The Economic Impact of Spatial Closures

Evidence from the Stellar Sea Lion Protective Measures in the North Pacific

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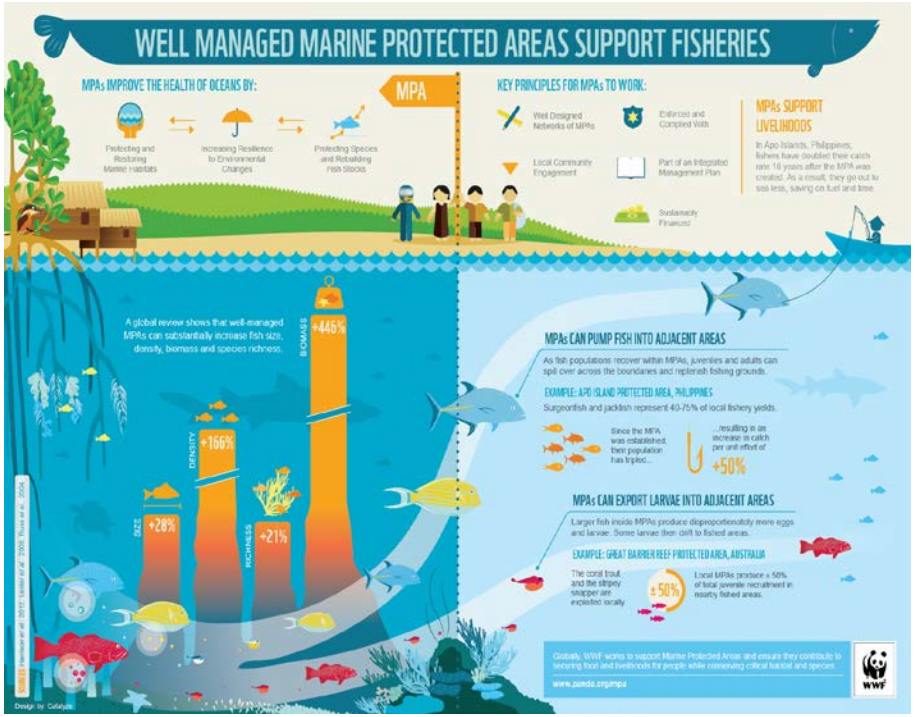
Motivation

- Spatial closures are a prominent tool for ecosystem-based management
  - Potential benefits have been discussed thoroughly in the literature



- Ex-post estimates of the short-run costs incurred by fishing industry are relatively scarce.

Why Are Closures Costly?

- Forgone harvests and revenues:
  - Can fishers catch target species in other areas?
    - Do other areas yield lower-valued products?
  - Can fishers target other species?
    - Are other target species less valuable?
- Increased operating costs:
  - Do other areas have lower CPUE?
  - Do fishers incur higher costs fishing other areas/species (e.g. fuel and/or processing)?
- Impacts of closures will be context-specific

Challenges for Estimating the Costs of Closures

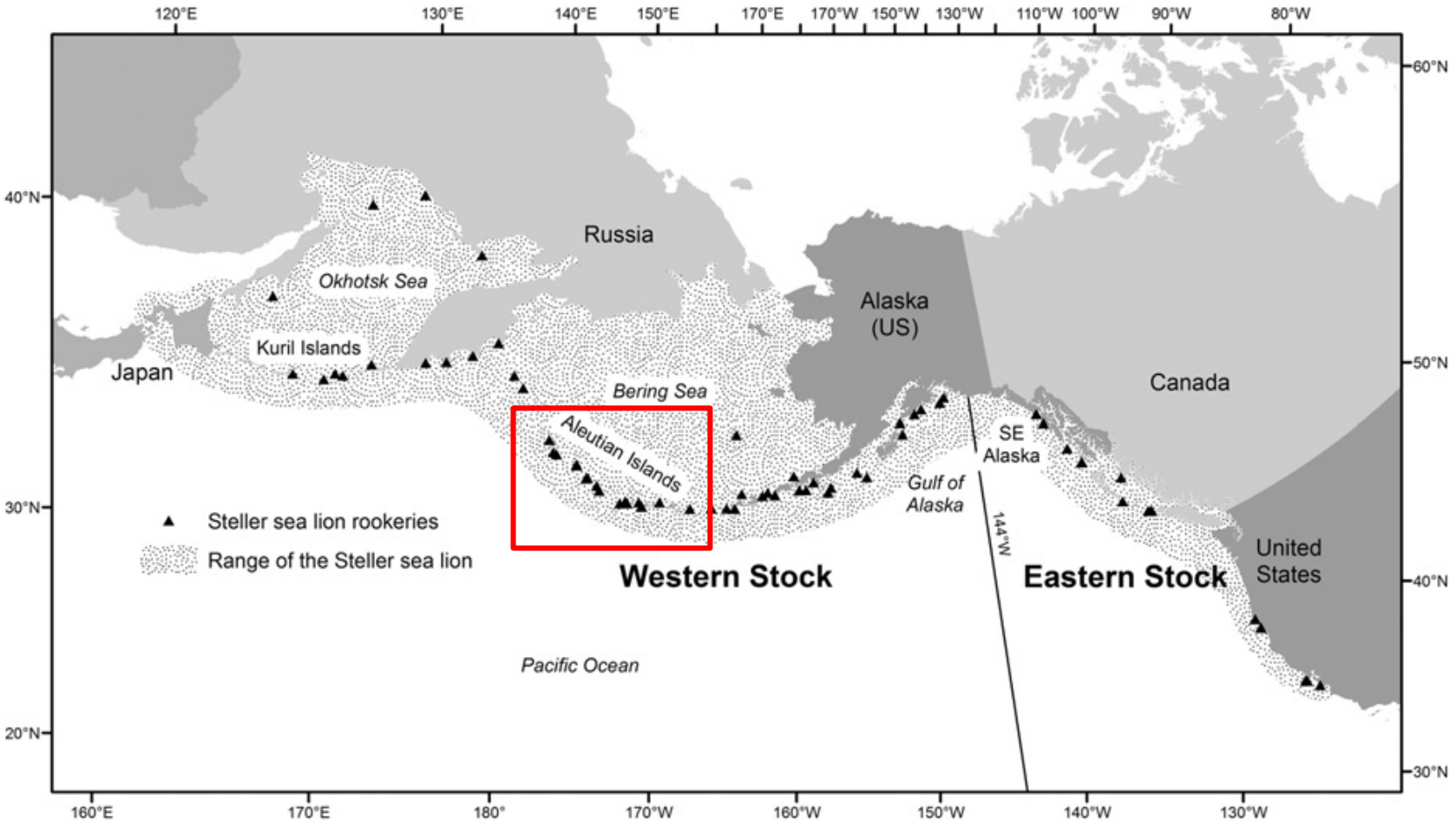
- No plausible estimate of the counterfactual:
  - *What would revenues/costs have been in the absence of the closures?*
  - Closures not designed with *ex-post* evaluation in mind
- Lack of economic data:
  - Revenue and catch data often exist
  - Cost data are relatively rare

Estimating the Cost of Closures

- We estimate the short-run costs of a large spatial closure to protect Stellar Sea Lions.
  - Multi-species fishery with harvester cooperatives
- We have a plausible estimate of the counterfactual:
  - Not all vessels were directly affected by closure
  - Comparative case study: Diff-in-diff, synthetic control
- We have annual revenue and cost data:
  - Vessels required to complete Economic Data Reports (EDR) on an annual basis.

Stellar Sea Lion Range

rine Policy 38 (2013) 523–530



Stellar Sea Lion Protection Measures

- Listed as “threatened” under ESA in 1990 and “endangered” in 1992
- Rely for food on commercial species: walleye pollock, Atka mackerel, and Pacific cod
- Protective measures:
  - Closures near SSL critical habitat
  - Seasonal and spatial TAC

Stellar Sea Lion Protection Measures

- ESA consultation finds previous measures "ineffective" (2010)
- Additional measures implemented in 2010:
  - More (and larger) spatial closures to Atka mackerel and Pacific cod fisheries

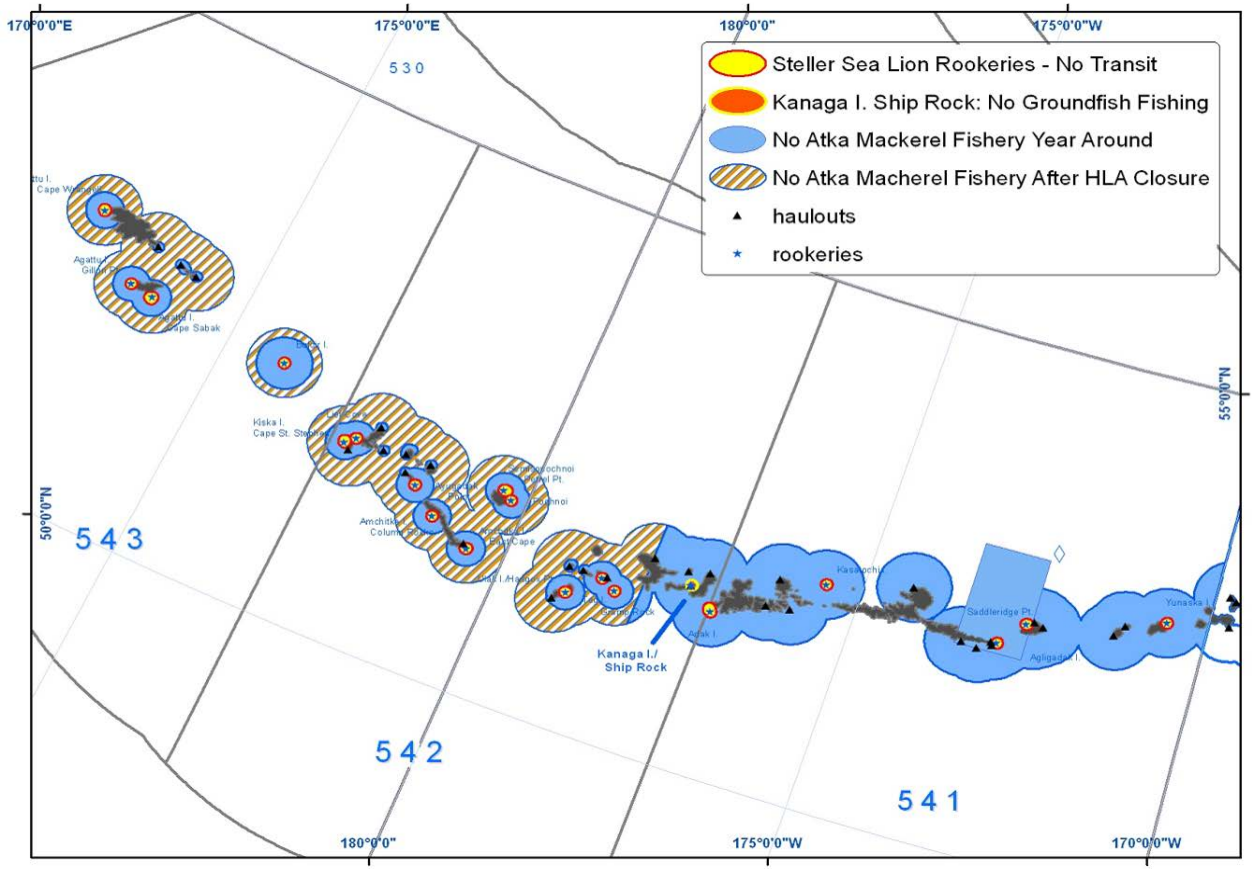
Aleutian Islands Commercial Fisheries

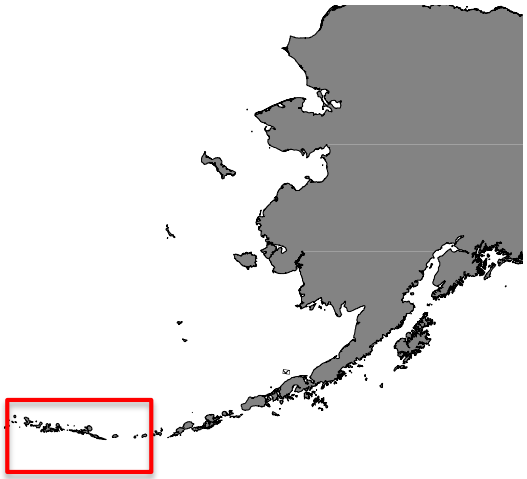
- Atka mackerel
  - One fleet of catcher processors (7 vessels)
  - 2008-2010: Average 61,000mt ($61.6 million wholesale), 25% in area 543
- Pacific cod
  - Multiple fleets, variety of vessels/gear
  - 2008-2010: Average 24,000mt ($24.1 million wholesale)
- Regulatory Impact Review
  - $24-47 million wholesale “at risk” for Atka mackerel CPs

Aleutian Islands Commercial Fisheries

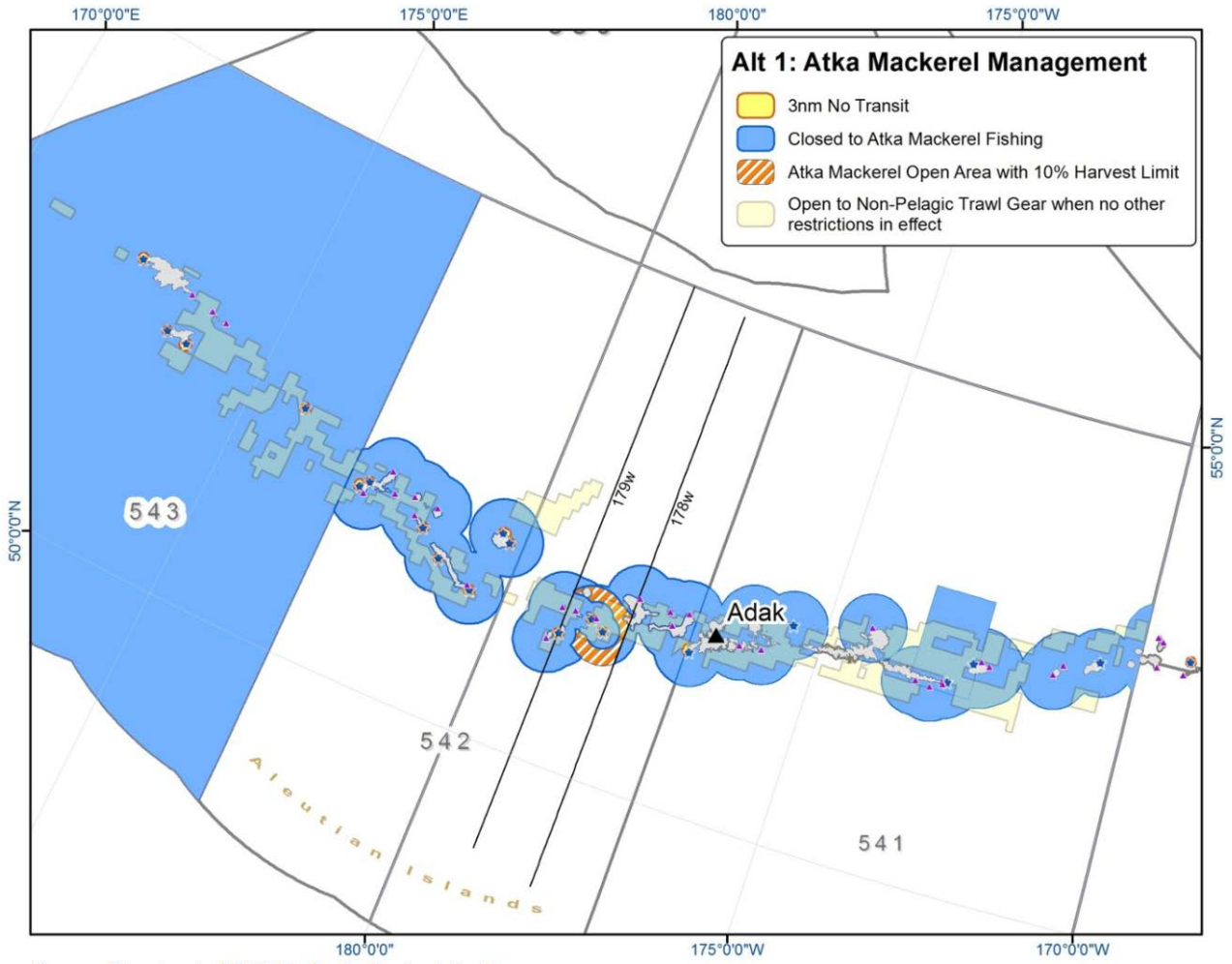
- Focus on just the Atka mackerel CPs. Why?
  - We have a plausible control group for estimating the counterfactual
  - We have annual revenue and cost data:
    - Revenues from selling product and leasing quota
    - Operating expenditures (e.g. fuel, labor, food, fish taxes, etc.)
    - 3 years before, 4 years after, 17 vessels, a total of 119 observations

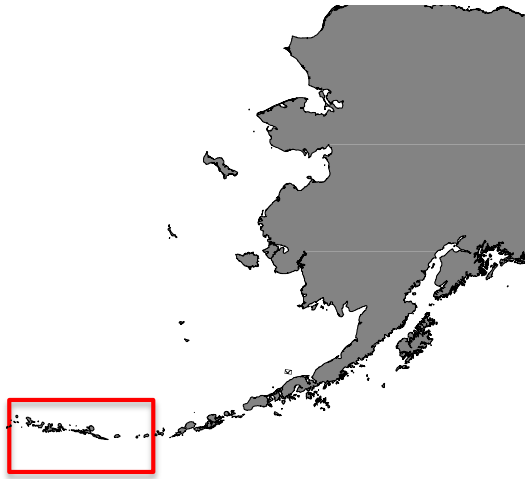
SSL Protective Measures: Pre-2011





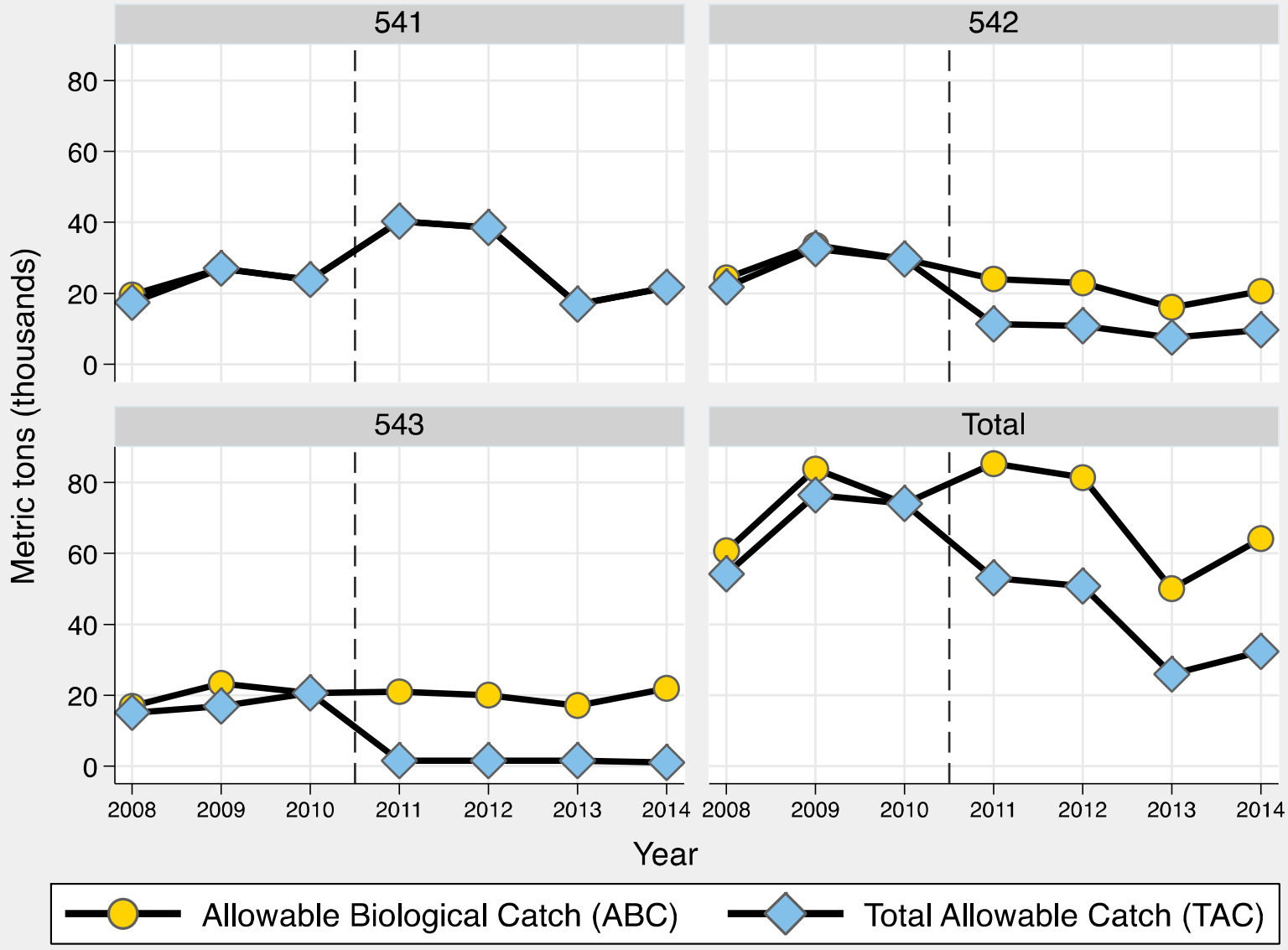
SSL Protective Measures: Post-2011





Source: Steve Lewis, NMFS Alaska Region Analytical Team

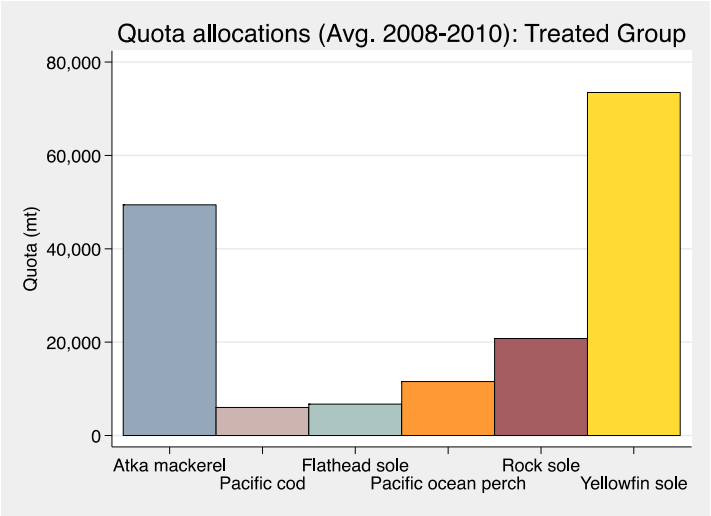
SSL Protective Measures

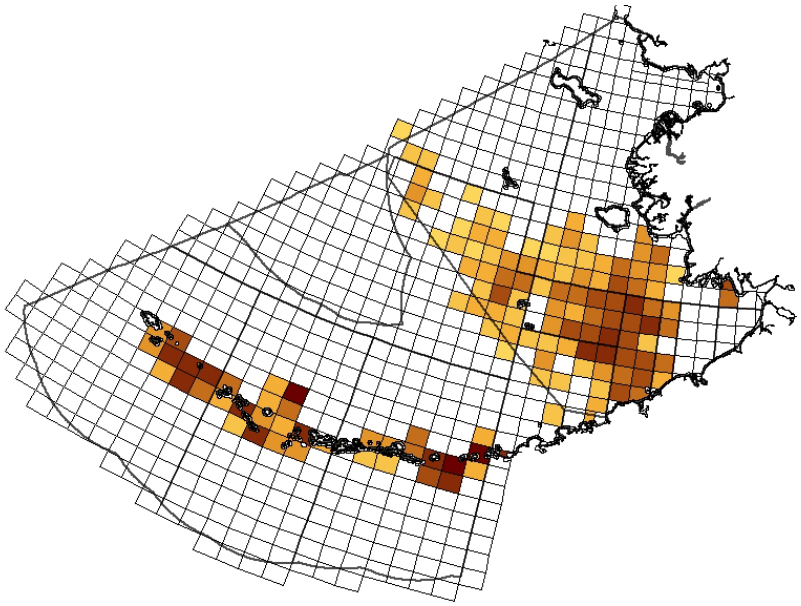


Estimating the Impact: Identification

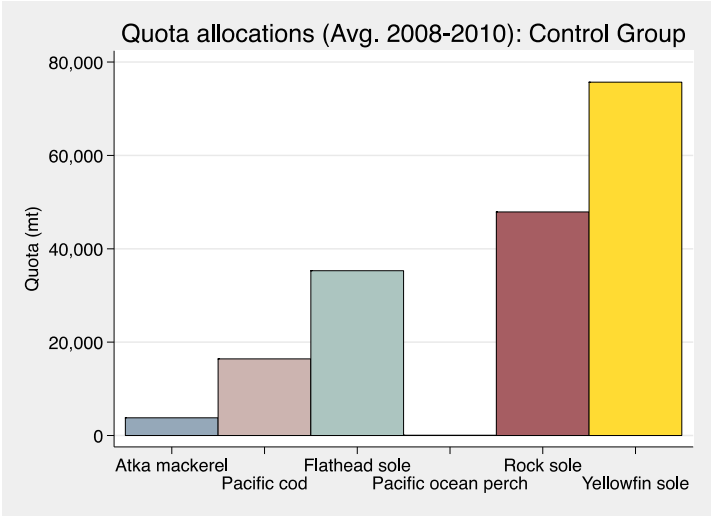
- Counterfactual: *annual net revenues (revenue – variable costs) that would have been earned in the absence of the closure*.
- Strategy:
  - Atka mackerel vessels part of a larger fleet of similar vessels not directly affected by closure
  - Use unaffected vessels as a control group for the Atka mackerel vessels (i.e. the treated group)

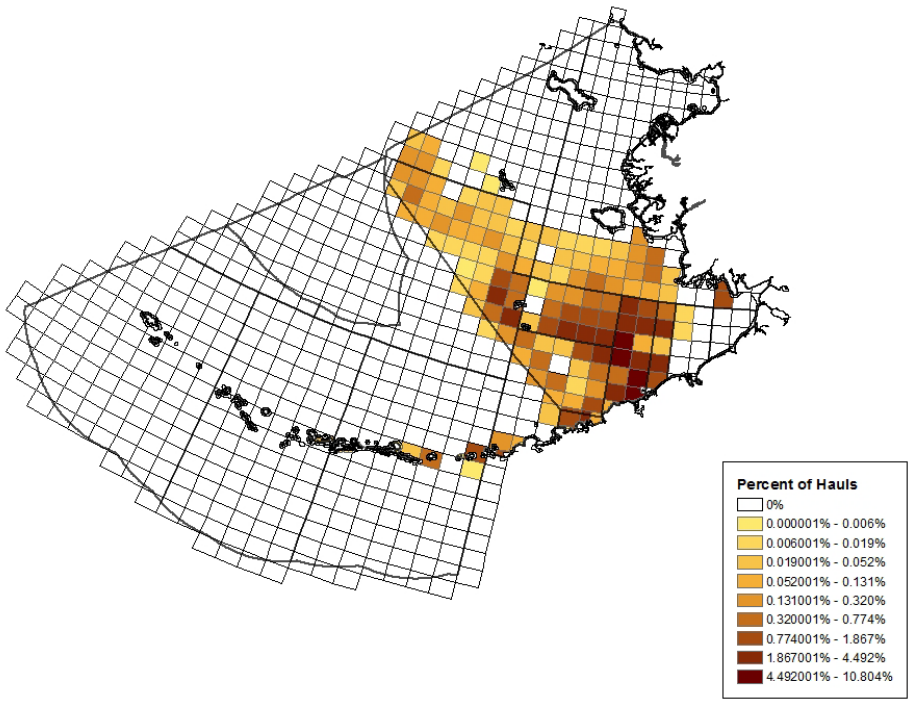
Treated Group (N=7)





Control Group (N=11)



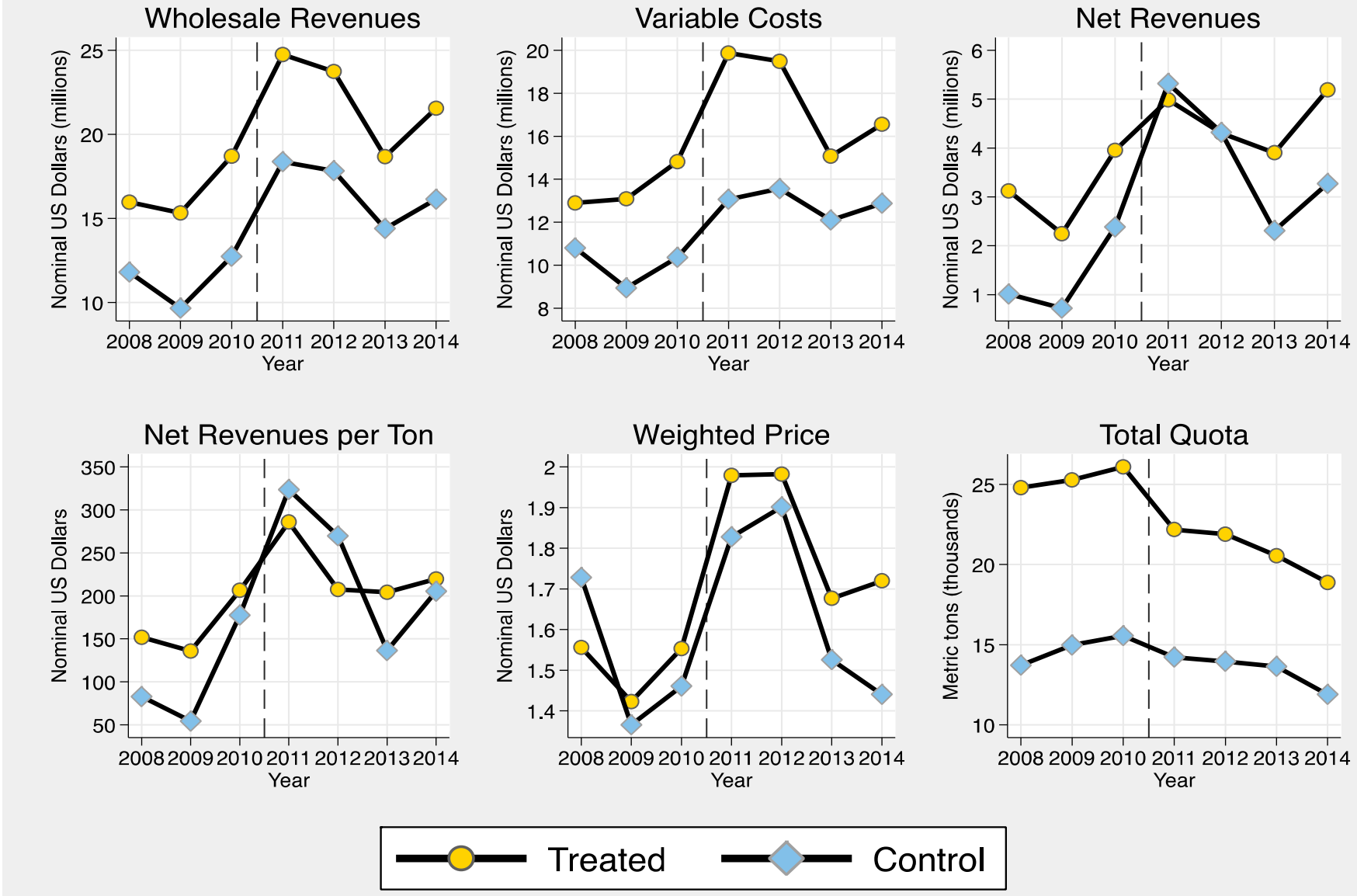


Difference-in-Differences

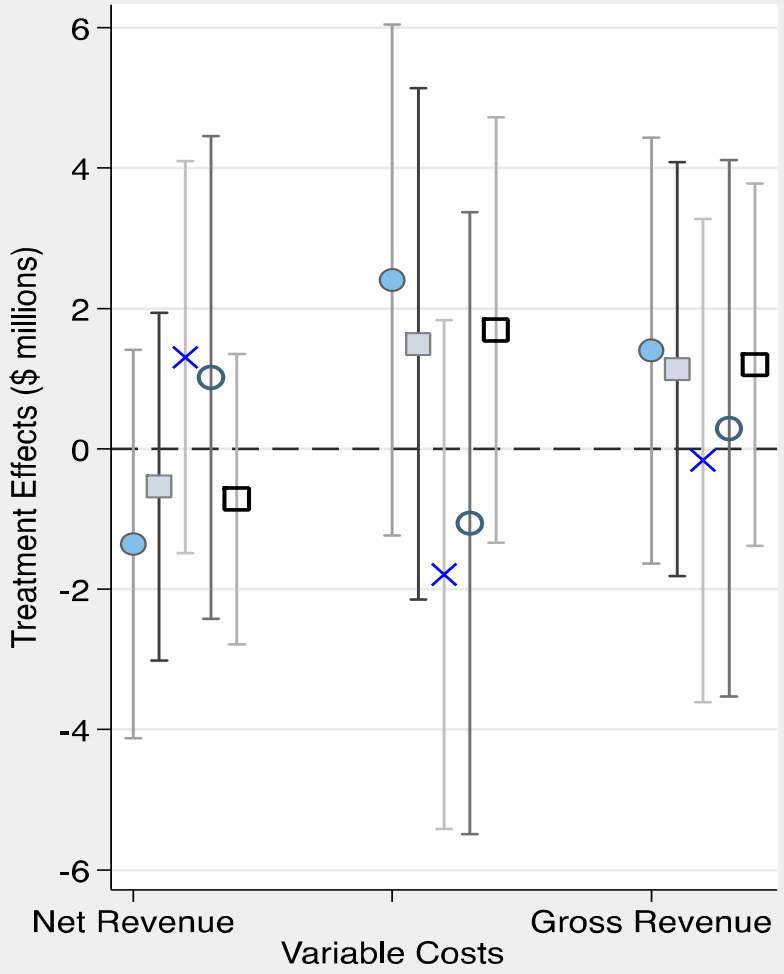
$$Y_{it} = \alpha + \phi_i + \theta_t + \delta treat_i \times post_t + X'_{it}\beta + \varepsilon_{it}$$

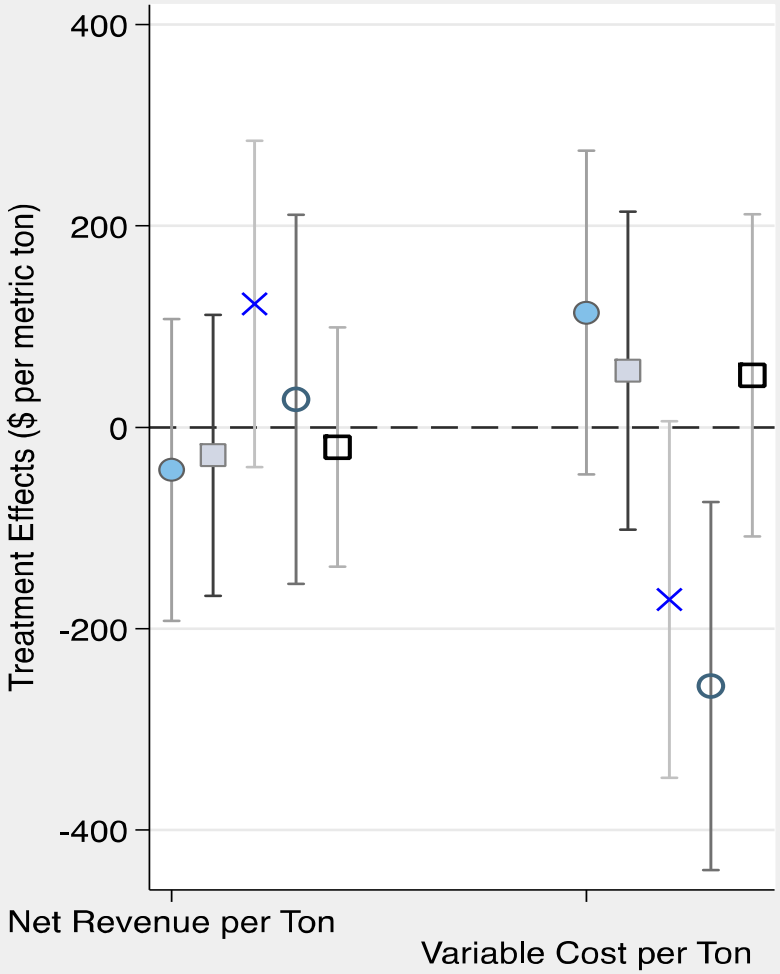
- X_{it} = [weighted price, total quota]
- Key assumptions:
  - "Parallel trends"
    - Unobserved time-varying factors affect all vessels the same
  - Exogeneity
    - Estimate the average treatment on the treated (ATT)
  - No spillover or contamination of control group

Parallel Trends



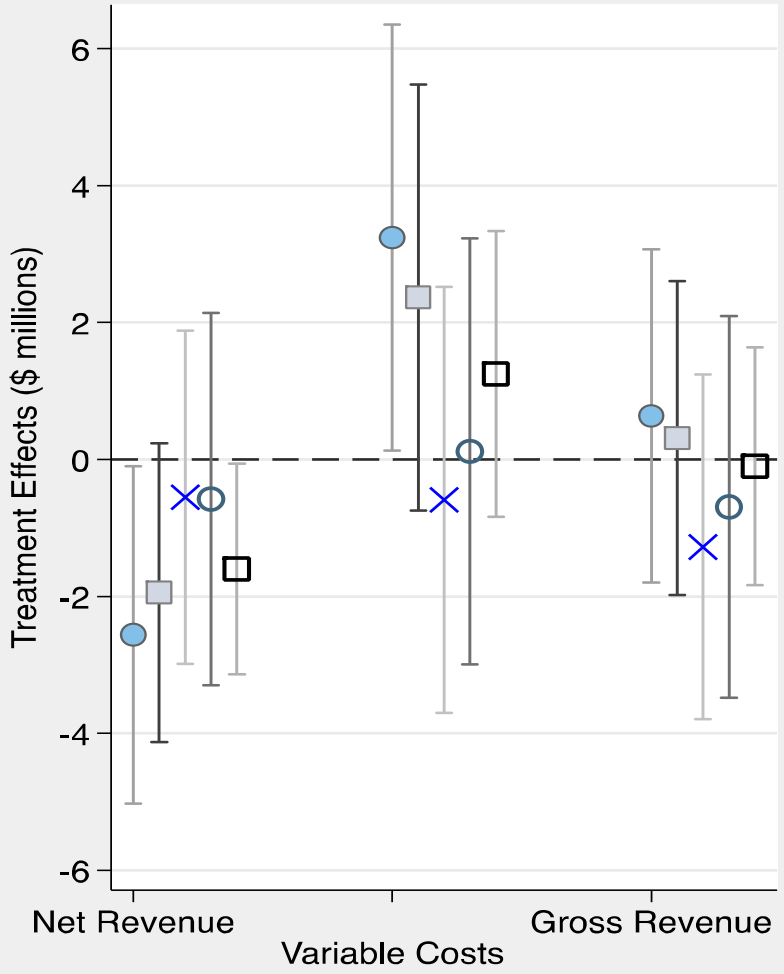
Difference-in-Differences: with quota

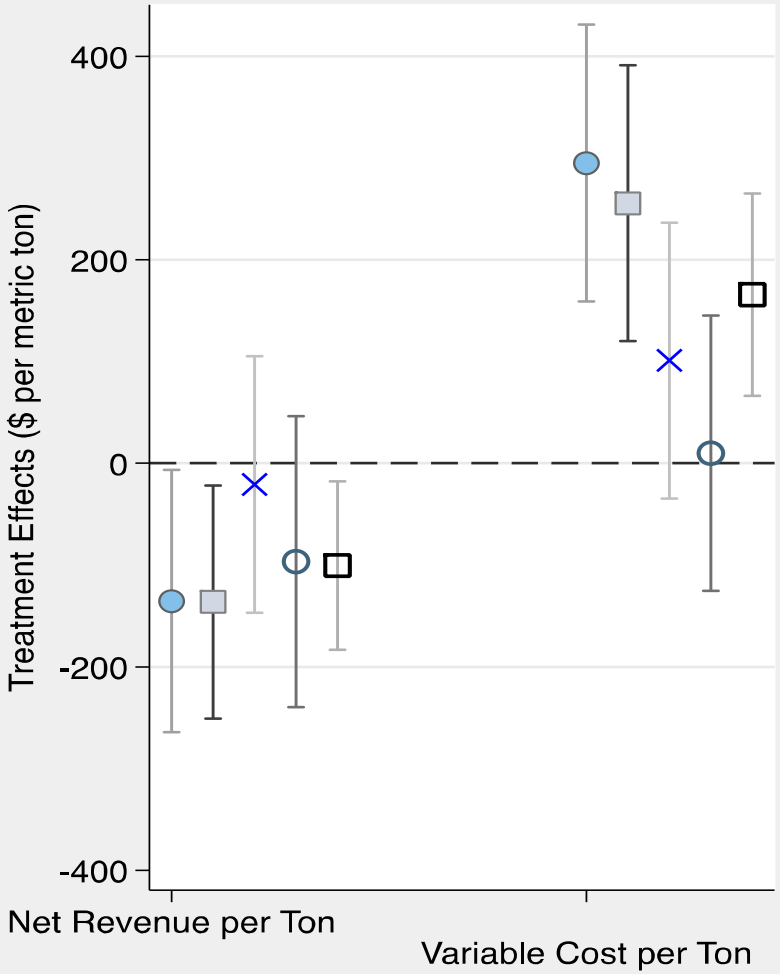


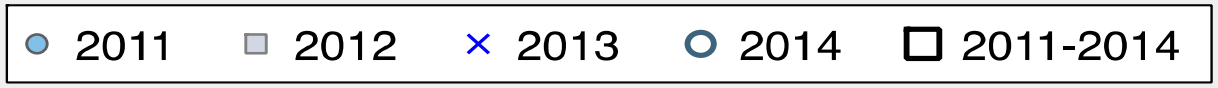


2011 2012 2013 2014 2011-2014

Difference-in-Differences: without quota







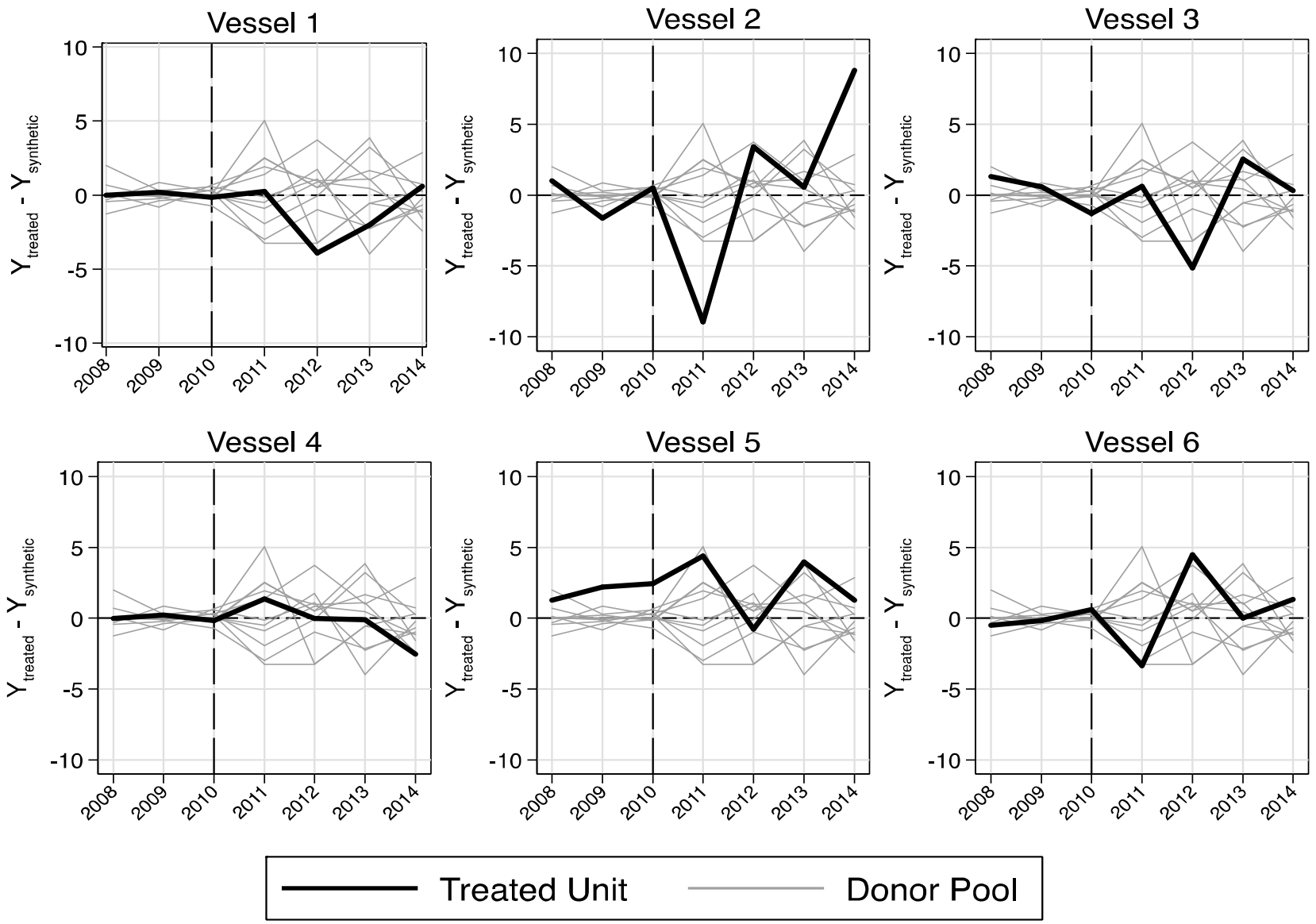
Difference-in-Differences: Permutation

Synthetic Control Method

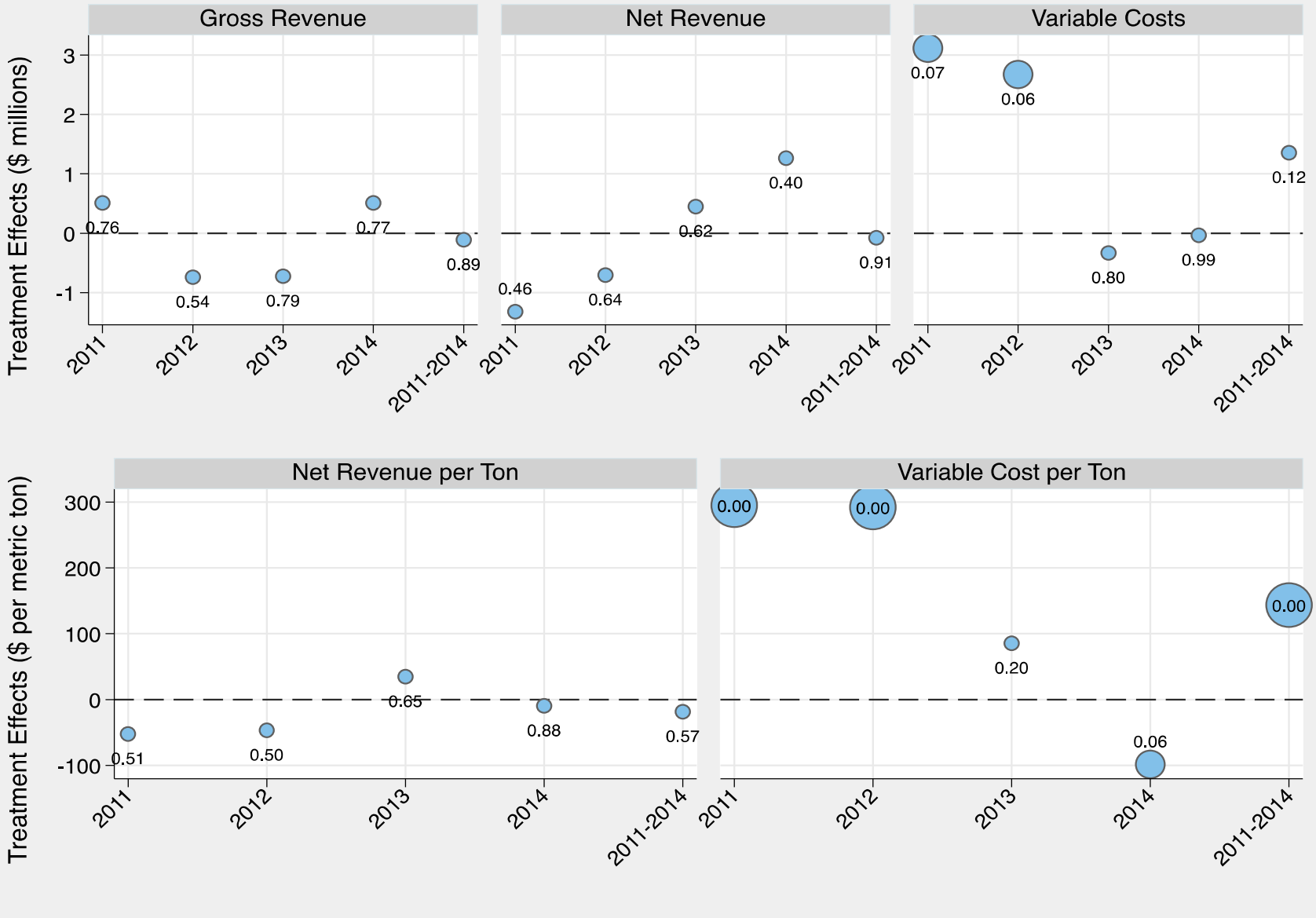
$$\hat{\delta}_{it} = Y_{it} - \sum_{j \neq i} w_j^* Y_{jt}, \qquad t \in \{T_0 + 1, \ldots, T\}$$

- SCM generalizes diff-in-diff, with advantages:
  - Data-driven process to construct comparison group (Abadie et al., 2010)
  - Allows the effects of unobserved vessel-specific factors to vary with time
  - Allows for heterogeneity in treatment effects across vessels

Synthetic Control Results: Net Revenues

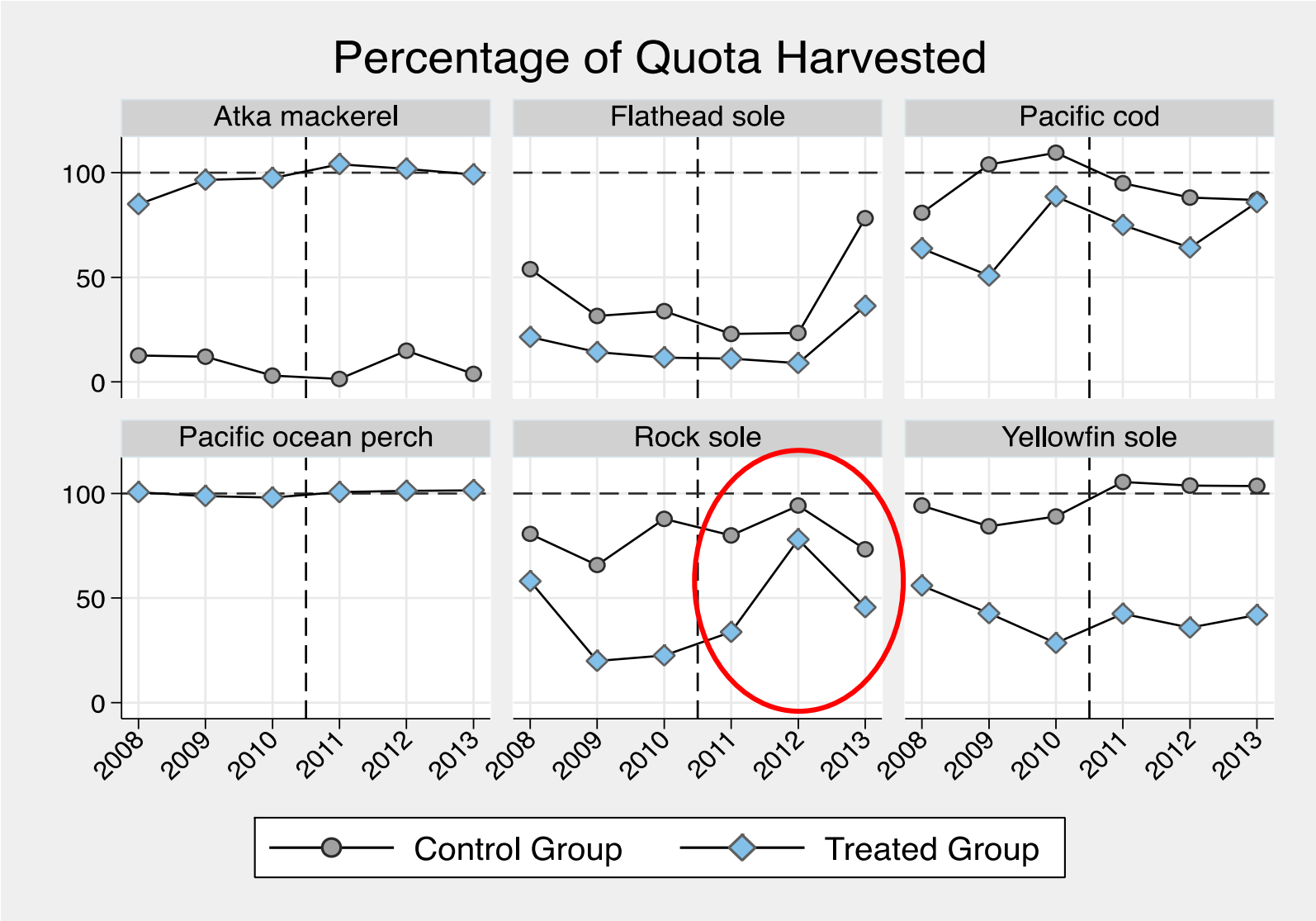


Synthetic Control Results: DnD effects



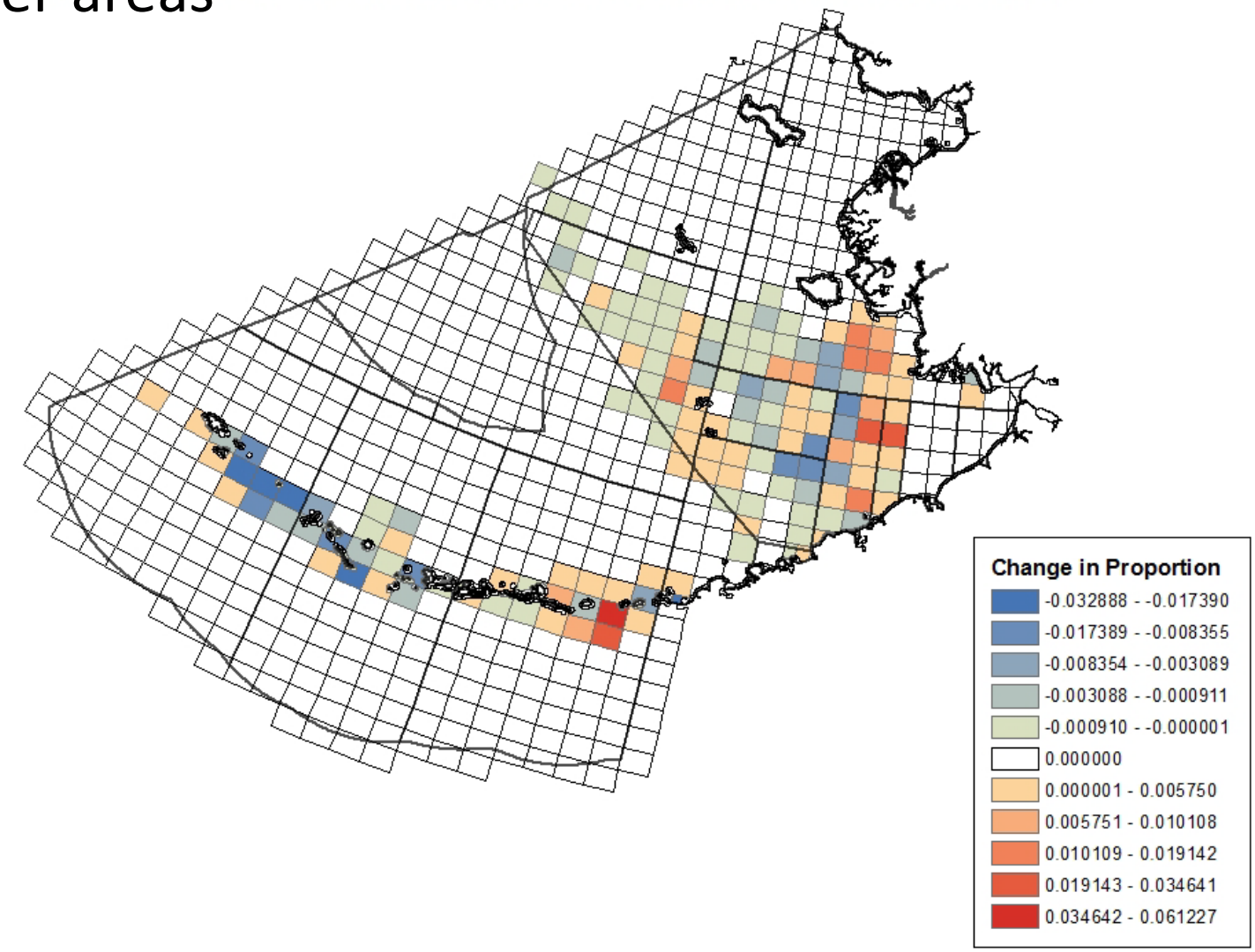
Little evidence of an effect: Why?

Substitution possibilities: “slack” in flatfish allocations



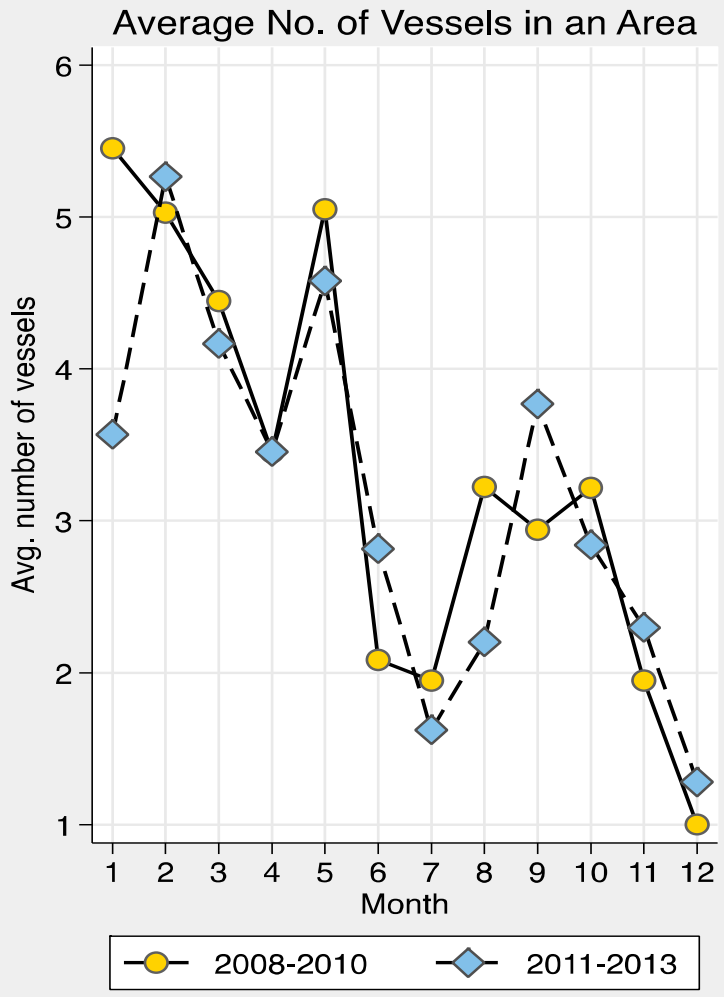
Little evidence of an effect: Why?

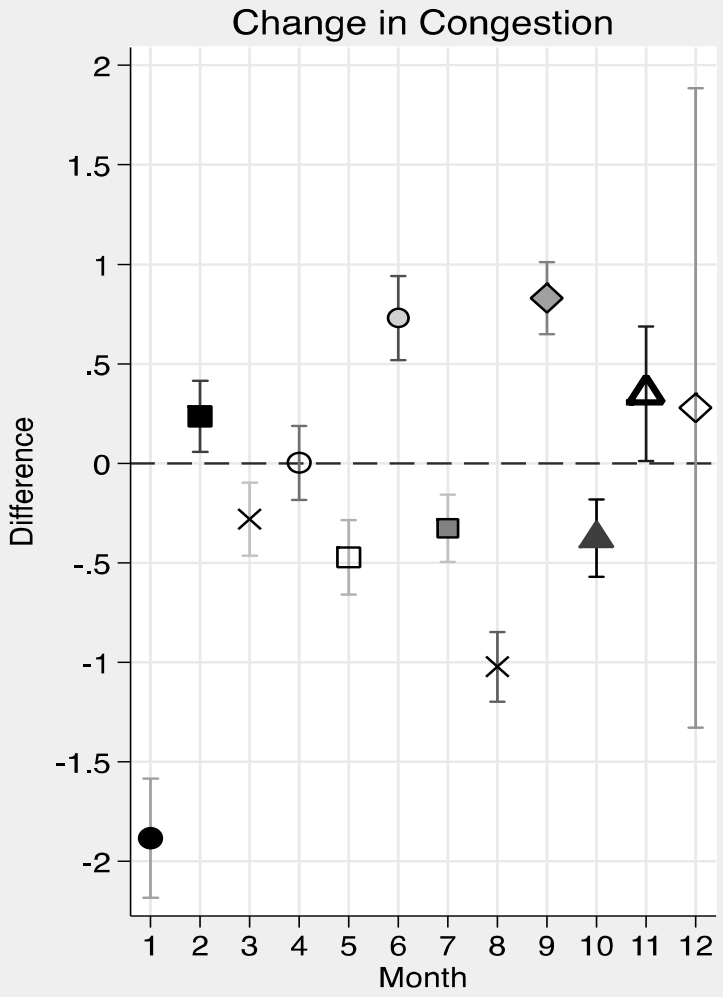
Substitution possibilities: mackerel and flatfish in other areas



Little evidence of an effect: Why?

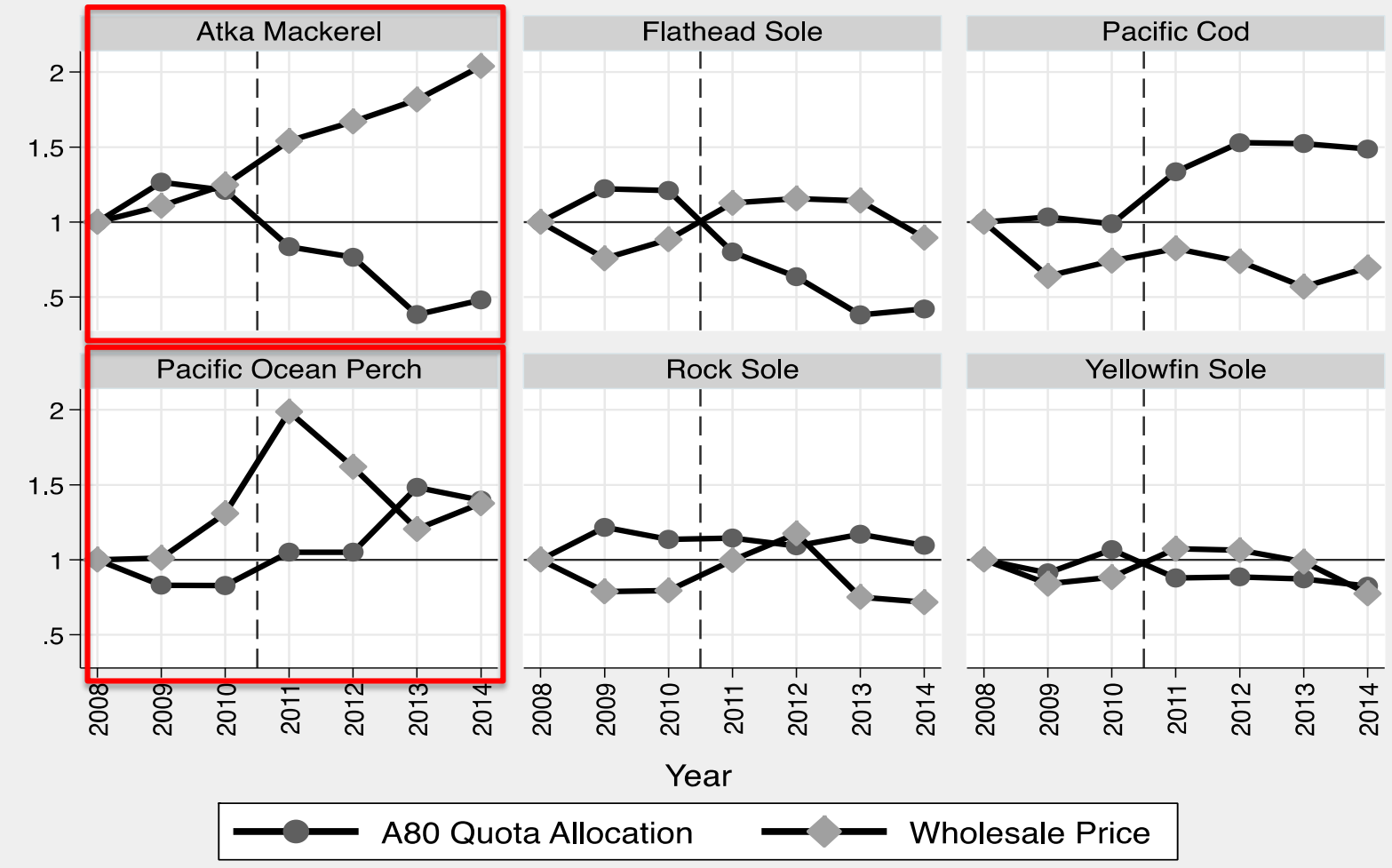
Challenges to identification: contamination/congestion





Little evidence of an effect: Why?

Challenges to identification: confounding factors



Note: quota allocations and wholesale prices measured relative to 2008

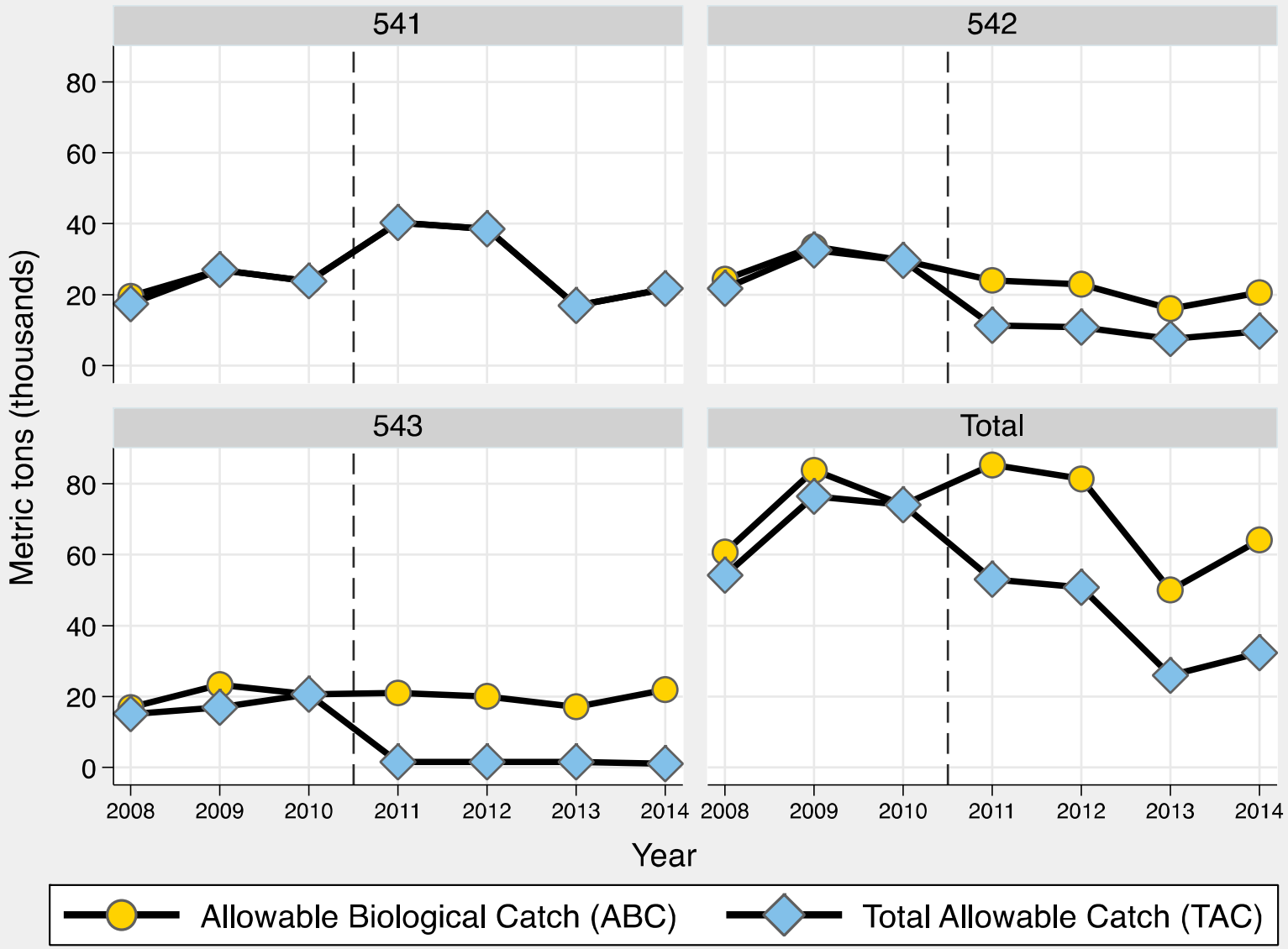
Little evidence of an effect: Why?

Challenges to identification: confounding factors

- SSL protective measures were not the only thing to happen in/after 2011:
  - Majority of the treated group formed a harvester cooperative in 2011
  - Protective measures closed more areas, but relaxed temporal restrictions in the small area that remained open
  - Years further away from intervention less likely to provide meaningful comparisons

Conclusion

- Little evidence of negative impact associated with SSL protective measures
  - Negative effects occur through higher costs, not forgone revenue
- SCM results indicate heterogeneous effects, but largely consistent with diff-in-diff
- Lack of effect likely due to substitution possibilities of fleet—slack in flatfish quota
- Costs associated with closures will be context specific, and will depend on other management institutions and substitution possibilities

Questions?

SSL Protective Measures: Allocations