	-21.03	1.06	-0.67	-1.12	-15.98	-3.67	0.43	-0.71	-1.81	-3.90	-24.08	-2.20	-0.52	-3.38	0.68
Ningxia	-1.91	-16.74	-9.10	-2.38	-2.19	-4.00	-6.58	-3.42	-2.05	-2.12	-6.32	-4.88	-2.43	-1.29	-2.28	-0.97
Qinghai	1.38	-3.79	-1.07	-0.81	0.10	-3.69	0.79	-2.67	1.75	0.27	-2.06	-7.42	-0.29	-0.10	-0.45	-0.24
Shaanxi	-0.55	-9.32	-3.56	-0.28	-0.77	-3.60	-1.55	-1.32	-0.85	-0.41	-7.32	-3.10	-1.01	-0.68	-0.85	0.06
Shandong	0.97	-6.99	-7.63	-2.43	-1.19	-4.59	-3.66	-1.70	-1.86	-1.78	-7.99	-9.20	-1.85	-1.16	-0.71	0.86
Shanghai	-0.44	-	-3.41		-0.51	-2.35	-1.88	1.15	-7.39	-0.86	-9.07	-9.51	-0.76	-0.98	-2.28	0.18
Shanxi	-1.44	-11.50	-8.67	-3.73	-1.92	-18.86	-4.17	-8.18	-3.69	-1.88	-11.32	-11.84	-3.18	-1.79	-3.29	-0.56
Sichuan	-0.09	-7.77	-3.90	-1.27	-0.32	-5.82	-0.99	-1.25	-1.42	-0.97	-5.77	-3.72	-1.10	-0.86	-0.26	0.33
Tianjin	0.90	-22.77	-4.33	-1.31	-0.28	-3.11	0.02	0.37	-1.00	-0.54	-5.08	-5.28	-0.67	-0.85	-0.78	0.73
Xinjiang	0.51	-3.84	-1.78	-0.15	0.00	-4.13	-0.49	-0.80	-0.67	-0.72	-2.90	-6.25	-0.58	-0.62	-0.92	0.49
Xizang	0.33	-	-	0.85	1.13	-	0.80	4.47	-0.32	0.51	-0.23	-	0.05	-0.15	0.52	0.09
Yunnan	0.83	-4.54	-	-0.34	-0.17	-10.52	-0.90	-1.17	-0.18	-0.68	-2.81	-14.39	-0.74	-0.70	-0.54	0.18
Zhejiang	0.27	-38.77	-	-2.28	-0.68	-2.47	-0.60	-1.27	-1.42	-0.99	-7.11	-6.27	-0.81	-1.03	-0.30	0.76

Impacts on sectoral outputs in 2030 (%) when auction revenue is recycled to households through a lump-sum transfer

Province	AGRI	COAL	OILNG	MINE	FTPMF	PETRO	CHEMI	NMETA	METAL	OTHMF	ELECT	GAS	WATER	CONST	TRANS	SERVI
Anhui	0.2	-10.2	-	-2.2	-0.2	-4.5	-2.1	-7.3	-2.1	-1.4	-9.1	-11.5	-2.0	-0.7	-1.1	-0.9
Beijing	-0.4	-19.3	4.1	1.7	0.4	2.1	3.5	3.6	2.8	0.7	6.2	1.7	1.0	-0.1	-1.7	0.4
Chongqing	1.3	-6.0	3.0	1.0	1.0	0.3	1.4	1.4	0.6	0.5	-2.6	1.0	0.8	-0.2	0.6	0.6
Fujian	0.5	-17.2		0.3	0.8	-1.5	0.9	0.3	0.0	0.4	-2.2	-9.0	1.0	-0.1	-0.1	0.4
Gansu	0.1	-10.4	0.7	-1.4	-0.3	-0.6	-0.8	-2.0	-0.5	-0.6	-4.4	-3.2	-1.2	-0.6	-0.6	-0.2
Guangdong	1.1	-	0.7	-0.6	0.1	-3.2	0.2	-2.0	-0.4	0.3	-9.2	-25.6	-1.1	-0.5	-0.5	0.1
Guangxi	1.6	-6.2	-	1.3	0.7	-0.7	1.1	1.3	0.2	0.3	-3.5	-3.3	0.3	-0.2	0.4	0.5
Guizhou	-0.4	-19.0	-	-2.5	-0.4	-15.2	-2.4	-8.1	-3.5	-1.5	-6.1	-15.1	-2.1	-1.0	-1.4	-1.2
Hainan	0.8	-	-	0.7	0.9	-1.0	1.0	0.4	0.5	0.1	-1.5	-2.7	0.2	0.0	-0.4	0.3
Hebei	0.1	0.5	-9.2	-2.7	-0.5	-7.0	-2.3	-3.2	-2.1	-1.7	-9.5	-7.5	-2.3	-1.0	-1.4	-0.7
Heilongjiang	0.2	-8.6	-1.9	-1.3	-0.7	-4.6	-0.7	-2.6	-2.8	-1.6	-7.2	-9.6	-1.7	-0.9	-1.4	-0.8
Henan	0.6	-19.7	-5.1	-0.5	0.3	-10.0	-1.3	0.9	-0.6	-0.9	-8.9	-6.6	-1.1	-0.5	-0.9	-0.1
Hubei	0.7	-20.6	1.6	0.7	0.6	-2.8	-2.3	-3.7	1.2	0.6	-6.5	-5.2	2.4	-0.2	-0.3	0.0
Hunan	0.1	-17.4	-	-1.6	-0.1	-9.2	-0.8	-2.5	-1.2	-0.6	-6.9	-7.0	-0.9	-0.8	-0.8	-0.6
Jiangsu	1.3	-16.3	-0.9	-3.0	0.0	-1.8	0.2	0.6	-0.5	-0.4	-4.4	-10.5	-0.4	-0.4	0.0	0.1
Jiangxi	0.8	-8.8	-	-0.6	0.7	-2.4	0.5	-1.7	-0.6	-0.6	-2.5	-6.0	-0.6	-0.5	-0.2	-0.1
Jilin	-0.1	6.7	-3.5	-0.7	-0.6	-3.4	-1.3	-2.3	-0.1	-0.4	-6.8	-2.6	-1.0	-0.6	-0.6	-0.5
Liaoning	1.4	9.0	1.4	0.1	0.7	-1.0	0.9	0.3	0.1	0.1	-4.2	-5.9	0.2	-0.3	0.4	0.3
Neimenggu	-0.8	-21.0	0.9	-0.2	-0.1	-15.9	-3.1	1.0	-0.2	-1.3	-3.4	-24.0	-1.6	-0.1	-3.7	-0.3
Ningxia	-1.0	-16.7	-9.3	-2.2	-1.4	-3.7	-6.4	-3.1	-1.8	-1.8	-6.1	-4.7	-2.0	-0.9	-2.1	-1.7
Qinghai	1.4	-4.2	-1.3	-0.9	0.1	-4.0	1.0	-3.3	2.2	0.5	-2.4	-7.2	-0.4	0.3	-0.6	-0.7
Shaanxi	-0.1	-9.1	-3.3	0.0	-0.2	-3.4	-1.3	-1.0	-0.5	-0.1	-7.1	-2.8	-0.8	-0.3	-1.1	-0.5
Shandong	1.0	-6.8	-7.5	-2.0	-0.9	-4.5	-3.4	-1.3	-1.5	-1.4	-7.9	-9.0	-1.3	-0.7	-1.2	-0.6
Shanghai	0.1	-	-3.6	-	-0.2	-2.5	-1.7	1.6	-7.1	-0.5	-9.1	-9.4	-0.8	-0.6	-2.5	-0.4
Shanxi	-1.0	-11.5	-8.1	-3.4	-1.5	-19.2	-3.9	-8.0	-3.4	-1.5	-11.3	-11.3	-3.0	-1.4	-3.7	-3.1
Sichuan	0.2	-7.7	-3.8	-0.9	0.0	-5.7	-0.7	-0.9	-1.1	-0.6	-5.6	-3.1	-0.8	-0.5	-0.5	-0.2
Tianjin	1.0	-23.0	-4.2	-1.0	-0.1	-3.0	0.3	0.8	-0.6	-0.1	-5.0	-5.1	-0.6	-0.4	-0.8	-0.1
Xinjiang	0.8	-3.6	-1.6	0.2	0.6	-4.1	-0.3	-0.4	-0.3	-0.4	-2.6	-5.8	-0.3	-0.2	-0.9	-0.1
Xizang	0.7	-	-	1.3	1.7	-	1.3	5.3	0.1	1.0	0.1	-	0.4	0.2	0.9	0.5
Yunnan	1.2	-4.4	-	0.0	0.2	-10.4	-0.6	-0.8	0.2	-0.3	-2.5	-14.3	-0.3	-0.3	-0.3	0.0
Zhejiang	0.5	-38.8	-	-1.9	-0.4	-2.3	-0.4	-0.9	-1.0	-0.7	-7.0	-6.0	-0.5	-0.6	-0.4	-0.1

IMPACTS ON INTER-PROVINCIAL AND INTERNATIONAL TRADE IN 2030 (%) - IMPORT

Province	Grandfathering				Auctioning			
	Emission-based		Output-based		Revenue to GOV		Revenue to HH	
	Rest of China	Foreign	Rest of China	Foreign	Rest of China	Foreign	Rest of China	Foreign
Anhui	-1.2	-0.4	-1.5	-0.9	-1.8	-1.5	-1.7	-1.1
Beijing	-2.5	-1.5	-3.7	0.1	-4.0	-0.6	-4.3	-0.7
Chongqing	-0.7	-0.6	0.0	-0.2	-0.9	-1.1	-0.6	-0.6
Fujian	-0.5	-0.5	-0.5	-0.2	-1.1	-0.7	-0.8	-0.4
Gansu	-1.0	-0.3	-0.8	0.5	-1.1	-0.6	-0.9	-0.2
Guangdong	-0.3	-0.7	0.2	-0.5	-0.2	-1.0	0.1	-0.8
Guangxi	-0.4	-1.3	-0.3	-0.7	-0.9	-1.5	-0.5	-1.1
Guizhou	-0.6	-0.3	-0.4	-2.7	-0.7	-3.3	-0.4	-2.8
Hainan	-0.5	-1.1	0.0	-0.1	-0.3	-1.1	-0.1	-0.8
Hebei	-2.0	-0.2	-1.7	-0.7	-2.1	-1.0	-2.0	-0.9
Heilongjiang	-0.9	-0.8	-0.9	-1.3	-1.3	-1.8	-1.0	-1.6
Henan	-0.6	-0.5	-0.4	-0.4	-0.8	-1.0	-0.5	-0.7
Hubei	-0.4	-1.0	-0.3	-0.3	-0.8	-0.8	-0.5	-0.4
Hunan	-0.7	-0.4	-0.2	0.2	-0.8	-0.5	-0.5	0.0
Jiangsu	-1.7	-0.5	-2.1	-0.1	-2.3	-0.6	-2.3	-0.3
Jiangxi	-0.8	-0.2	0.0	-0.1	-1.0	-0.6	-0.7	-0.2
Jilin	-0.8	-0.5	-0.5	-0.8	-1.1	-1.4	-0.8	-1.0
Liaoning	-1.8	-0.5	-1.3	0.0	-1.9	-0.9	-1.6	-0.5
Neimenggu	-0.9	-1.2	-0.6	-1.7	-1.0	-1.0	-0.7	-1.6
Ningxia	-3.1	-0.4	-3.7	-1.4	-4.2	-2.1	-3.8	-1.5
Qinghai	-3.3	-1.9	3.8	2.9	-1.9	-1.6	-1.9	-1.5
Shaanxi	-1.0	-1.0	0.0	-0.6	-0.4	-1.2	-0.4	-0.8
Shandong	-2.2	-0.9	-1.5	-0.6	-2.3	-1.3	-2.2	-1.2
Shanghai	-1.0	-0.7	-1.3	-0.5	-1.7	-1.2	-1.8	-1.1
Shanxi	-0.9	-0.7	0.2	-1.4	-0.5	-1.9	-0.1	-1.5
Sichuan	-0.9	-0.4	-0.6	-0.2	-1.1	-0.9	-0.7	-0.5
Tianjin	-2.1	-0.8	-1.8	-0.7	-2.4	-1.2	-2.4	-1.1
Xinjiang	-0.7	-0.5	-0.4	-0.6	-0.9	-1.5	-0.6	-1.1
Xizang	-0.6	-0.6	0.2	0.0	-0.6	-0.7	-0.2	-0.2
Yunnan	-0.5	-0.8	-0.2	-0.6	-0.8	-1.5	-0.4	-1.0
Zhejiang	-0.8	-0.6	-0.7	-0.4	-1.2	-0.9	-1.0	-0.7
China	-	-0.8	-	-0.3	-	-1.0	-	-0.8

IMPACTS ON INTER-PROVINCIAL AND INTERNATIONAL TRADE IN 2030 (%) - EXPORT

Province	Grandfathering				Auctioning			
	Emission-based		Output-based		Revenue to GOV		Revenue to HH	
	Rest of China	Foreign	Rest of China	Foreign	Rest of China	Foreign	Rest of China	Foreign
Anhui	-0.8	-1.2	-2.2	-6.1	-2.6	-6.5	-2.5	-6.6
Beijing	-3.7	-6.0	-0.6	-7.6	-2.4	-10.0	-2.3	-10.0
Chongqing	-0.5	-0.4	0.6	1.9	0.5	2.1	0.7	2.3
Fujian	0.1	0.3	0.7	0.5	0.6	0.8	0.8	0.9
Gansu	-0.6	-0.5	-0.2	-5.9	-0.7	-5.7	-0.5	-5.7
Guangdong	-0.3	0.0	-0.2	-0.4	-0.8	-0.7	-0.5	-0.7
Guangxi	-0.1	-0.3	0.5	0.4	0.2	0.2	0.5	0.4
Guizhou	-1.5	-0.5	-5.4	-5.9	-4.9	-5.6	-4.9	-5.6
Hainan	-0.9	-2.0	0.5	-9.3	-0.1	4.9	0.1	4.9
Hebei	-0.4	-0.8	-2.2	-6.3	-2.6	-6.8	-2.4	-6.7
Heilongjiang	-1.4	-1.2	-1.9	-4.9	-1.6	-4.5	-1.4	-4.5
Henan	-0.4	-0.6	-0.3	-1.9	-0.5	-1.9	-0.3	-1.7
Hubei	-0.1	-0.4	-0.5	-2.8	-0.3	-1.8	0.0	-1.7
Hunan	-0.2	-0.5	-1.4	-5.3	-1.2	-4.7	-1.0	-4.5
Jiangsu	-0.6	-1.1	-0.1	-0.2	-0.6	-0.9	-0.3	-0.5
Jiangxi	-1.3	-3.1	0.5	-2.8	-0.8	-4.8	-0.5	-4.5
Jilin	-0.6	-1.2	-0.8	-2.1	-1.2	-2.2	-0.9	-2.0
Liaoning	-0.4	-0.6	0.6	0.4	0.1	-0.6	0.4	-0.4
Neimenggu	-2.6	-0.3	-4.5	-4.7	-4.2	-3.2	-4.0	-3.7
Ningxia	-3.0	-0.5	-5.5	-9.4	-6.1	-10.0	-5.9	-10.0
Qinghai	-2.2	-4.4	4.0	7.7	1.2	-2.5	1.5	-3.2
Shaanxi	-3.0	-0.1	-2.3	-1.2	-2.3	-1.7	-2.2	-1.6
Shandong	-1.6	-3.0	-1.1	-3.9	-2.5	-7.0	-2.3	-6.9
Shanghai	-0.5	-0.8	-0.4	-1.9	-1.1	-3.5	-1.1	-3.4
Shanxi	-5.8	-1.8	-10.0	-2.6	-9.5	-7.3	-9.5	-7.3
Sichuan	-0.6	-0.6	-1.0	-2.3	-0.8	-2.0	-0.6	-1.8
Tianjin	-1.7	-1.0	-2.1	-1.4	-2.7	-2.2	-2.6	-2.1
Xinjiang	-2.0	-0.2	-1.0	-2.7	-1.4	-2.4	-1.2	-2.4
Xizang	-0.9	-0.1	1.8	1.7	1.3	1.5	1.6	1.8
Yunnan	-0.4	-0.4	-0.1	-2.1	-0.1	-1.8	0.0	-1.7
Zhejiang	-0.5	-0.6	-0.4	-0.6	-0.9	-1.4	-0.7	-1.4
China	-	-3.5	-	1.5	-	-3.6	-	-3.6

CONCLUSIONS

❖ China would require to reduce about 13% of its CO_2 emissions from the baseline in 2030 to meet its NDC targets. It would cause 0.3% to 0.5% reduction of GDP in 2030 depending on the criteria to allocate emission allowances.

❖ Provincial GDP impacts widely vary depending upon economic structures and energy supply systems.

❖ For some provinces, the ETS provides an opportunity to increase their economic outputs (e.g., Fujian, Guangdong, Guangxi, Liaoning) under all schemes of allowances allocation/distribution.

❖ Provincial economies of Neimenggu, Ningxia, Shanxi and Shaanxi that highly rely on the coal mining sector and coal-intensive manufacturing sectors (electricity, non-metallic minerals, metals) would face relatively higher economic loss under all schemes of allowances allocation considered.

CONCLUSIONS

❖ **Allowances allocation rules change not only the magnitude of the impacts but also their direction.**

❖ **Detailed results show that fossil fuel sectors of some provinces would face a deep decline in their outputs. Coal sector outputs, for example, drop more than 20% in several provinces under all allowances distribution rules.**

❖ **The ETS also significantly affects the interprovincial and international trade of goods and services in China. While the ETS would have negative effects on trade of goods and services at the national level, some provinces experience increase in trade depending on the schemes to allocate emission allowances.**

THANK YOU FOR YOUR ATTENTION!

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