# The effect of fuel subsidies on Chinese distant water fishing

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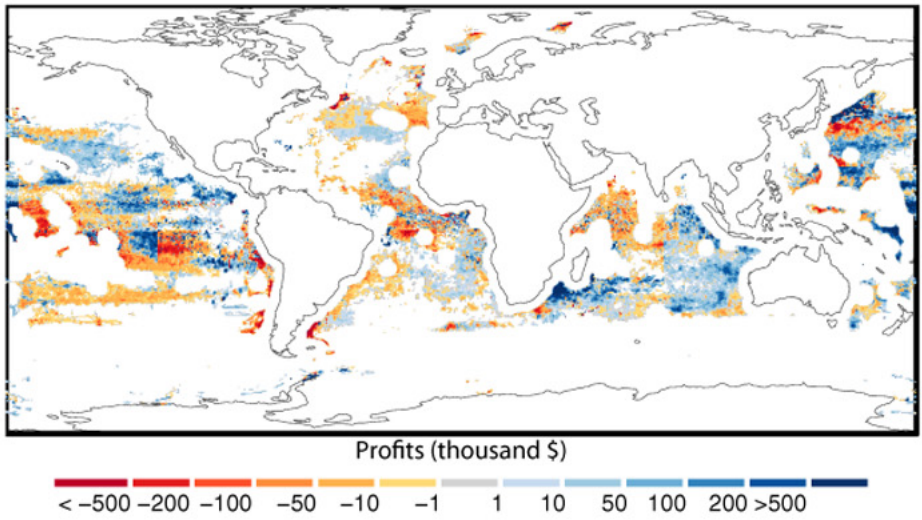
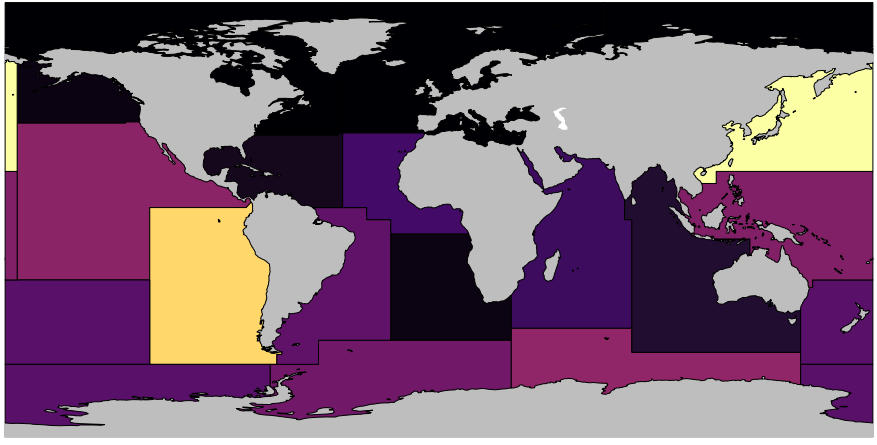
January 8, 2023

# Sala et al. (2018): Without subsidies, revenue $<$ cost for half of HS fishing





Percent of total fishing hours by Chinese vessels, 2015 - 2022

0% 20% 40% 60%

# First causal estimate of effect of fuel subsidies on fishing

- Largest fleet
- Regression discontinuity design
- Satellite and administrative data
- WTO subsidy reform

# Fuel subsidy for distant water fishing vessels, 2016-2020

$$Subsidy_{ijt} = SubsidyStandard_t \times SubsidyFactor_j \times SubsidyDays_{it} \times SubsidizedEnginePower_{ij}$$

where $i$ = vessel, $j$ = gear, and $t$ = year

Median vessel-year subsidy is \$182K (10% of variable costs)

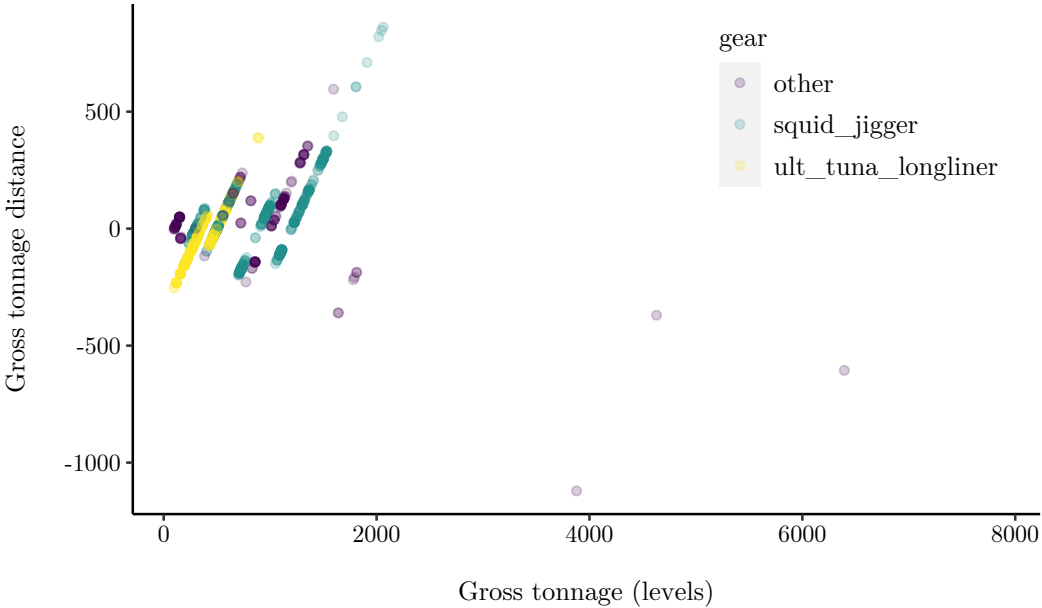
| Gear | Gross tonnage | Ceiling of subsidized engine power (kW) |
|---|---|---|
| Tuna purse seiner | $\geq$ 2000 | 3650 |
| | 1000-1999 | 2800 |
| | $\leq$ 999 | 1800 |
| ULT tuna longliner | $\geq$ 500 | 1200 |
| | 350-499 | 1000 |
| | $\leq$ 349 | 800 |
| Tuna longliner | $\geq$ 400 | 1000 |
| | 200-399 | 750 |
| | 100-199 | 550 |
| | $\leq$ 99 | 300 |
| Squid jigger | $\geq$ 1200 | 1800 |
| | 900-1199 | 1500 |
| | 500-899 | 1000 |
| | 300-499 | 750 |
| | $\leq$ 299 | 600 |

# Treatment status (T or C) depends on vessels' gross tonnage (GT) and engine power (EP)

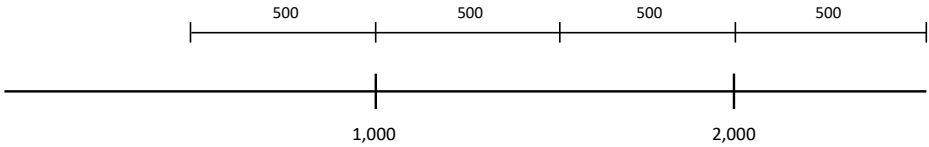
Squid jiggers below 300 GT have an EP ceiling of 600. Those between 300 and 499 GT have an EP ceiling of 750.

Table: Example squid jigger corresponding to the four vessel types

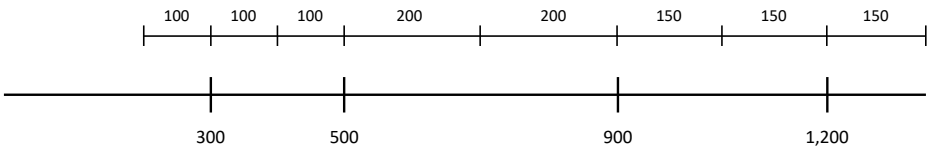
| | | **EP** | |
|---|---|---|---|
| | | **Non-binding** | **Binding** |
| **GT** | **Below** | (299, 500) | (299, 700) |
| | **Above** | (301, 500) | (301, 700) |


gear
other
squid_jigger
ult_tuna_longliner
Gross tonnage distance
500
0
-500
-1000
0
2000
4000
6000
8000
Gross tonnage (levels)

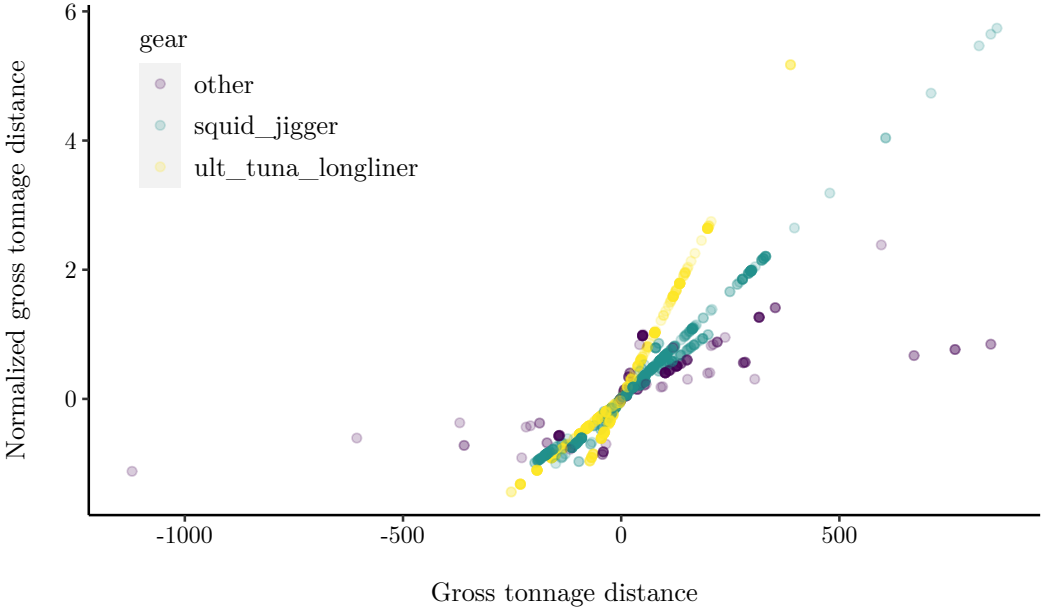
# Normalized gross tonnage distance example




Tuna purse seiner




Squid jigger


gear
other
squid_jigger
ult_tuna_longliner
Normalized gross tonnage distance
6
4
2
0
-1000
-500
0
500
Gross tonnage distance

# Data

- Characteristics of 2,216 Chinese distant water fishing vessels from international organizations and Chinese government agencies, fishing firms, and media
  - 2,705 authorized vessels in 2020 (Chinese Fisheries Statistical Yearbook)
- Match to satellite-inferred fishing data (Kroodsma et al., 2018)
  - 1,224 vessels Density
  - 52,092 vessel-month-year observations
- Primary regressions subset vessels to those built before 2016
  - 778 vessels
  - 37,332 vessel-month-year observations

# Estimating equation

$$\begin{aligned} fishing\_hours_{ijt} = {} & \beta_1 \mathbb{1}\{gt\_normalized\_distance_{ij} > 0\} + \beta_2 gt\_normalized\_distance_{ij} \; + \\ & \beta_3 gt\_normalized\_distance_{ij} \times \mathbb{1}\{gt\_normalized\_distance_{ij} > 0\} + \\ & \beta_4 gt_i + \beta_5 engine\_power\_kw_i + \beta_6 length\_m_i + \alpha_j + \epsilon_{ijt} \end{aligned} \tag{1}$$

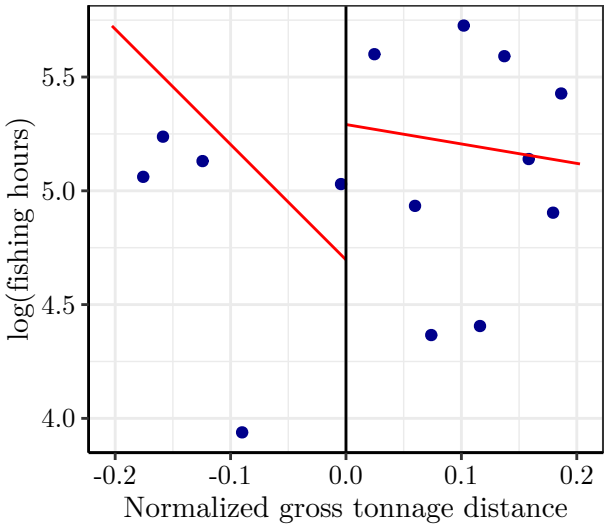
where $i$ = vessel, $j$ = gear, and $t$ = month-year

# Default options in rdrobust package

- Mean squared error optimal bandwidth selection (Imbens and Kalyanaraman, 2012)
- Minimum 10 unique values of running variable
- Same bandwidth above and below threshold
- Local linear running variable
- Triangular kernel
- Report conventional and bias-corrected point estimates and standard errors
- Local quadratic for bias-correction

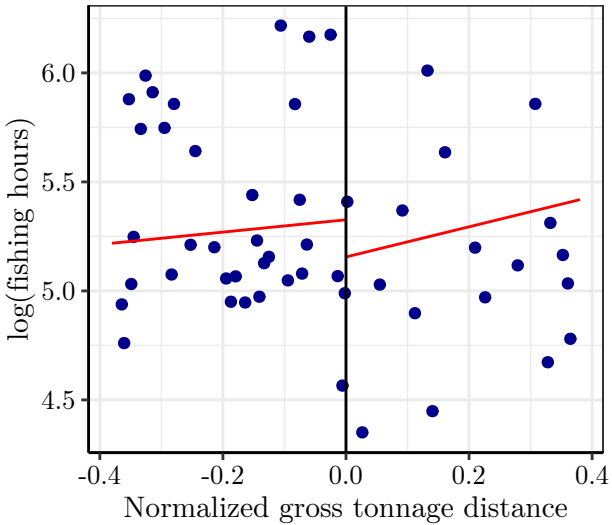
Visually reproduce regressions with rdplot command

# Effect on log(fishing hours), **binding vessels**, controls



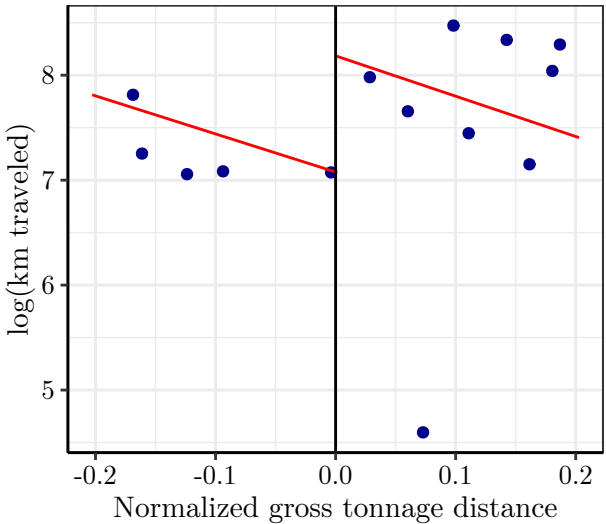

| | |
|---|---|
| Conventional | 0.594 |
| | (0.246) |
| Bias-Corrected | 0.843 |
| | (0.246) |
| Robust | 0.843 |
| | (0.283) |
| Bandwidth | 0.203 |
| N | 1,050 |
| RI p-value | 0.085 |

# Effect on log(fishing hours), **non-binding vessels**, controls



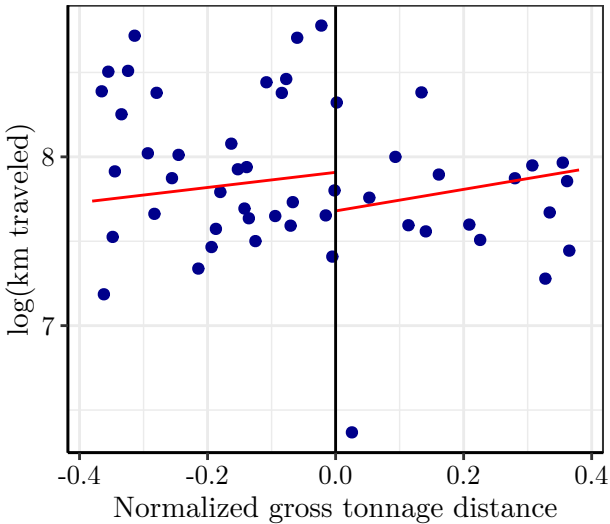

| | |
|---|---|
| Conventional | -0.170 |
| | (0.061) |
| Bias-Corrected | -0.206 |
| | (0.061) |
| Robust | -0.206 |
| | (0.064) |
| Bandwidth | 0.380 |
| N | 7,976 |
| RI p-value | 0.700 |

# Effect on **log(distance traveled)**, **binding vessels**, controls




| | |
|---|---|
| Conventional | 1.107 |
| | (0.260) |
| Bias-Corrected | 1.368 |
| | (0.260) |
| Robust | 1.368 |
| | (0.365) |
| Bandwidth | 0.203 |
| N | 1,234 |
| RI p-value | 0.041 |

# Effect on **log(distance traveled)**, **non-binding vessels**, controls




| | |
|---|---|
| Conventional | -0.229 |
| | (0.046) |
| Bias-Corrected | -0.246 |
| | (0.046) |
| Robust | -0.246 |
| | (0.056) |
| Bandwidth | 0.380 |
| N | 8,974 |
| RI p-value | 0.801 |

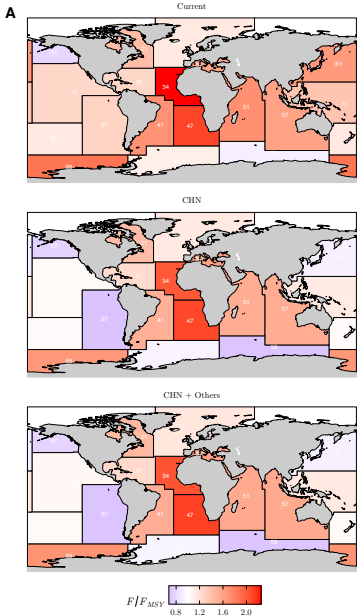
# Elasticities of fishing hours and distance traveled with respect to subsidy

first stage plots

| | log(fishing hours) | | | log(km traveled) | | |
|---|---|---|---|---|---|---|
| | RF | FS | Elasticity | RF | FS | Elasticity |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Conventional | 0.594 | 0.437 | 1.359 | 0.977 | 0.821 | 1.190 |
| | (0.246) | (0.103) | (0.647) | (0.250) | (0.189) | (0.409) |
| Bias-Corrected | 0.843 | 0.497 | 1.696 | 1.159 | 0.929 | 1.248 |
| | (0.246) | (0.103) | (0.607) | (0.250) | (0.189) | (0.370) |
| Robust | 0.843 | 0.497 | 1.696 | 1.159 | 0.929 | 1.248 |
| | (0.283) | (0.153) | (0.772) | (0.305) | (0.283) | (0.502) |
| Bandwidth | 0.203 | 0.203 | 0.203 | 0.203 | 0.203 | 0.203 |
| N | 1,050 | 1,050 | 1,050 | 1,227 | 1,227 | 1,227 |
| RI p-value | 0.085 | 0.259 | 0.149 | 0.041 | 0.077 | 0.184 |

# What if China reduced distant water fuel subsidies by 50%?

- A 1% reduction in fuel subsidy reduces Chinese fishing by 1.359%
- Reducing Chinese fuel subsidies may affect non-Chinese fishing
  - Instrument with timing of Chinese New Year
- Apply change in fishing 1:1 to $F/F_{MSY}$ ratios (Costello et al., 2016; McDermott et al., 2019)


A
Current
CHN
CHN + Others
$F/F_{MSY}$
0.8
1.2
1.6
2.0
B
Pacific, SE (87)
Pacific, NW (61)
Indian Ocean, Antarctic (58)
Pacific, East Central (77)
Pacific, West Central (71)
Atlantic, Antarctic (48)
Atlantic, SE (41)
Atlantic, East Central (34)
Pacific, SE (81)
Pacific, Antarctic (88)
Indian Ocean, West (51)
Indian Ocean, East (57)
Pacific, NE (67)
Atlantic, West Central (31)
Atlantic, SE (47)
Atlantic, NE (27)
Med. and Black Sea (37)
Atlantic, NW (21)
Ocean
Atlantic
Indian
Pacific
Southern
-40%
-30%
-20%
-10%
0%
% Change $F/F_{MSY}$

# Conclusion

- A 1% increase in fuel subsidy increases Chinese distant water fishing by 1.4%
- Long-run elasticities larger than short-run elasticities (Feehan, 2018; Buchsbaum, 2022)
- Reducing Chinese distant water fuel subsidies would eliminate overfishing in some regions and reduce it in most others
- Inform subsidy reform and guide expectations of effects

# Additional results

- Randomization inference go
- Placebo test: RD on pre-period fishing go
- Extensive margin go
- Entry and exit go
- Alternative specifications go
- SUTVA: Fishing over time go
- Relationship between pre-period fishing and gross tonnage go
- Number of vessels built each year go

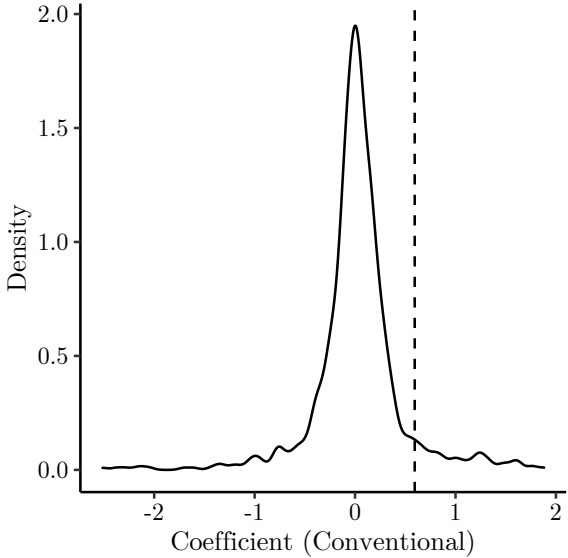
# Randomization inference

Back

- log(fishing hours), binding vessels
- log(fishing hours), non-binding vessels
- log(distance traveled), binding vessels
- log(distance traveled), non-binding vessels
- first stage, fishing
- fishing elasticity
- first stage, distance traveled
- distance traveled elasticity

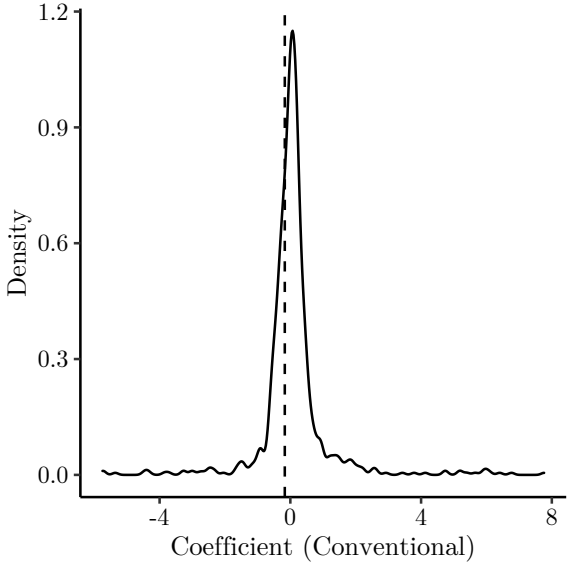
# Randomization inference: p-value is 0.085, vs. 0.016

Back



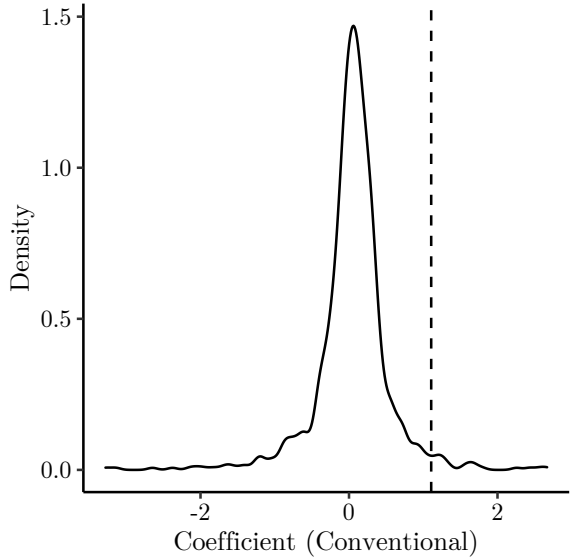
# Randomization inference: p-value is 0.700, vs. 0.005

Back



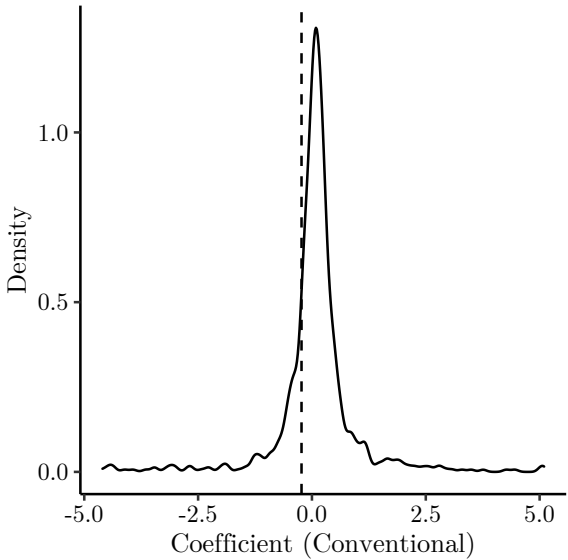
# Randomization inference: p-value is 0.041, vs. 2e-05

Back

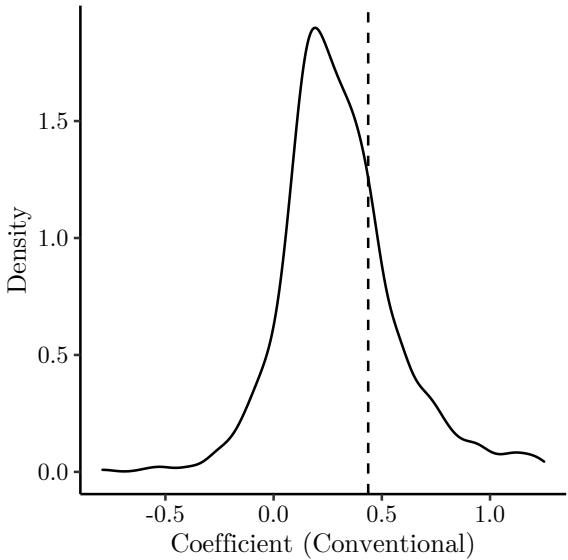


# Randomization inference: p-value is 0.808, vs. 7e-07

Back

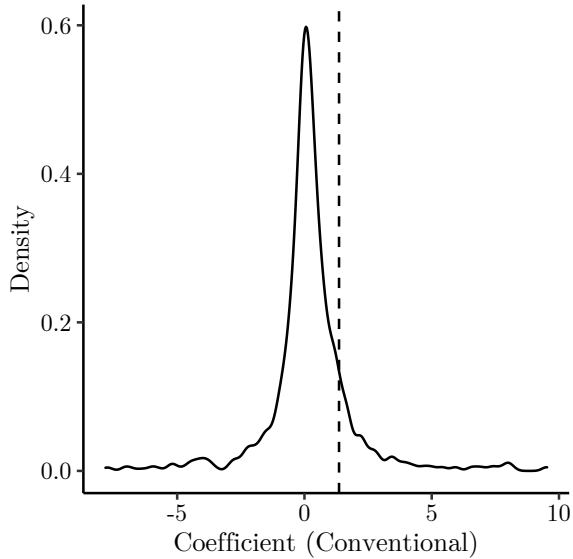


# Randomization inference: p-value is 0.259 vs. 2e-05 Back

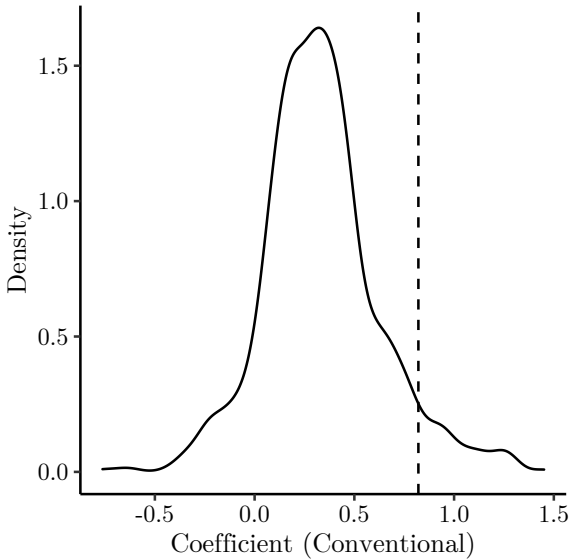


# Randomization inference: p-value is 0.149 vs. 0.036

Back

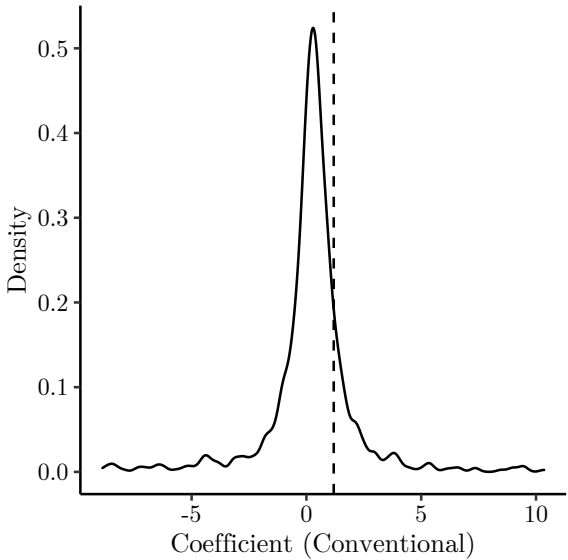


# Randomization inference: p-value is 0.077 vs. 2e-05 Back



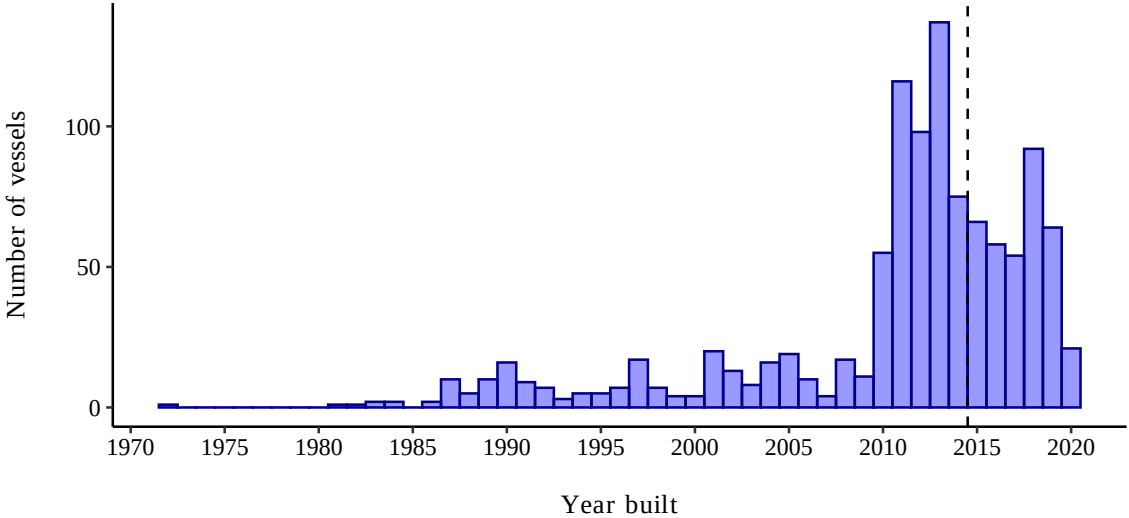
# Randomization inference: p-value is 0.184 vs. 0.004

Back



# Number of vessels built by year

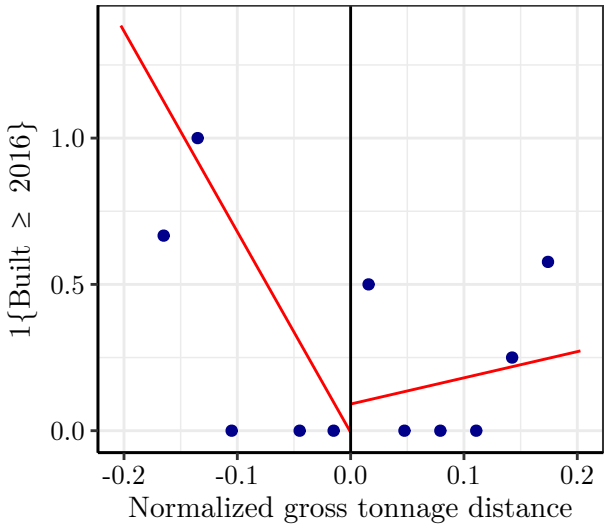
Back



# Entry and exit

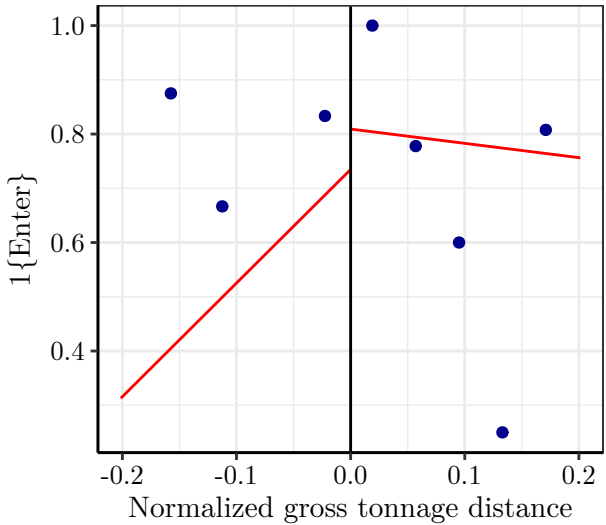
- One observation per vessel
- Binding vessels with controls, any year built
- Two indicators of entry
  1. Vessel built on or after 2016
  2. First year in data is not 2016
- Exit indicator: Last year in data is not 2020

# Effect on 1{Vessel built on or after 2016}




| | |
|---|---|
| Conventional | 0.097 |
| | (0.043) |
| Bias-Corrected | 0.181 |
| | (0.043) |
| Robust | 0.181 |
| | (0.126) |
| Bandwidth | 0.203 |
| N | 79 |
| RI p-value | 0.247 |

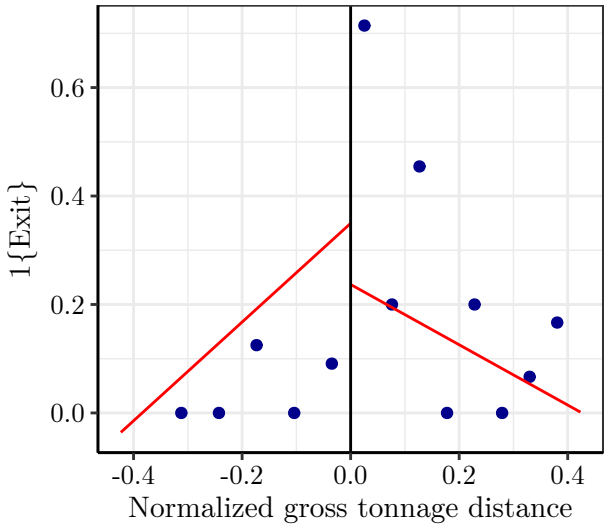
# Effect on 1{First year in data is not 2016}




| | |
|---|---|
| Conventional | 0.074 |
| | (0.179) |
| Bias-Corrected | -0.098 |
| | (0.179) |
| Robust | -0.098 |
| | (0.224) |
| Bandwidth | 0.201 |
| N | 79 |

# Effect on 1{Last year in data is not 2020}

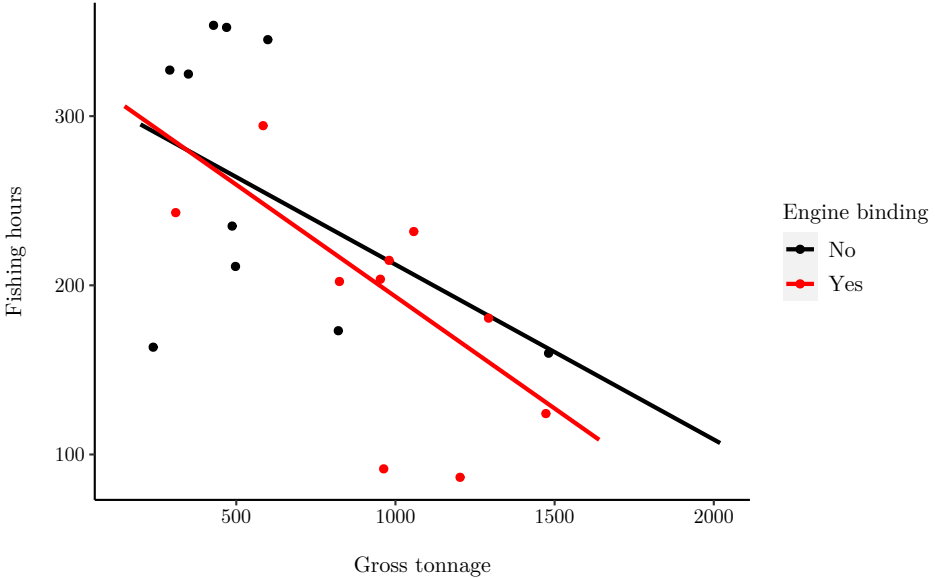
Back



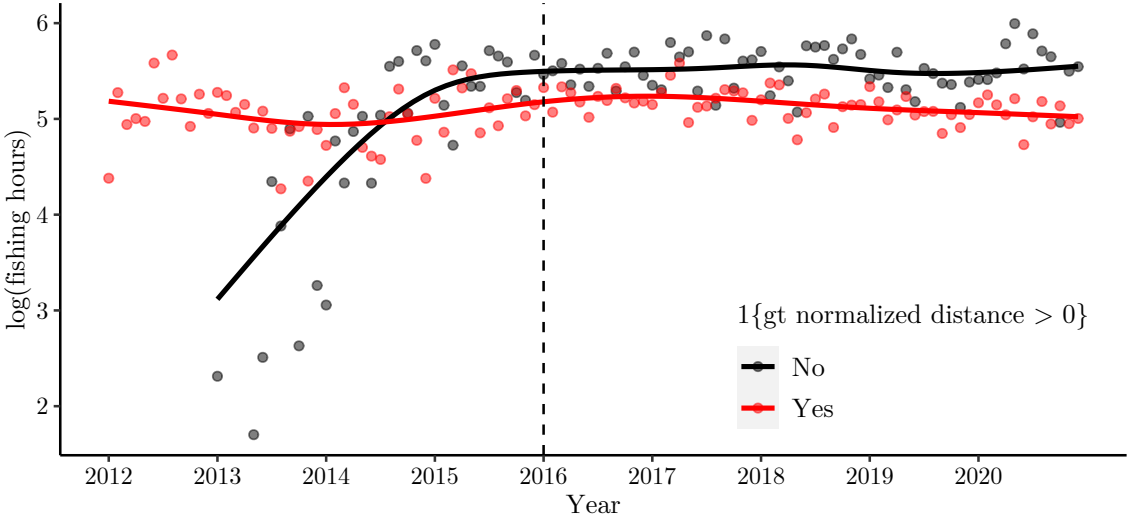

| | |
|---|---|
| Conventional | -0.113 |
| | (0.119) |
| Bias-Corrected | -0.119 |
| | (0.119) |
| Robust | -0.119 |
| | (0.145) |
| Bandwidth | 0.423 |
| N | 176 |

# Pre-period monthly fishing hours and gross tonnage in levels

Back

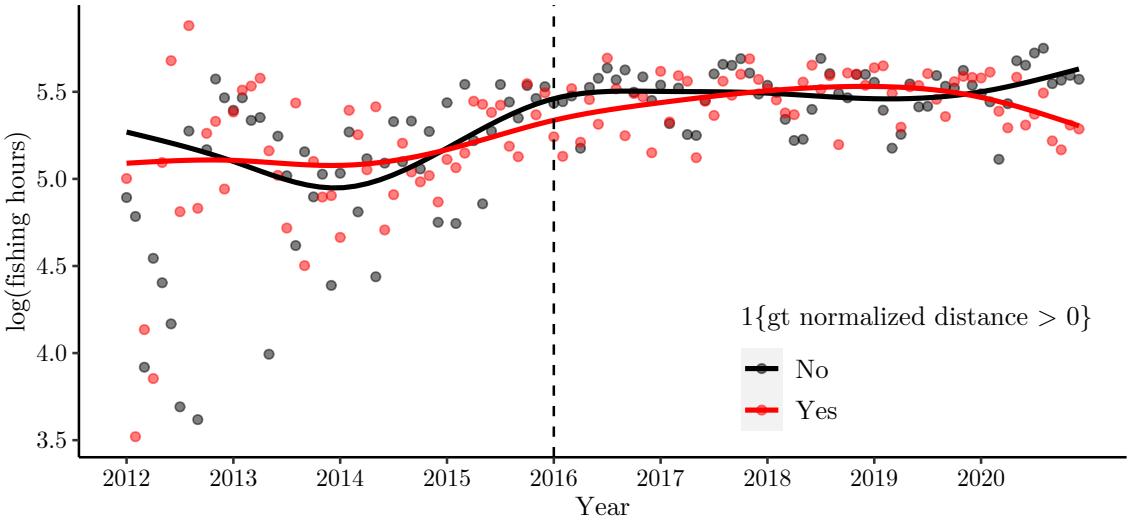


# Control vessels continue fishing, binding vessels built before 2016



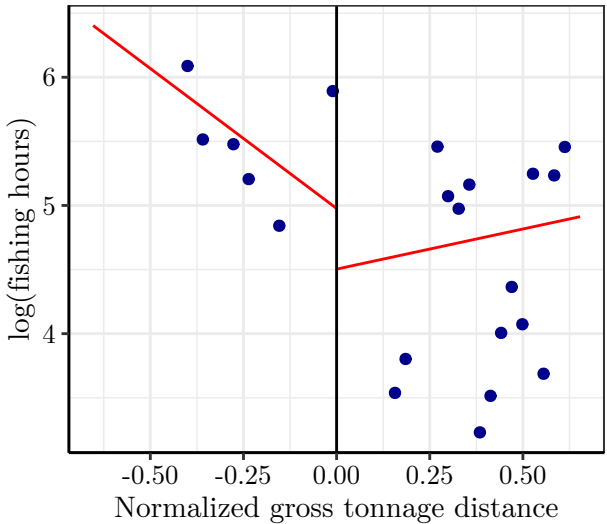
# Control vessels continue fishing, non-binding vessels built before 2016

Back



# Pre-period log fishing hours

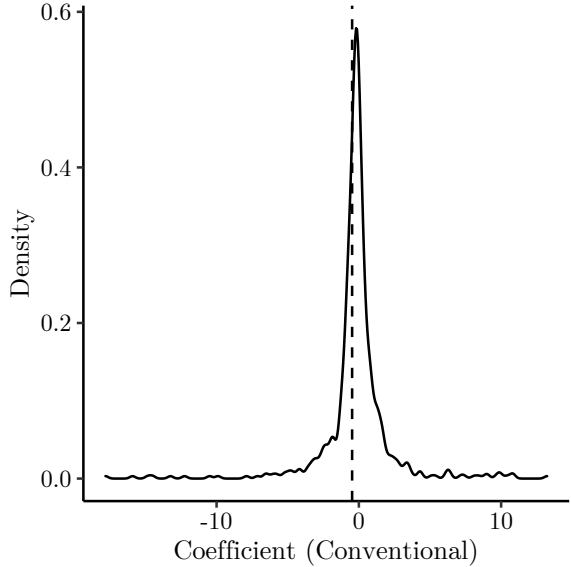
Back




| | |
|---|---|
| Conventional | -0.473 |
| | (0.236) |
| Bias-Corrected | 1.182 |
| | (0.236) |
| Robust | 1.182 |
| | (1.283) |
| Bandwidth | 0.653 |
| N | 755 |
| RI p-value | 0.669 |

# Randomization inference: p-value is 0.669

Back

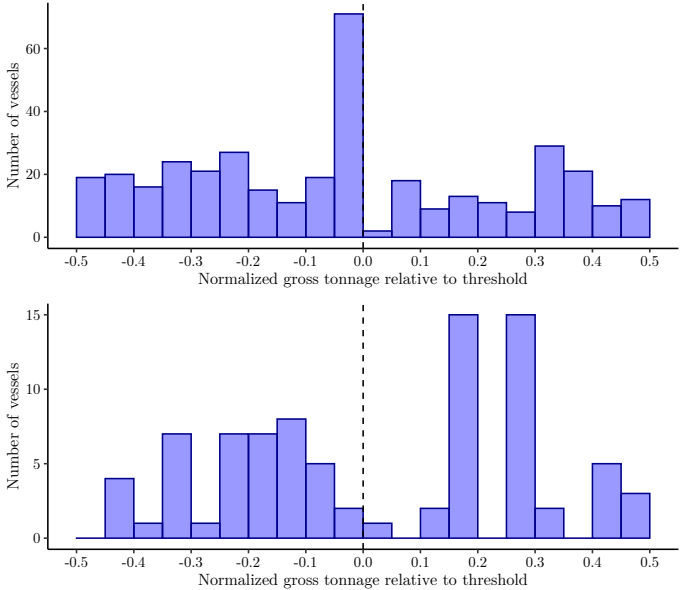


Back

| | Dependent variable: log(fishing hours) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | B15 | 16-19 | 15-20 | 15-20 | YFE | NNrm | NLen | NLen | Ann |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Convent- | 0.77 | 0.79 | 4.58 | 0.64 | 1.19 | 0.20 | 1.74 | 0.49 | 0.47 |
| ional | (0.24) | (0.20) | (0.27) | (0.25) | (0.22) | (0.22) | (0.28) | (0.26) | (0.36) |
| Bias- | 1.16 | 1.58 | 3.00 | 0.85 | 1.63 | 0.30 | 1.74 | 0.71 | 0.56 |
| Corrected | (0.24) | (0.20) | (0.27) | (0.25) | (0.22) | (0.22) | (0.28) | (0.26) | (0.36) |
| Robust | 1.16 | 1.58 | 3.00 | 0.85 | 1.63 | 0.30 | 1.74 | 0.71 | 0.56 |
| | (0.31) | (0.23) | (0.33) | (0.32) | (0.26) | (0.29) | (0.34) | (0.33) | (0.46) |
| Bandwidth | 0.194 | 0.190 | 0.146 | 0.203 | 0.197 | 51.570 | 0.148 | 0.203 | 0.321 |
| N | 1,050 | 715 | 737 | 1,143 | 1,050 | 3,485 | 700 | 1,050 | 506 |
| P BW | | | | X | | | | X | |

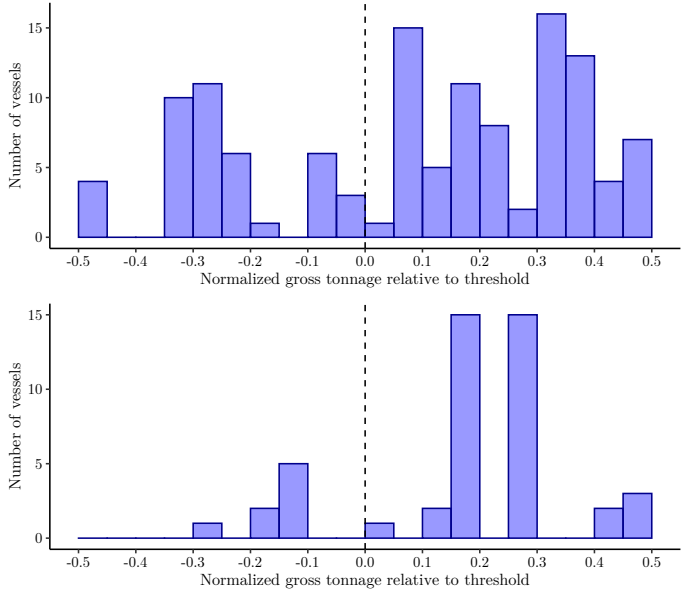
# Number of vessels built before (top) vs. after (bottom) policy

Back



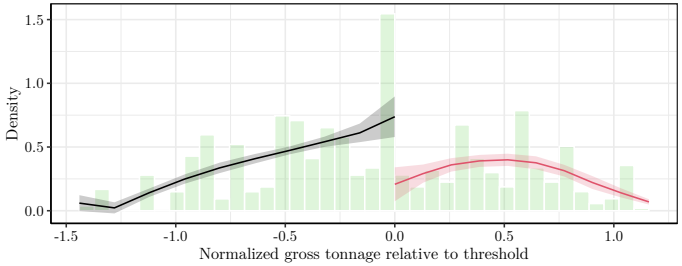
# N **binding** vessels built before (top) vs. after (bottom) policy

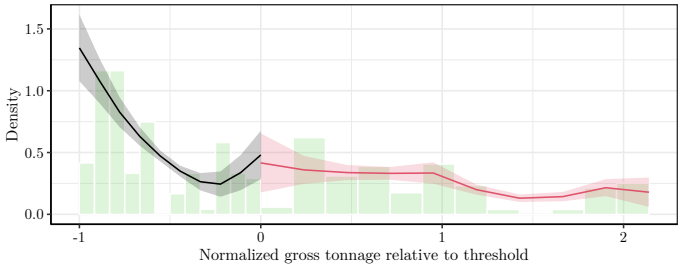
Back



# Density of vessels built before (top) vs. after (bottom) policy

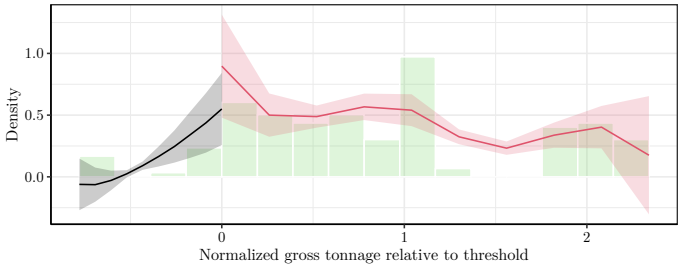
Back



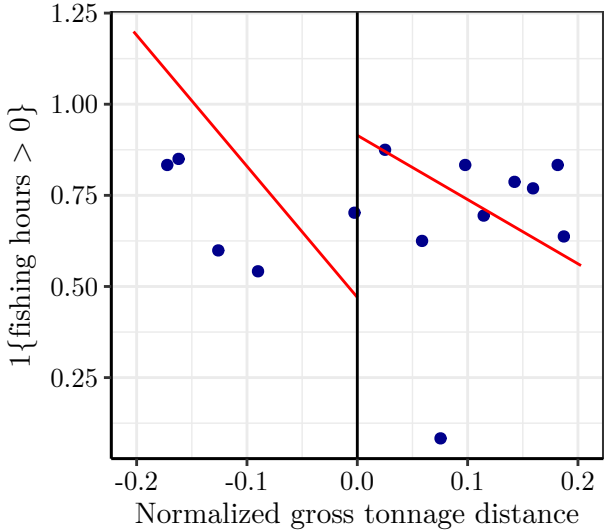
# Density of **binding** vessels built before (top) vs. after (bottom) policy

Back

# Effect on $\mathbb{1}\{\text{fishing hours} > 0\}$, binding vessels

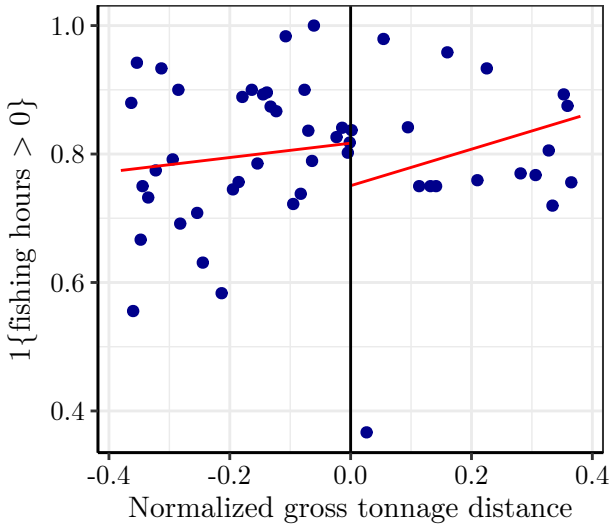
Back




| | |
|---|---|
| Conventional | 0.444 |
| | (0.100) |
| Bias-Corrected | 0.587 |
| | (0.100) |
| Robust | 0.587 |
| | (0.139) |
| Bandwidth | 0.203 |
| N | 1,500 |
| RI p-value | 0.028 |

# Effect on $\mathbb{1}\{\text{fishing hours} > 0\}$, non-binding vessels

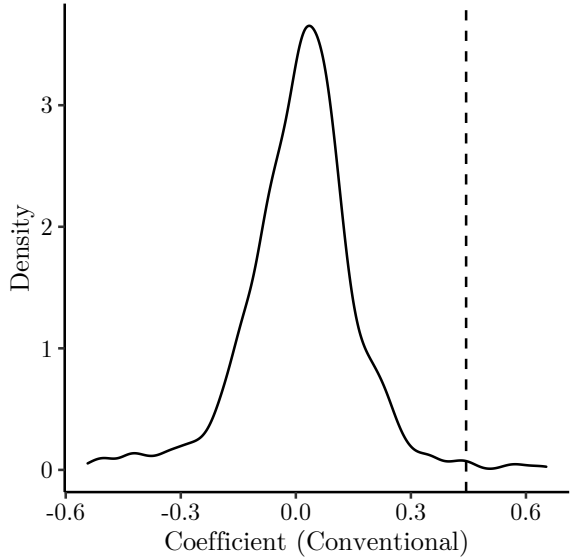
Back




| | |
|---|---|
| Conventional | -0.066 |
| | (0.017) |
| Bias-Corrected | -0.085 |
| | (0.017) |
| Robust | -0.085 |
| | (0.021) |
| Bandwidth | 0.380 |
| N | 9,876 |
| RI p-value | 0.809 |

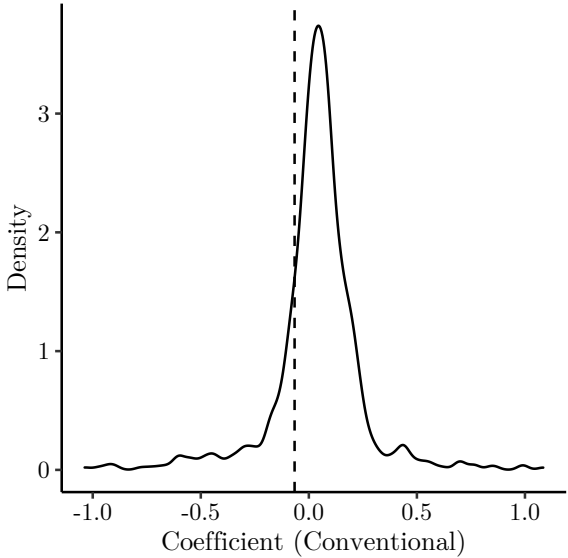
# Randomization inference: p-value is 0.028, vs. 1e-05

Back



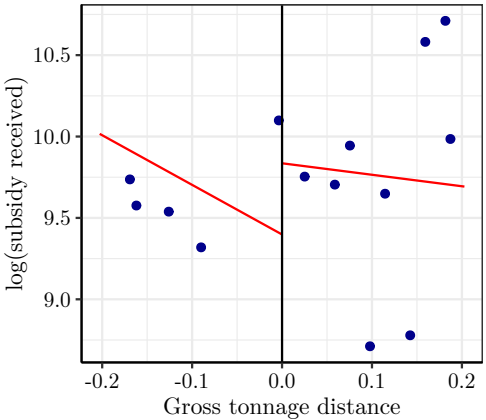
# Randomization inference: p-value is 0.809, vs. 0.0001

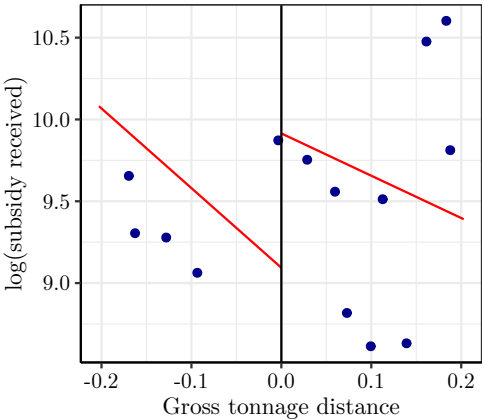
Back



# Fishing and distance first stages

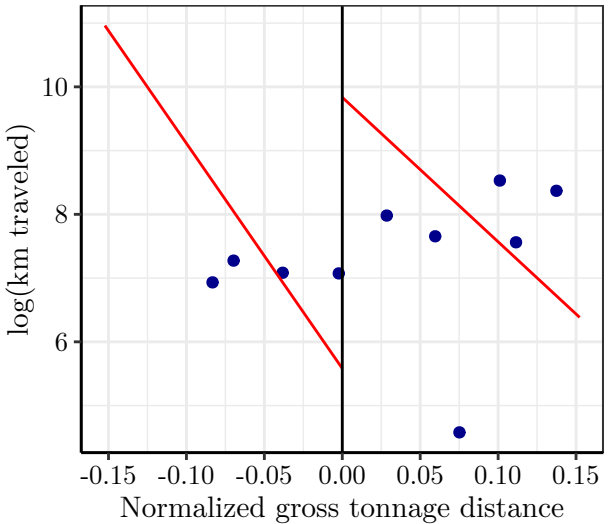
Back



# Own bandwidth log(distance traveled), binding vessels, controls

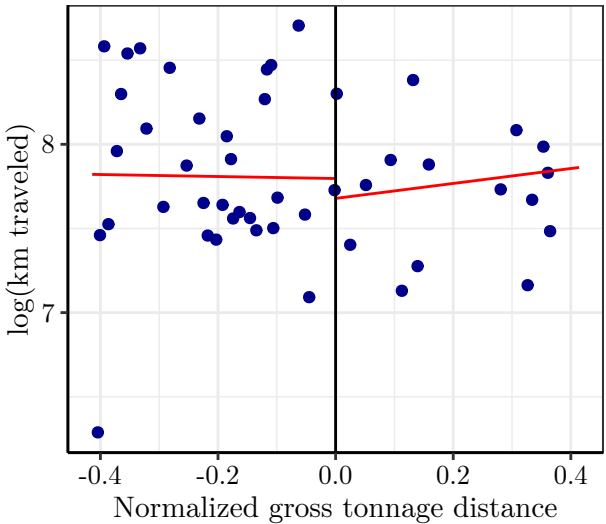
Back




| | |
|---|---|
| Conventional | 4.253 |
| | (0.226) |
| Bias-Corrected | 3.202 |
| | (0.226) |
| Robust | 3.202 |
| | (0.299) |
| Bandwidth | 0.152 |
| N | 881 |

# Own bandwidth log(distance traveled), non-binding vessels, controls

Back




| | |
|---|---|
| Conventional | -0.118 |
| | (0.052) |
| Bias-Corrected | -0.110 |
| | (0.052) |
| Robust | -0.110 |
| | (0.055) |
| Bandwidth | 0.414 |
| N | 9,810 |