China's Nationwide CO_2 Emissions Trading System: A General Equilibrium Assessment

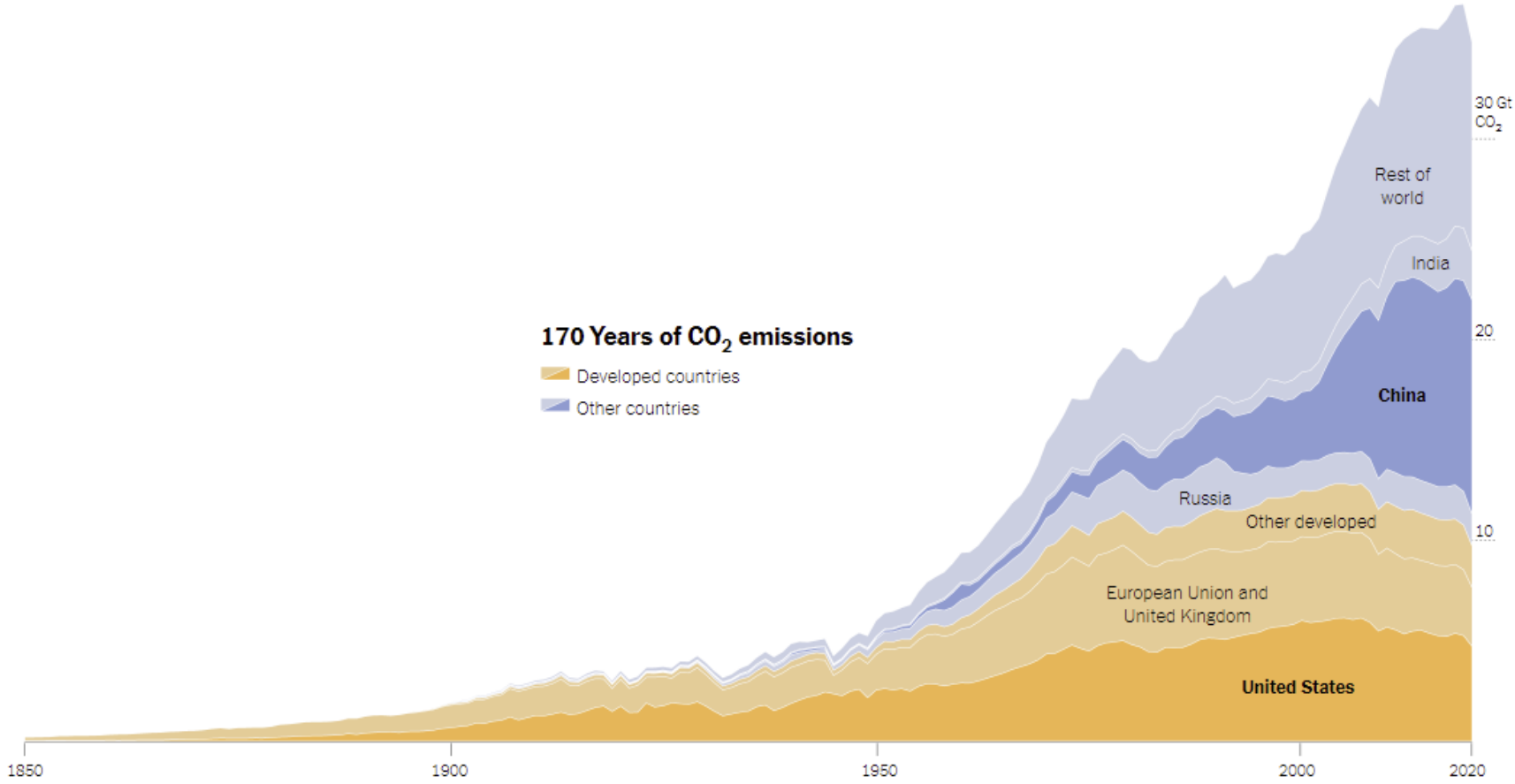
Lawrence H. Goulder
Stanford University, NBER, and Resources for the Future

Xianling Long
National School of Development, Peking University

Chenfei Qu
Institute of Energy, Environment and Economy, Tsinghua University

Da Zhang
Institute of Energy, Environment and Economy, Tsinghua University

NBER Environmental and Energy Economics
Program Meeting
March 2023



Source: Global Carbon Project

Emerging Nationwide CO_2 Emissions Trading System

- Supplants eight municipal or provincial pilot programs
- Already the largest in the world; expected to more than double the CO_2 covered by emissions pricing worldwide
- Expected to contribute to about half of the CO_2 reductions needed to meet China's 2060 net zero pledge
- This paper:

  We employ a multi-period general equilibrium model to assess this new venture's benefits and costs, in the aggregate and across sectors and provinces, and under a range of alternative specific policy designs.

The System: A Tradable Performance Standard (TPS)

- A rate-based (emissions-intensity-based) system (cf. cap and trade)
- Sector coverage:
  - **First phase** (2021-2023): Electricity sector only
  - **Second Phase** (2023-2026): Cement, aluminum, and iron&steel added
  - **Third Phase** (2026-): Pulp & paper, non-metal products, refined petroleum, and chemicals added
- Includes provisions for emissions allowance trading across all provinces and all covered sectors

The System: A Tradable Performance Standard (TPS)

	Covered Facility's Allowance Allocation	*Aggregate Cap*
C&T	Exogenous	Set *ex ante* by regulator
TPS	Endogenous	Determined by market

*A facility's allowance allocation is β*q*
where β is the intensity standard (or "benchmark") and q is output

This is an implicit subsidy to output (Fischer, 2001),
which compromises cost-effectiveness relative to C&T

Examples of Intensity Standards

Output-oriented (ceilings):

- China's Tradable Performance Standard — *Pizer and Zhang, 2018; Karplus and Zhang, 2017; Wang et al., 2022*
- Obama's Clean Power Plan — *Fowlie et al ., 2014; Bushnell et al. , 2017; Kotchen et al., 2022*
- US CAFE standards — *Davis and Knittel, 2019; Jacobsen et al., forthcoming*
- Sector-level performance standards — *Fischer et al., 2017; Dimanchev and Knittel, 2020*

Input-oriented (floors):

- Low-Carbon Fuel Standard (CA, OR) — *Holland et al, 2009; Stock, 2018*
- Renewable Portfolio Standards (29 US states) — *Bento et al., 2020*
- Proposed US Clean Electricity Standard — *Goulder et al., 2016; Borenstein and Kellogg, 2022*

Limitations and Attractions of TPS Relative to C&T

- Limitations
  - Less cost-effective (implicit output subsidy)
  - Uncertainty about emissions reductions (endogenous allowance allocation)

- Attractions
  - Lower output price (implicit output subsidy) -> less emissions leakage
  - Automatic adjustment of stringency to economy's overall booms and busts

The Model

- Multi-Sector General Equilibrium
- Multi-Period (2020-2035)
- Heterogeneity within Sectors
- Institutional Features
  - Fixed and market prices
  - Existing taxes

	Sectors		
Phase 1	Electricity		
Phase 2	Cement	Aluminum	Iron & Steel
Phase 3	Pulp & Paper	Petroleum refining	Raw chemicals
	Other non-ferrous metals	Other non-metal products	
Other sectors	Agriculture	General equipment	
	Mining	Transport equipment	
	Food	Electronic equipment	
	Textile	Other manufacturing	
	Clothing	Water	
	Log furniture	Construction	
	Printing & Stationery	Transport	
	Daily chemicals	Services	
	Metal products	Coal	
	Gas distribution	Crude oil	
	Heat	Natural gas	

Data

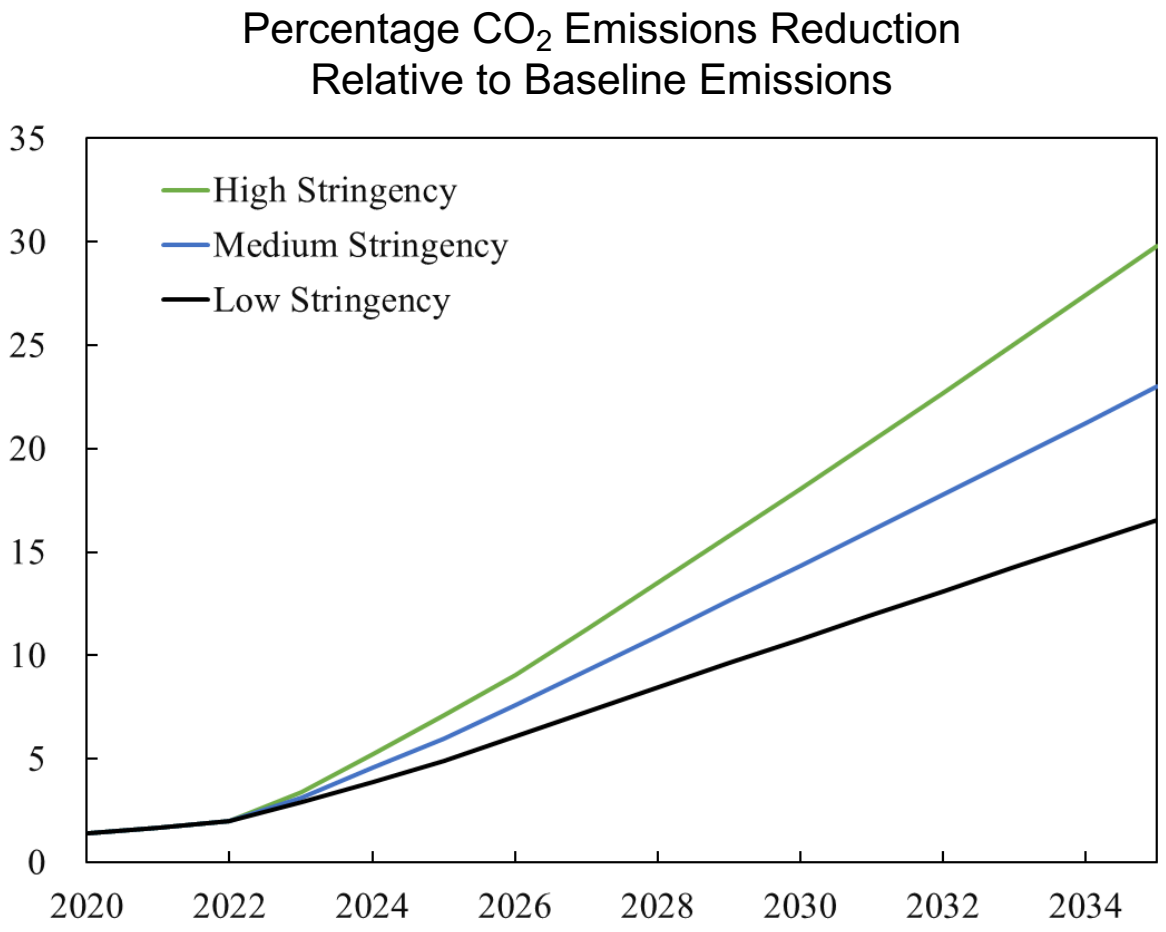
- Sector-level data
  - Production, consumption and investment: input-output table (National Bureau of Statistics, 2018)
  - CO_2 emissions: energy balance table (National Bureau of Statistics, 2018)
  - Existing taxes and subsidies: GTAP 10 dataset

- Subsector-level data
  - Firm-level dataset for electricity, cement, aluminum, iron & steel (Ministry of Ecology and Environment)

Questions Addressed

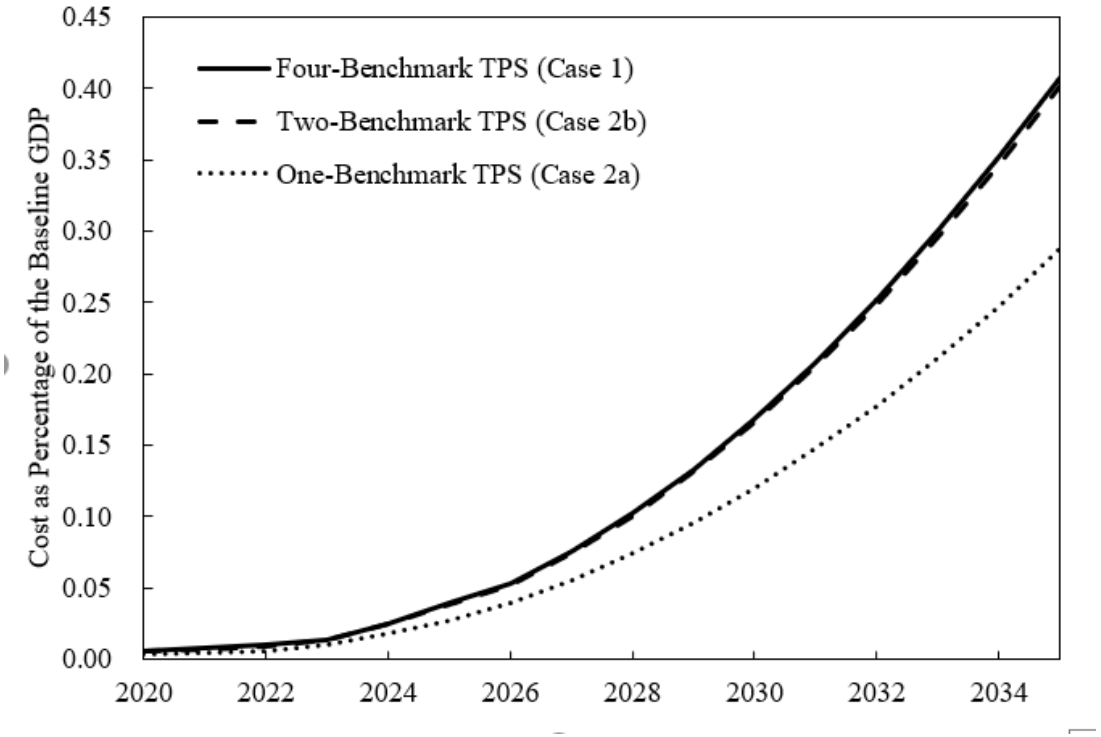
- How can the system be designed to minimize aggregate costs per ton abated?
- How are the TPS's costs distributed across sectors, regions, and time?
- Do the TPS's benefits exceed its costs?
- How do costs compare with those of an equally stringent cap-and-trade system?
- What's ahead?

Emission Reductions



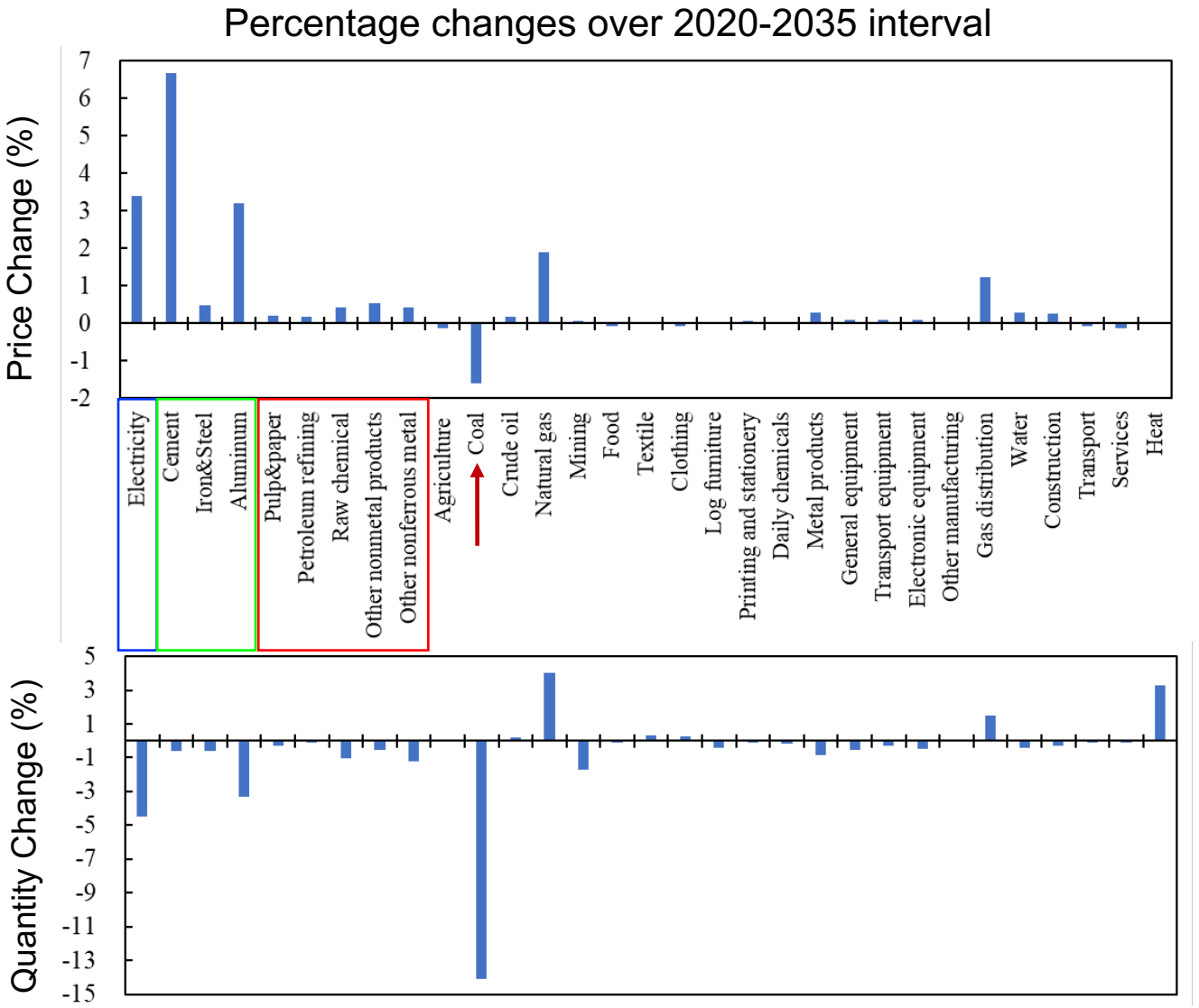
How can the system be designed to minimize costs per ton abated?

Percentage Loss of GDP



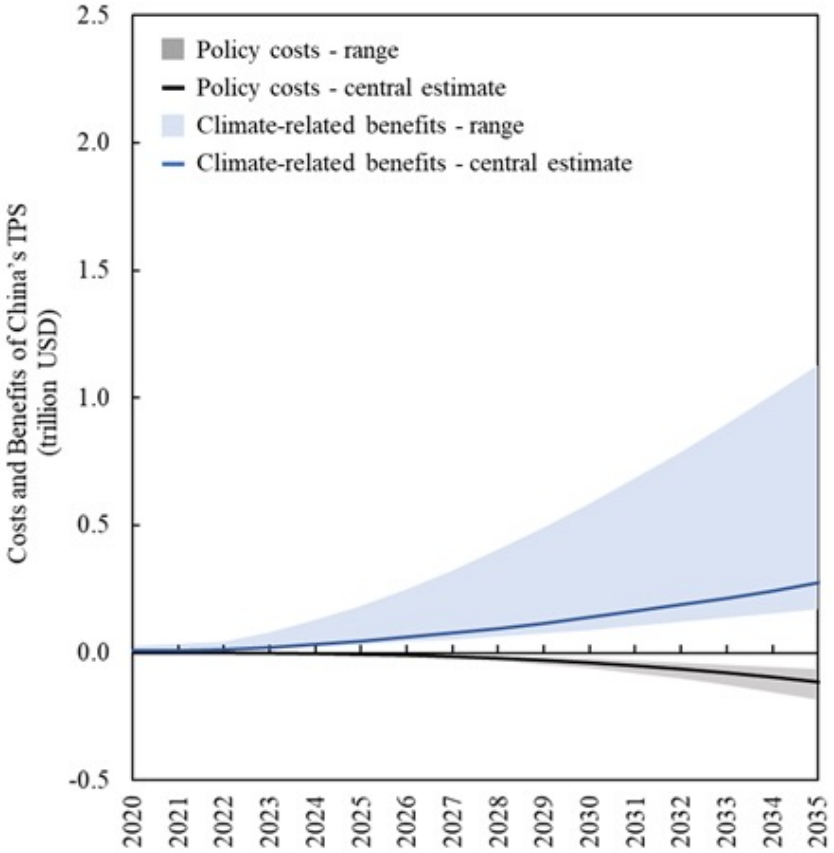
Trade-off: The most cost-effective TPS is one with a single benchmark.
But using varying (multiple) benchmarks can help address distributional goals.

How are the TPS's costs distributed across sectors?

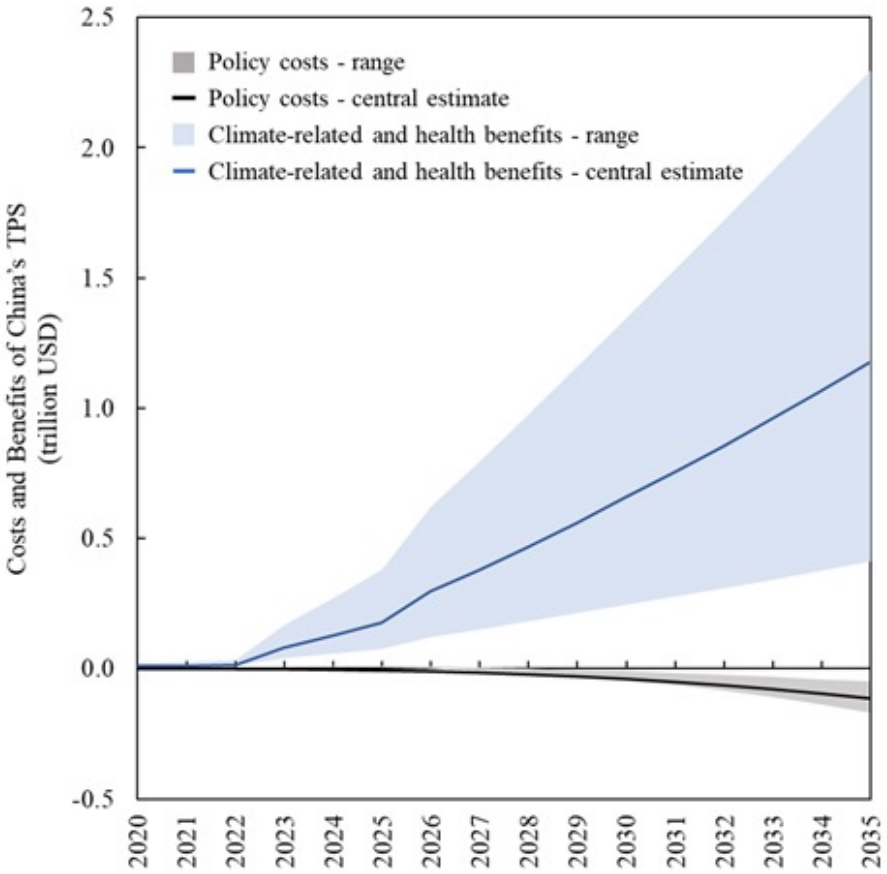


Do the TPS's benefits exceed the costs?

Excluding air quality benefits

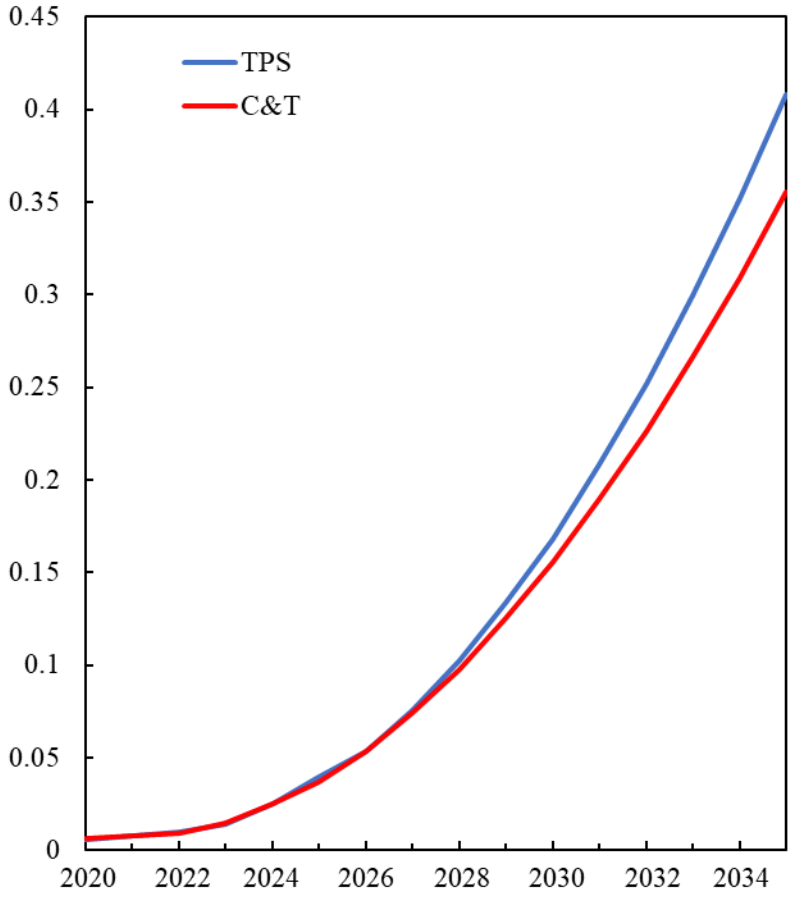


Including air quality benefits

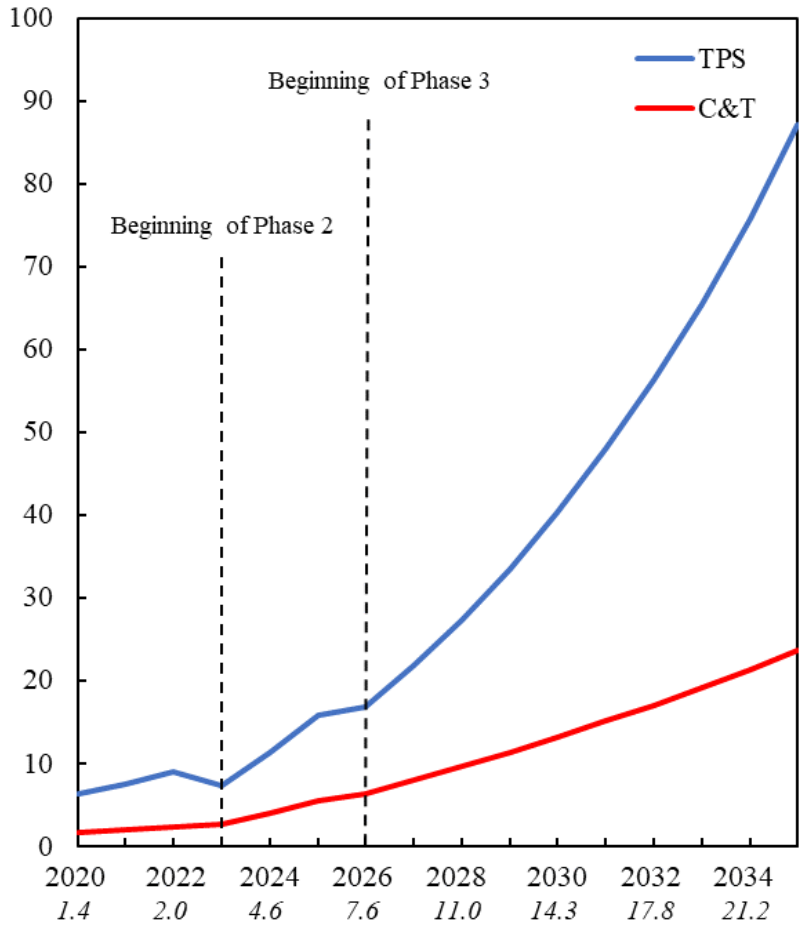


How do costs compare with those of an equally stringent cap-and-trade system?

TPS and C&T Costs
as Percentage of Baseline GDP



Allowance Prices
in 2020 US dollars
percentage emissions reductions in italics



Lingering Policy Issues

- Should some of the allowances be introduced via an auction?
- Should China eventually transition from the TPS to a cap-and-trade program?

Questions Addressed

- How can the system be designed to minimize aggregate costs per ton abated?
- How are the TPS's costs distributed across sectors, regions, and time?
- Do the TPS's benefits exceed its costs?
- How do costs compare with those of an equally stringent cap-and-trade system?
- What's ahead?