

Impacts of China's Emissions Trading Scheme on the National and Hong Kong Economies: A Dynamic CGE Analysis

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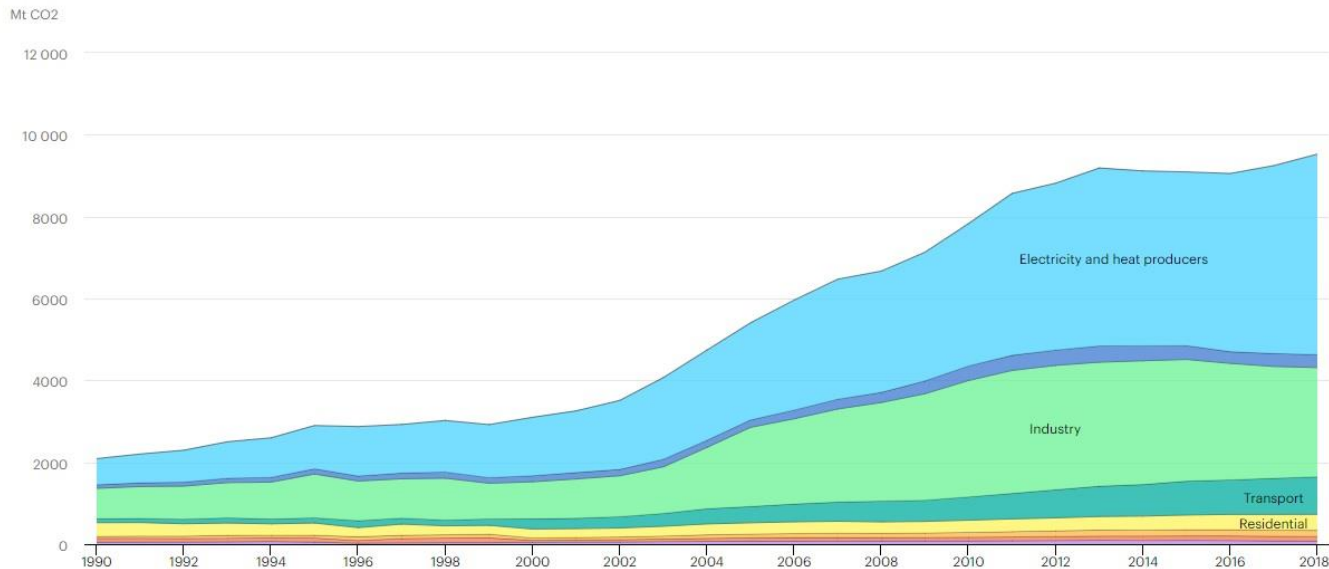
Outline

- Background
- Research Question
- Method and Data
- Key Findings
- Implications

Research Area



Emissions Profile (Mainland)



Key contributors (2018)

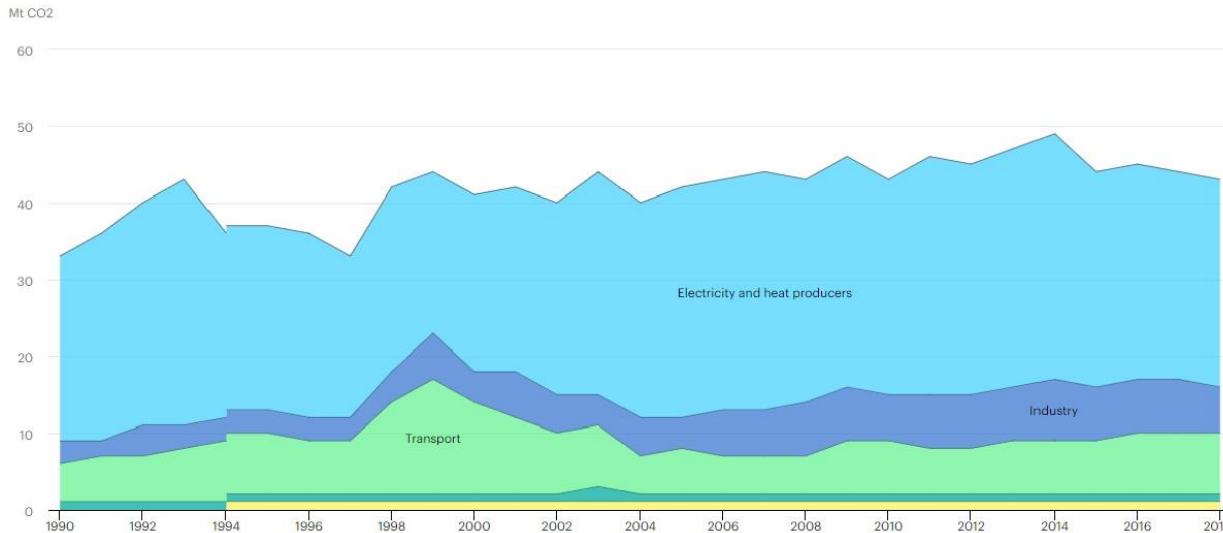
Electricity and heat producers: 51.4%

Industry: 28%

Transport: 9.6%

Source: International Energy Agency (2018)
<https://www.iea.org/countries/china>

Emissions Profile (Hong Kong)



Key contributors (2018)

Electricity and heat producers: 62.8%

Transport: 18.6%

Industry: 14%

Source: International Energy Agency (2018)

<https://www.iea.org/countries/hong-kong>

Governments' Initiatives to Climate Change

- National Commitment
 - 60-65% carbon intensity (carbon emissions per unit GDP) reduction by 2030 relative to 2005 level
 - Carbon neutral by 2060
- Hong Kong's Pledge
 - 65-70% carbon intensity reduction by 2030 relative to 2005 level
 - i.e. 26-36% absolute reduction and a reduction to 3.3-3.8 tonnes per capita
- Hong Kong's target is **stricter**

Regional and National Emissions Trading Scheme

- Eight pilot carbon markets: 2013-2016 (three provinces and five cities) across the Mainland
- National ETS: launched in 2017, **in force** since January 2021
- **Focused sector and Greenhouse Gas: Power including combined heat and power, as well as captive power plants of other sectors which emit more than 26,000 t CO₂ per year**
- Hong Kong: **no ETS**, but seek cross-border mitigation collaboration with the Mainland actively

Research Questions

- What does China's proposed carbon mitigation targets mean to both Mainland China and Hong Kong's economy assuming they operate independent carbon market?
- How does Hong Kong's full integration into China's national ETS affect local regulatory costs and their distribution?

Data

- Economic data (Social Accounting Matrix):
 - Global Trade Analysis Project (GTAP9-Power)
- National emission:
 - MEIC (<http://www.meicmodel.org/>)
 - GAINS
(<https://iiasa.ac.at/web/home/research/researchPrograms/air/GAINS.html>)
 - IEA (<https://www.iea.org/>)
- Hong Kong's emission:
 - The Environment Bureau Hong Kong
- Dynamic: 2011-2030

Method

Dynamic multi-region, multi-sector CGE model, including aggregated 6 regions and 16 sectors

Region	Description
CHN	China, excluding Hong Kong and Macau
HKG	Hong Kong
MAC	Macau
JPN	Japan
KOR	South Korea
ROW	Rest of the World

8 electricity
sectors

Sector	Description
AGR	Primary industry
MAN	Secondary industry, excluding energy production sectors
TRN	Transport services
SER	Tertiary industry, excluding transportation services
COA	Coal mining
CRU	Crude oil extraction
REFINE	Oil refinery
GASS	Natural gas production
EOA	Power generation from coal
EOIL	Power generation from oil
EGAS	Power generation from natural gas
EHYD	Power generation from hydro
ENUC	Power generation from nuclear
ESOL	Power generation from solar
EWIND	Power generation from wind
EOTH	Power generation from other technologies

4 energy
sectors

Scenarios

<i>Scenario</i>	<i>Binding Emission Cap</i>	<i>Mitigation Targets for 2030</i>	<i>ETS Operation</i>	<i>Nature of ETS</i>
BAU	Not Imposed*	N/A	No	N/A
PARIS	Imposed	65% intensity reduction (vs. 2005)	Yes	Independent#
PARIS_INT	Imposed	65% intensity reduction (vs. 2005)	Yes	Integrated*
IPCC	Imposed	45% emission reduction (vs. 2010)	Yes	Independent
IPCC_INT	Imposed	45% emission reduction (vs. 2010)	Yes	Integrated

Note: * We treat carbon price as a shadow price, it is zero under the BAU

Mainland China and HK each operate an independent ETS with a unique carbon price

* Mainland China and HK share a single carbon price in each year.

PARIS: translate the “keep global temperature rise below 2 Celsius” set by Paris Agreement into yearly reduction target by region

IPCC: translate the “keep global temperature rise below 1.5 Celsius degree” set by IPCC into yearly reduction target by region

Key Results - GDP

	Mainland China					Hong Kong				
	PARIS		PARIS_INT		Difference (%) [†]	PARIS		PARIS_INT		Difference (%) [†]
	US\$bn	%*	US\$bn	%*		US\$bn	%*	US\$bn	%*	
2021	16.5	0.1	16.6	0.1	0.6	0.3	0.1	0.1	0.0	-66.7
2022	22.1	0.1	22.2	0.1	0.5	0.4	0.2	0.2	0.1	-50.0
2023	23.4	0.1	23.5	0.2	0.4	0.8	0.3	0.2	0.1	-75.0
2024	26.1	0.2	26.2	0.2	0.4	1.2	0.4	0.3	0.1	-75.0
2025	37.5	0.2	37.6	0.2	0.3	1.8	0.6	0.4	0.1	-77.8
2026	50.9	0.3	51.0	0.3	0.2	2.6	0.9	0.6	0.2	-76.9
2027	68.9	0.4	68.9	0.4	0.0	3.6	1.2	0.8	0.3	-77.8
2028	92.7	0.5	92.4	0.5	-0.3	4.8	1.5	1.2	0.4	-75.0
2029	123.7	0.6	123.1	0.6	-0.5	6.4	2.0	1.7	0.5	-73.4
2030	164.1	0.7	163.0	0.7	-0.7	8.4	2.5	2.4	0.7	-71.4

GDP is measured in 2011 US\$bn, and % is the difference of GDP loss between simulated year and the base year 2011

Linking carbon market to Hong Kong does not affect the national economy too much;

	Mainland China					Hong Kong				
	IPCC		IPCC_INT		Difference (%) [†]	IPCC		IPCC_INT		Difference (%) [†]
	US\$bn	%*	US\$bn	%*		US\$bn	%*	US\$bn	%*	
2021	67.0	0.5	67.0	0.5	0.00	0.6	0.2	0.4	0.1	-33.3
2022	156.7	1.0	156.8	1.0	0.06	1.1	0.4	0.9	0.3	-18.2
2023	282.9	1.8	283.0	1.8	0.04	2.1	0.8	1.7	0.6	-19.0
2024	473.9	2.8	473.9	2.8	0.00	3.5	1.2	2.9	1.0	-17.1
2025	750.8	4.2	750.8	4.2	0.00	5.6	1.9	4.8	1.6	-14.3
2026	1,150.2	6.2	1,150.1	6.2	-0.01	8.4	2.8	7.5	2.5	-10.7
2027	1,732.3	8.9	1,731.9	8.9	-0.02	12.3	4.0	11.4	3.6	-7.3
2028	2,567.7	12.6	2,567.0	12.6	-0.03	17.7	5.5	16.6	5.2	-6.2
2029	3,739.3	17.6	3,737.8	17.6	-0.04	24.8	7.6	23.5	7.2	-5.2
2030	5,317.6	23.9	5,314.9	23.9	-0.05	33.7	10.0	32.4	9.7	-3.9

Joint with national ETS benefits Hong Kong's economy in either scenario;

Both sides' GDP losses much under the stringent target (IPCC 1.5 Celsius degree)

Key Results – Carbon Price

Unit: 2011 US\$/tCO₂

	<i>Mainland China</i>		<i>Hong Kong</i>	
	PARIS	PARIS_INT	PARIS	PARIS_INT
2021	6.3	6.4	61.6	6.4
2022	8.4	8.4	80.9	8.4
2023	9.0	9.1	123.1	9.1
2024	10.2	10.3	172.3	10.3
2025	14.6	14.8	231.0	14.8
2026	19.9	20.2	300.4	20.2
2027	27.0	27.4	380.7	27.4
2028	36.6	37.1	477.3	37.1
2029	49.5	50.0	594.3	50.0
2030	67.1	67.8	737.6	67.8

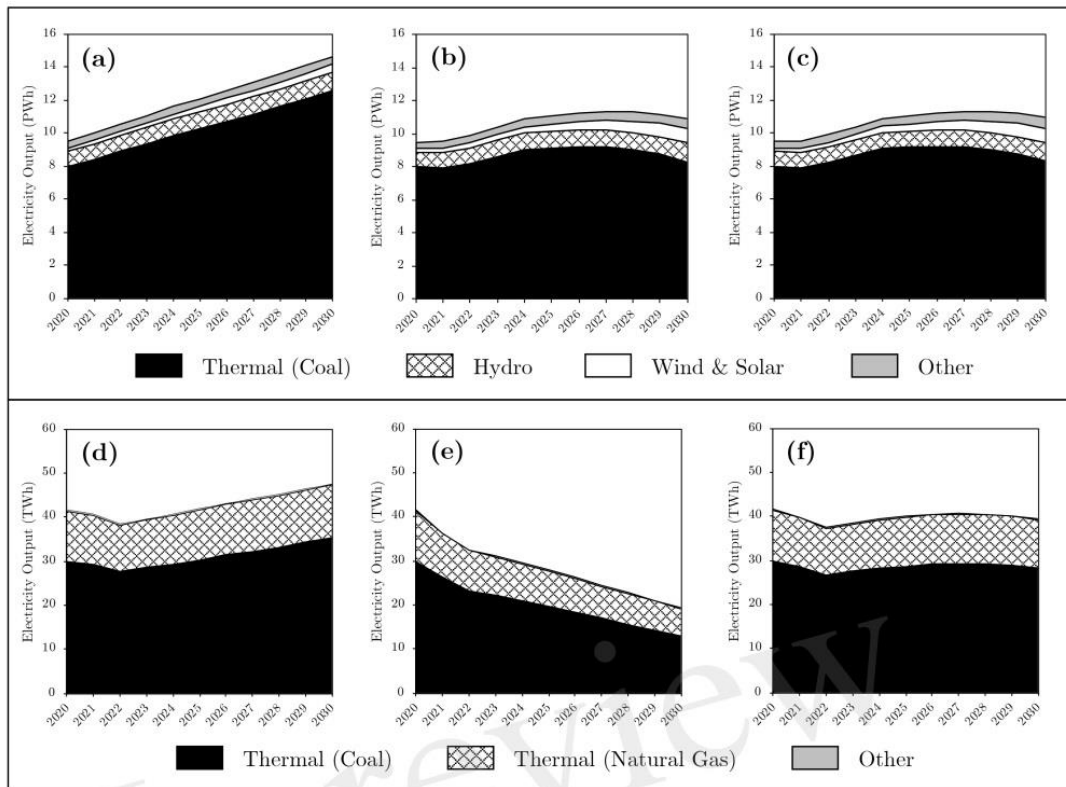
Unit: 2011 US\$/tCO₂

	<i>Mainland China</i>		<i>Hong Kong</i>	
	IPCC	IPCC_INT	IPCC	IPCC_INT
2021	23.7	23.8	81.5	23.8
2022	49.6	49.7	123.2	49.7
2023	84.4	84.6	196.9	84.6
2024	135.8	136.1	289.2	136.1
2025	210.6	211.1	409.9	211.1
2026	320.8	321.4	572.7	321.4
2027	484.3	485.1	795.8	485.1
2028	721.5	722.4	1,116.4	722.4
2029	1,060.1	1,061.4	1,580.6	1,061.4
2030	1,577.8	1,579.4	2,244.2	1,579.4

Improvement in carbon intensity in Mainland China is driven by high GDP growth, but HK has to cut absolute emissions to reduce intensity due to its lower GDP growth;

Carbon price increases by year because of the higher emission reduction rate. HK faces less compliance cost if it integrates to the national carbon market

Key Results – Energy Mix, PARIS



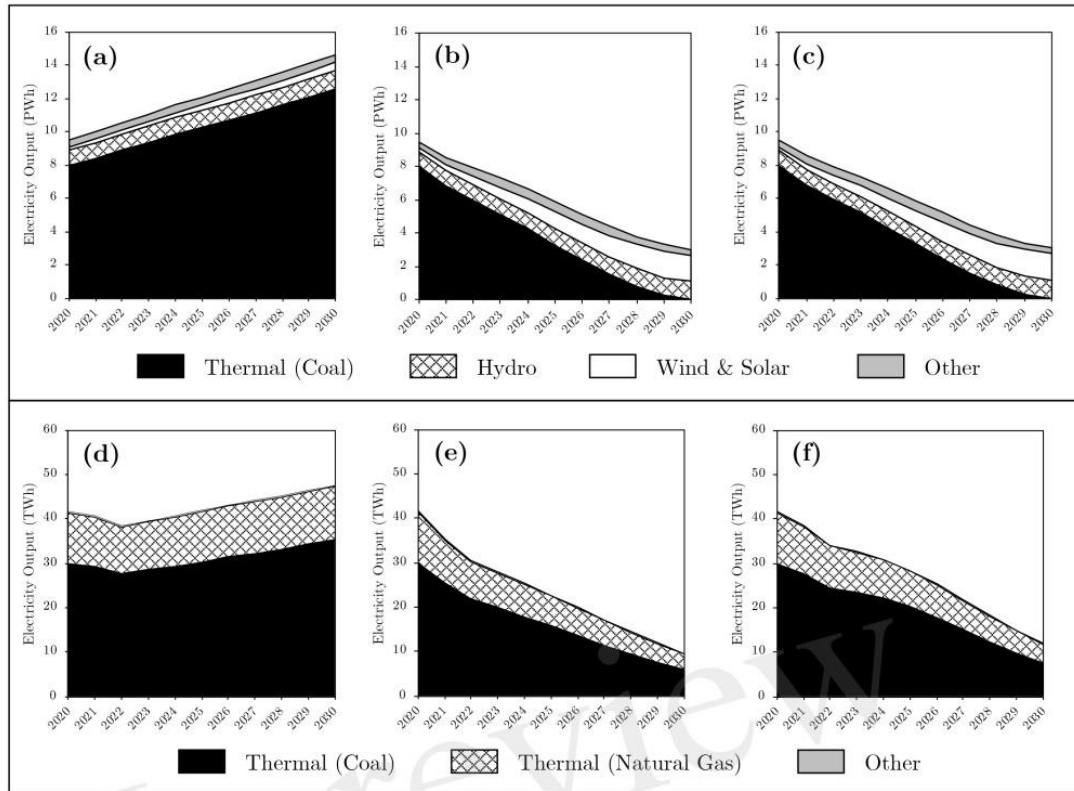
Local electricity output mix:

- (a) Mainland, BAU
- (b) Mainland, PARIS
- (c) Mainland, PARIS_INT
- (d) Hong Kong, BAU
- (e) Hong Kong, PARIS
- (f) Hong Kong, PARIS_INT

A decline in coal use but rise in clean energy;

Hong Kong is more sensitive to linking with national market, as seen in a rising output but lower emission cost

Key Results – Energy Mix, IPCC

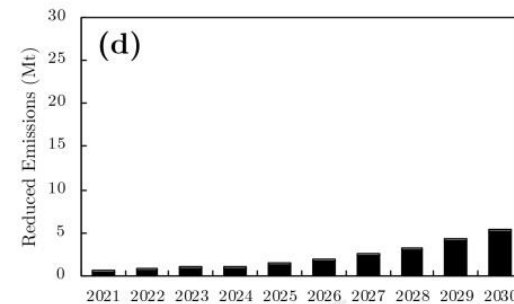
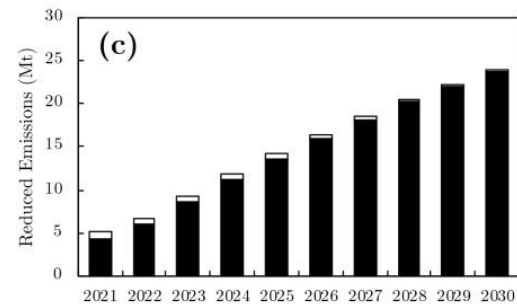
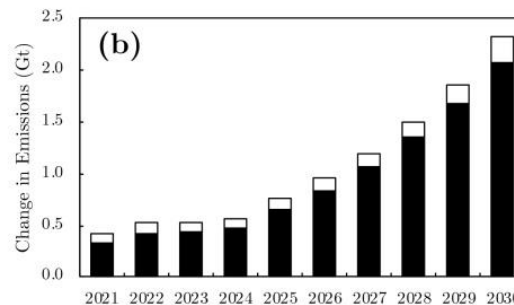
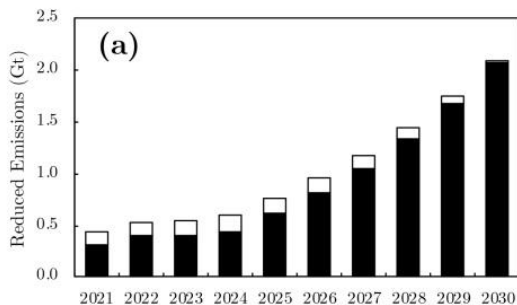


Local electricity output mix:

- (a) Mainland, BAU
- (b) Mainland, IPCC
- (c) Mainland, IPCC_INT
- (d) Hong Kong, BAU
- (e) Hong Kong, IPCC
- (f) Hong Kong, IPCC_INT

A sharp decrease in coal use in both regions

Key Results – Mitigation, PARIS



Electricity Sector

Other Industries

Carbon mitigation under moderate PARIS mitigation scenarios:

(a) Mainland, PARIS

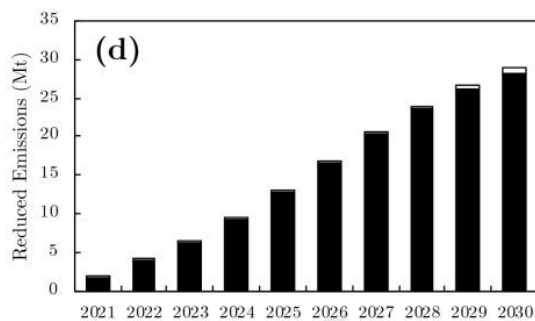
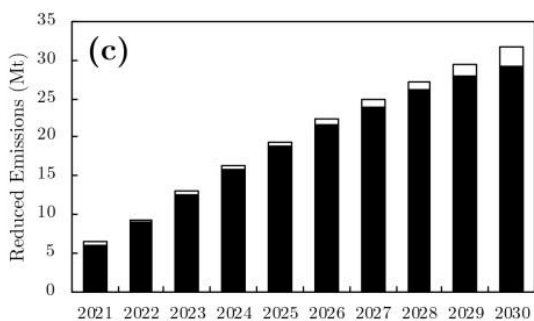
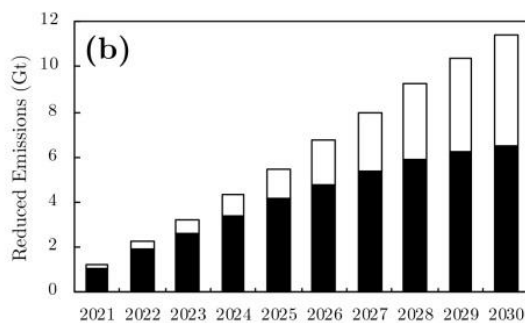
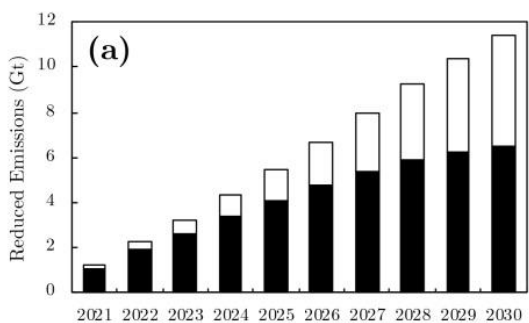
(b) Mainland, PARIS_INT

(c) Hong Kong, PARIS

(d) Hong Kong, PARIS_INT

With market integration, Hong Kong faces less stress as the company can buy carbon credit from the Mainland seller, to offset the local emissions

Key Results – Mitigation, IPCC



Electricity Sector

Other Industries

Carbon mitigation under stringent IPCC mitigation scenarios:

(a) Mainland, IPCC

(b) Mainland, IPCC_INT

(c) Hong Kong, IPCC

(d) Hong Kong, IPCC_INT

Implications

- Hong Kong's participation in China's national ETS will bring substantial efficiency improvement to Hong Kong without burdening the national economy;
- Hong Kong needs to be more actively in seeking for carbon market integration

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