Fleet Restructuring and Capacity Reduction under the Fishery Subsidy Reform of China

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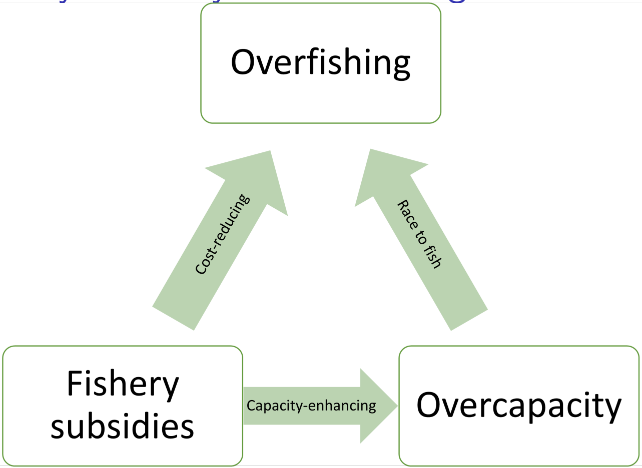
Fleet capacity & fishery subsidies are global issues



- Overcapacity is common for fisheries not rights-based
- Physical Measures of capacity: vessel count/power/tonnage
- Eliminating harmful subsidies: a task unfinished

Motivation

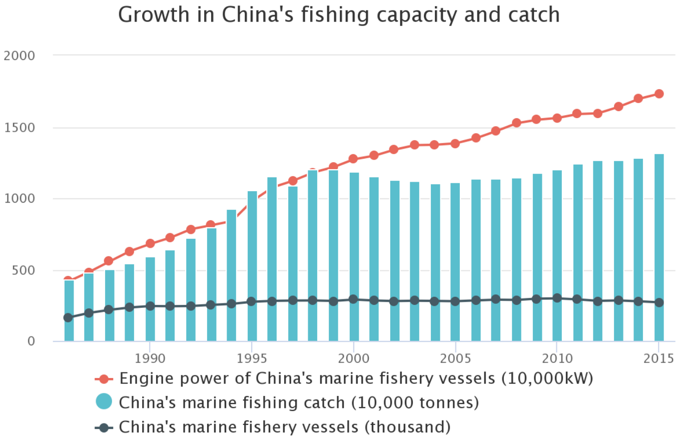
- Cost-benefit: Fishery subsidy reform
  - Valid Reform Costs: social & political
  - Unclear Benefits: capacity reduction?
- China's marine fishery management
  - Largest fleet, few empirical research
  - Changing for sustainability?
- The first micro-level empirical study on both fields

Outline

- Part I: Policy and Data background
- Part II: Empirical investigation
- Part III: Mechanism (conceptualizing)

Input control policies: fail till 2015

- Double-control target: Count & Power
- Entry control: Power quota & Licensing system
- Exit stimulus: Vessel buyback program



Fuel subsidy program in conflict with input control

- The fuel subsidy program (2006-2015)
  - Aimed to accompany the fuel price deregulation in 2006
  - Payment = engine power $\times$ F(yearly fuel price)
  - $\Longrightarrow$ a major income support for fishers
- Unexpected consequences:
  - Supporting unproductive and ill-maintained vessels
  - Stimulating the entry and the consolidation
  - Capitalized subsidy $\Longrightarrow$ Quota price ($<$500 $\rightarrow$ $>$8000/kW) $>$ Buyback price (2500/kW) $\Longrightarrow$ Few buybacks

Policy background: the 2016 fishery subsidy reform

- The fuel subsidy reform (2016-2020)
  - Aim: 1. Reduce capacity 2. Optimize structure
  - Introduce Length and Power thresholds $\rightarrow$ 12 vessel classes
  - Fix baseline payments of each class $\rightarrow$ Avg. level for 2015
  - 18% annual reduction in subsidy payments

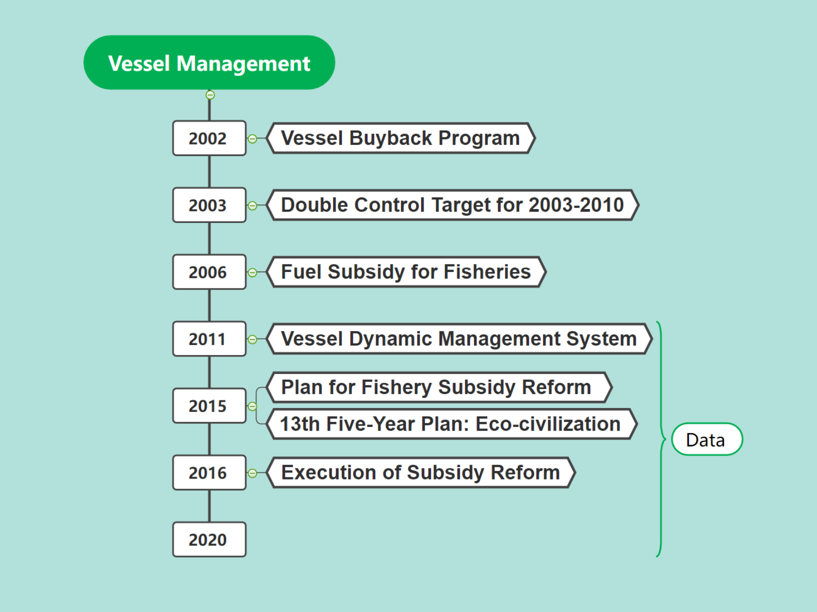
Pre-reform Years	2012	2013	2014	2015
Trawl (10kRMB/200kW)	33.63	36.61	35.48	32.17

Post-reform Years		2016		2017		2018		2019	
Trawl (10kRMB/Vessel)		Double	Others	Double	Others	Double	Others	Double	Others
24m$\leq$L$<$30m	P$\geq$130kW	18.00	23.21	14.76	19.04	12.11	15.61	9.93	12.80
30m$\leq$L$<$35m	P$\geq$180kW	24.64	29.85	20.20	24.48	16.57	20.07	13.58	16.46
35m$\leq$L$<$40m	P$\geq$220kW	30.32	38.69	24.86	31.73	20.39	26.02	16.72	21.33
40m$\leq$L$<$45m	P$\geq$250kW	34.11	43.11	27.97	35.35	22.94	28.99	18.81	23.77

2016 fishery subsidy reform: other policies

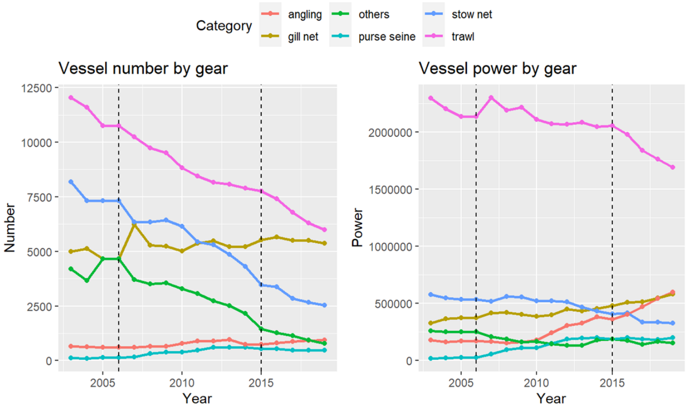
- The fuel subsidy reform: other designs
  - Harsher $\downarrow$ on harmful fishing gears
  - For new vessels: subsidy $\leq$ subsidy for retired vessels
  - Competitive buyback price $\uparrow$ (2500 $\rightarrow$7000/kW)
  - Support building standardized vessels
- Accompanied entry restriction:
  - No new double-otter trawlers (2017) and all trawlers (2019)
  - No quota from small vessels ($\leq$ 12m) into larger vessels

Policy background: reform timeline



Trawling fleet in Zhejiang: boom and bust

- 1986~1996: Fast growth $\Longleftarrow$ Unrivalled fishing efficiency
- 1997~2006: Stagnant $\Longleftarrow$ Recessing resource & high fuel cost
- 2007~2014: New wave $\Longleftarrow$ Profitable subsidy income
- 2015~Now: Reduction $\Longleftarrow$ Subsidy reduction & entry control



Empirical question

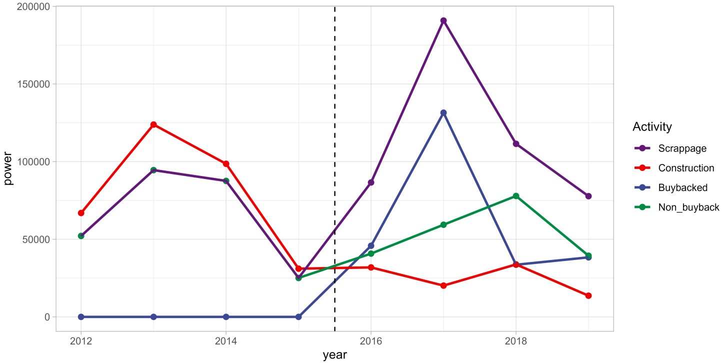
Does China's fuel subsidy reform

1. reduce the fleet capacity? 2. change the fleet structure?

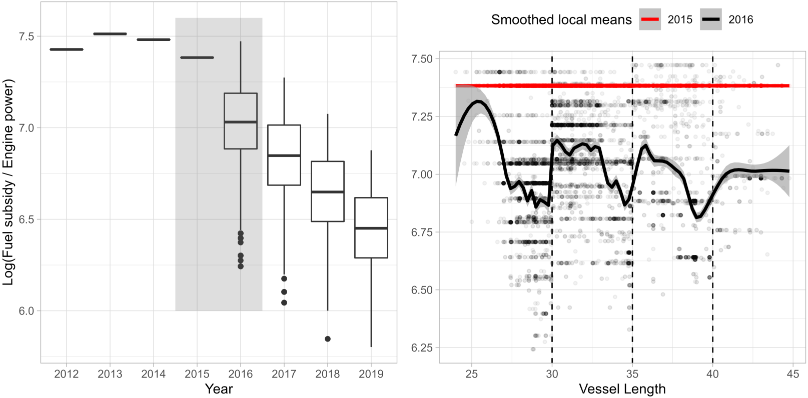
- Scrappage
- Buyback

Dataset: Vessel Dynamic Management System

- 9241 trawlers from 2012 to 2019
- Over 95% coverage comparing to yearbook
- Construction $\downarrow$, Scrappage $\uparrow$,
- Buyback out of total scrapped: 0 $\rightarrow \sim$ 50%



Exogenous variations in Fuel Subsidy Standard (RMB/kW)



- Predetermined reform exposure:

$$\Delta_i^{base} := \log\left(\frac{\bar{s}_i^{post}}{\bar{s}_i^{pre}}\right) = G(Power_i, Length_i, Gear_i)$$

Event study: comparing across reform exposure

- DiD with a continuous treatment:

$$y_{it} = \beta \Delta_i^{base} I_t^{Post} + \lambda_{a_{it}} + c_i + \gamma_t + \nu_t \mathbf{X}_i + u_{it}$$

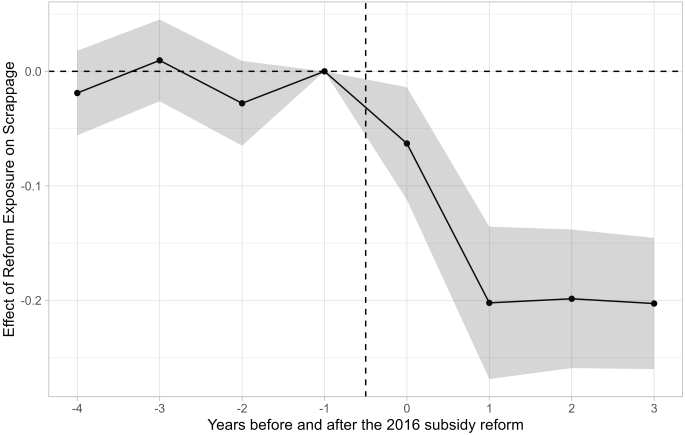
- Feature-specific common trends: $\nu_t \mathbf{X}_i$
- Age fixed effects: $\lambda_{a_{it}}$
- ATT of post-reform fuel subsidy on scrappage hazard

$$\beta = \frac{\partial h_{it}^{post}}{\partial \log(\bar{s}_i^{post})}$$

Semi-elasticity: h_{it} changes β % pts for 1% $\uparrow$ in $\bar{s}_i^{post}$

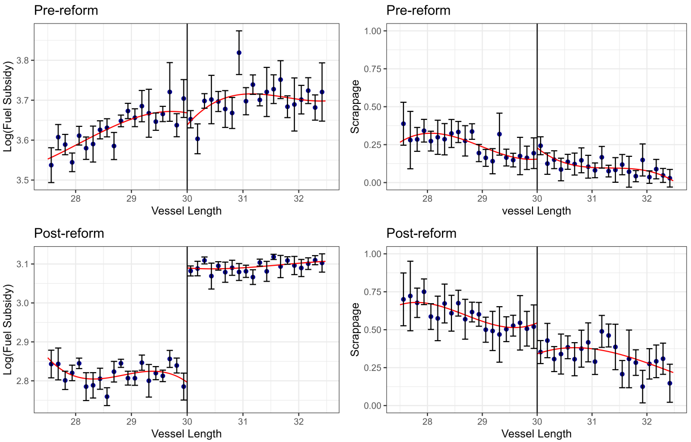
Event study: parallel trend

- DiD estimate: $\hat{\beta} = -0.153^{***}$ ($se = 0.0185$)



RD-DD: LATE at the 30m cutoff

- First-stage: ~30% jump at 30m threshold after reform
- Economic significance: 36% ↑ in subsidy income ≈ 100% ↑ in harvest profit [Shen & Chen, 2022]
- 2SLS estimate: $\hat{\beta} = -0.158^{*}$ ($se = 0.072$)



Two-period DiD: Vessel scrappage and buyback

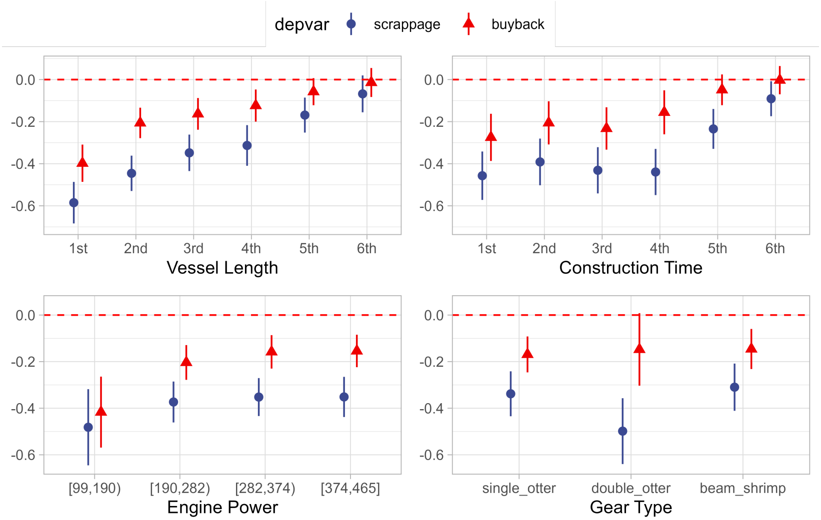
Table 1: Marginal Effect of Fuel Subsidy on Vessel Buyback

	(1) scrappage	(2) buyback	(3) scrappage	(4) buyback
β	-0.356***	-0.156***	-0.350***	-0.156***
	(0.0505)	(0.0345)	(0.0408)	(0.0350)
Vessel FE	No	No	Yes	Yes
R^2	0.260	0.241	0.509	0.303
Observations	14016	14016	14016	14016

Standard errors clustered at vessel level

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Heterogeneity: Larger shocks for trawlers shorter & older



Counterfactual: Crucial effect of buyback price

- CF1: Only Reforming Buyback Program
- CF2: No Reform

Period	Case	Fuel Subsidy	Buyback Price	Permit Price (RMB/kW)	Scrap Rate (%)	Buyback Rate (%)
Pre16	Obs	1724	2500	8000	15.4	0
Post16	Obs	880	7000	7000	30.2	16.4
Post16	CF1	1110	7000	7000*	19.4	9.7
Post16	CF2	1110	2500	5000*	[$\leq$ 19.4]	0

- *Permit value (inferred)= (Fisheries-level scarcity value + Coupled subsidy eligibility) / (Discount rate)

  *Permit price = Max(Permit value, Buyback price)

Key empirical findings

1. Reduced fleet capacity?
   - Fuel subsidy reduction $\Longrightarrow$ higher scrappage
     - Under risen buyback price: Subsidy reduction $\Longrightarrow$ 10% pts more exiting rate
   - Trawlers in 2016 subsidy reform: buyback $\uparrow$, capacity $\downarrow$
     - Risen buyback price $\Longrightarrow$ 10% pts more buyback rate
2. Shifted fleet structure?
   - Older, smaller, and double-otter trawlers: more sensitive to subsidy reduction

Concluding Remarks

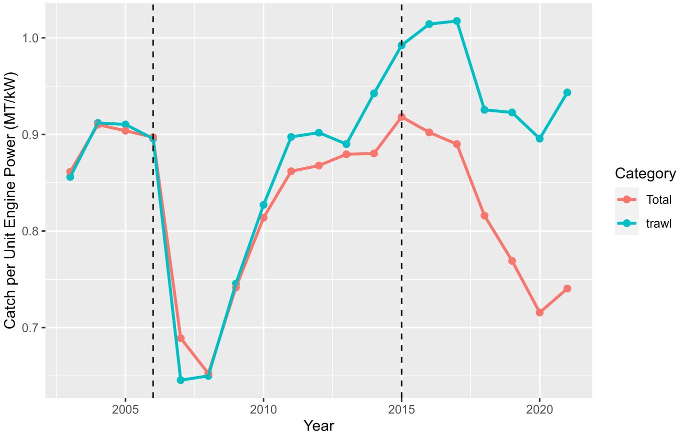
1. 2016 Fishery subsidy reform $\Longrightarrow$ Capacity reduction & More desired fleet structure

2. Incentive design is crucial: Eliminating fuel subsidy alone is not all the story.

3. The transitioning fishery management of China: changes for the better, experiences for the world.

To be explored: downstream effect of subsidy reduction

- Fishing effort, Harvest quantity and quality, Welfare...



Theoretical model: unexplained mechanisms

- How the subsidy level assigned to permits affects the scrappage decisions of vessels?
  - Should have no effect for the optimal replacement timing.
  - Field knowledge: It was common for trawl fishers to bankrupt and to leave post-reform.
- Why some exiting fishers choose buyback program while some not given binding buyback price?
  - Only one dominant option if vessels are homogeneous $P^B > V^* = P^M$.
  - Field knowledge: Lots of old and inefficient vessels staying in fisheries pre-reform.

Necessary conditions assuming perfect capitalization

- Exists inefficient skippers for whom buyback price is binding: $P^M = P^B > V^L$
- Exists efficient skippers willing to purchase permits at $P^M = P^B < V^H$
- Vessels purchased from low-skill skippers will not be maintained: $\forall j$, $T_i \geq T_j^*(s)$

Appendix

Theoretical model: optimal stopping problems

Consider the economic life T for a vessel

$$\max_{T} \int_{t=0}^{T} e^{-\rho t}[\pi_i + \alpha - m(t)]dt + e^{-\rho T}\beta(\alpha)$$

- π: operating profit, $m(E, t)$: maintenance cost at t
- α: Fuel subsidy rate, β: Scrap value
- $\beta = \max\{V_i^*(\alpha), P^M(\alpha), P^B\}$
- Buyback happens $\Leftrightarrow P^B \geq \max\{V_i^*, P^M\}$

Theoretical model: the optimal scrappage

$$\frac{\partial T^*}{\partial \alpha} = (1 - \rho\beta'(\alpha))\frac{1}{\dot{m}}$$

- With binding buyback price:

$$\beta'(\alpha) = 0 \Rightarrow \frac{\partial T^*}{\partial \alpha} > 0$$

- With subsidy fully carryover:

$$\beta'(\alpha) = \frac{1}{\rho} \Rightarrow \frac{\partial T^*}{\partial \alpha} = 0$$

Data description: covariates

- Variation of engine power and net tonnage conditional on vessel length