Efficiency Costs of Non-efficiency Objectives in Tradable Permit Programs

Kailin Kroetz

Resources for the Future, Washington DC

James N. Sanchirico

University of California, Davis, and
University Fellow, Resources for the Future

Daniel K. Lew

Alaska Fisheries Science Center, National Marine Fisheries Service

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Tradable permit programs: Cap and Trade interventions

- Policy instrument to manage emission and common-pool resource allocations
  - Pollution (air and water)
  - Resource use (catch in fisheries)
  - Production (dairy quotas, habitat)
- In theory the economically efficiency solution as long as cap is set optimally

Associated social impacts

- Trade of permits can redistribute negative impacts (e.g. hot spots for pollution) or scarce resources (e.g. fisheries catch allocations) raising distributional concerns
  - Within program equity concerns related to "winners" and "losers" (Hahn 1984)
  - Impacts beyond program participants (e.g. Olsen, 2011)
    - Environmental justice and community impacts of CA AB32 (CA Carbon Market)

Individual transferable quota (ITQ) programs

- In theory, with unrestricted trading, an ITQ program can achieve the ***highest net return*** for a given total allowable catch over time.
- In practice, ITQ programs incorporate non-economic efficiency objectives in their design.
  - Concerns over the winners and losers within the program participants
  - Impacts on regional economies
  - Values (benefits) associated with broader fishing community sustainability and local culture

Addressing Social Impacts

- Retain efficient cap and trade structure but tax rents and redistribute
  - FONCOPES: Peruvian program accompanying Anchovy permit program
    - Funded by landings tax
    - Offering benefits including job retraining programs and retirement incentives to crew
  - Revenue recycling to offset electricity price increases of households
- Alter program design of cap and trade (e.g., trading restrictions)

NOAA's Policy goal

- "To achieve long-term ecological and economic sustainability of the Nation's fishery resources and fishing communities, NOAA **encourages the consideration and adoption of catch shares (ITQs, cooperatives)** wherever appropriate ..., and will support the design, implementation, and monitoring of catch share programs."
- Policy includes guiding principles to "ensure the best possible design and outcomes."
  - Examples:
    - ***Transferability***: Councils should thoroughly assess the *net benefits* of catch share transferability.
    - ***Fishing Community Sustainability***: Councils should develop policies to engage with and promote the sustained participation of fishing communities.

Research question

- ***What are the potential economic costs of meeting non-efficiency goals and what are the impacts of them on the dynamics of the industry?***
  - Magnitude of costs are context dependent. However there is little information on them.
  - To provide a measure of the costs, we use data from the Alaskan Halibut and Sablefish ITQ program to gain insights into these questions.

Research methodology: Two approaches

- **Long-run economic cost:** We use parametric and non-parametric regression analysis.
- **Dynamics of adjustment:** We develop a structural dynamic discrete choice econometric model of entry/exit decisions.
- In both approaches, we utilize the fact that the designers of the Alaskan Halibut and Sablefish program included a "policy" experiment where some quota was restricted and some was not.
  - Exploit the policy experiment to identify of the costs

Summary of findings (long-run)

Change in long-run resource rent ($ million)	
Halibut	-139.7 (-117.3, -94.9)
Sablefish	-39.5 (-62.7, -16.3)

Kroetz, Sanchirico, and Lew, JAERE 2015

- ~25% and 9% reductions in resource rent in the halibut and sablefish fisheries, respectively
- Key assumption is that vessels/fishermen have had the opportunity to optimize their operations under the restrictions.

Summary of **preliminary** findings on dynamic adjustment

- During the early years of the program, we estimate that without one of the restrictions (vessel length), the average yearly resource rent would be
  - ~80% higher in halibut
  - ~60% higher in sablefish.
- Restrictions change the spatial and size distribution of vessels remaining in the fishery.

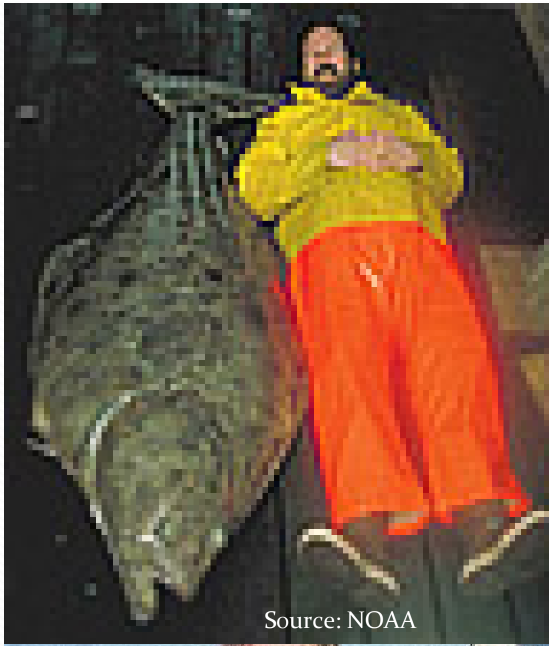
Overview of the talk

- Introduction
- Alaskan halibut and sablefish ITQ program
- Long-run analysis
  - Methodology & Data
  - Results
- Dynamic analysis
  - Methodology & Data
  - Preliminary results
- Conclusions and further work


Source: Sea Grant

Alaskan halibut and sablefish

- Implemented an IFQ in 1995 to manage the two fisheries
- Limits on transferability created by assigning attributes to permits (species/area/blocking status/vessel class)
- Effectively creates submarkets
  - Not everyone can fish all types (attribute groups) of permits
  - In effect, can only buy/sell permits within an attribute grouping


Source: NOAA


Source: ADFG

Limits on transferability

- Permits (quota) assigned to vessel classes
  - **<u>Halibut:</u>**
    - A (Unrestricted size and type)
    - B (>60ft catcher vessel)
    - C (35-60ft catcher vessel)
    - D (<35ft catcher vessel)
  - **<u>Sablefish:</u>**
    - A (Unrestricted size and type)
    - B (>60ft catcher vessel)
    - C (<60ft catcher vessel)

Limits on transferability

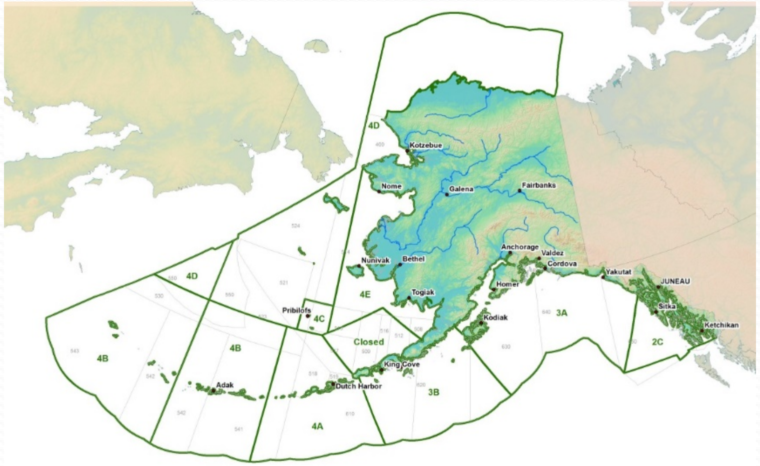
- Quota assigned blocking status (unblocked or blocked)
  - Restricts divisibility and accumulation
    - Participants eligible for very small amounts of quota received their quota as blocks - a block of QS must be bought/sold together
    - If you hold two blocks of quota, you cannot hold unblocked
    - Limited in number of blocks you can hold(changed over time)
- Quota assigned to biological management areas

Total allowable catch by restriction in 2011

	Halibut			Sablefish		
Vessel Class	Unblocked	Blocked	*Total*	Unblocked	Blocked	*Total*
A	2%	1%	*3%*	20%	2%	*22%*
B	32%	10%	*42%*	35%	6%	*41%*
C	21%	27%	*48%*	29%	8%	*37%*
D	1%	6%	*7%*	–	–	–
Total	*55%*	*45%*	*100%*	*84%*	*16%*	*100%*

Rationale for restrictions

- Limit consolidation of ownership
  - Slow down the reorganization of the fleet over time
- Maintain diversity of the fleet
- Minimize adverse community impacts, especially in the more remote Alaskan communities



Source: NOAA

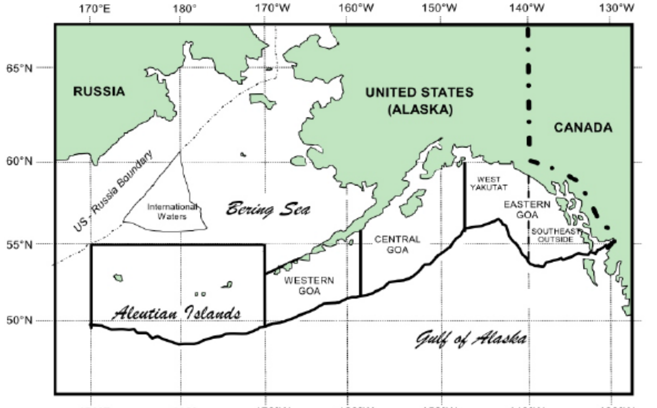


Figure 2: Sablefish Regulatory Areas
Reprinted from the National Marine Fisheries, Alaska Regional Office webpage

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Long-run analysis: Methodology

- Quota share is an asset granting access to current and future percentage of the total allowable catch.
  - Sale price of the quota share equals the present discounted return to fishing a percentage of the TAC in the future.
- Due to the relationship between profitability and sale prices, restrictions impact sale prices.
  - With restricted and unrestricted submarkets, marginal costs are equalized ***within*** the submarket and not necessarily ***between*** submarkets.

Long-run analysis: Methodology

- Identification
  - Restrictions only apply to segments of the fishery
  - Observe restricted and unrestricted quota prices
- Assumptions
  - Competitive markets for quota
  - Equilibrium without restrictions would consist of vessels with similar cost structures to those fishing in the unrestricted segment of the fishery.

Long-run analysis: Methodology

- Measuring the cost:
  - Difference in per-unit resource rent between unrestricted and restricted quota.
  - Difference in total resource rent between the scenario with restrictions in place versus without

    (Difference in per-unit rent*quantity of restricted quota)

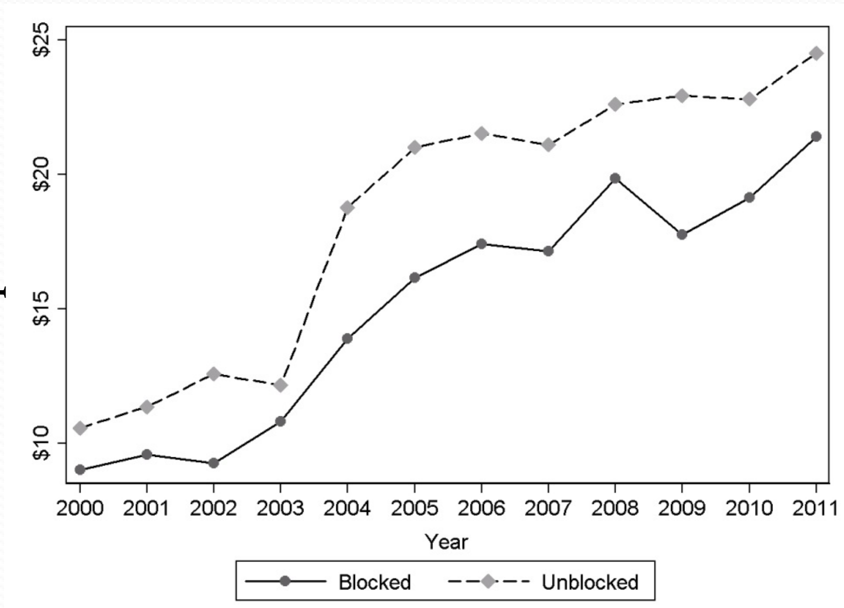
Long-run analysis: Data

- Quota trading data
  - Use "arms length" transactions from **2000-2011**
    - Approximately 3,100 halibut transactions
    - Approximately 1,300 sablefish transactions
  - Fields include:
    - Quota attributes (e.g. species/class/area/blocking)
    - Quantity traded
    - Price per unit paid in the exchange
    - Buyer characteristics
    - Seller characteristics

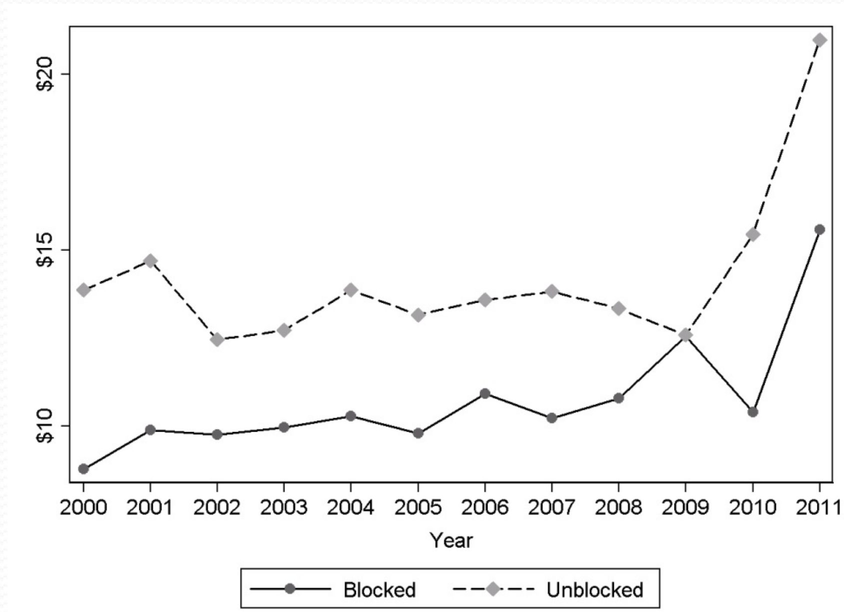
Quota prices by blocking status

Halibut

$ per lb.



Sablefish

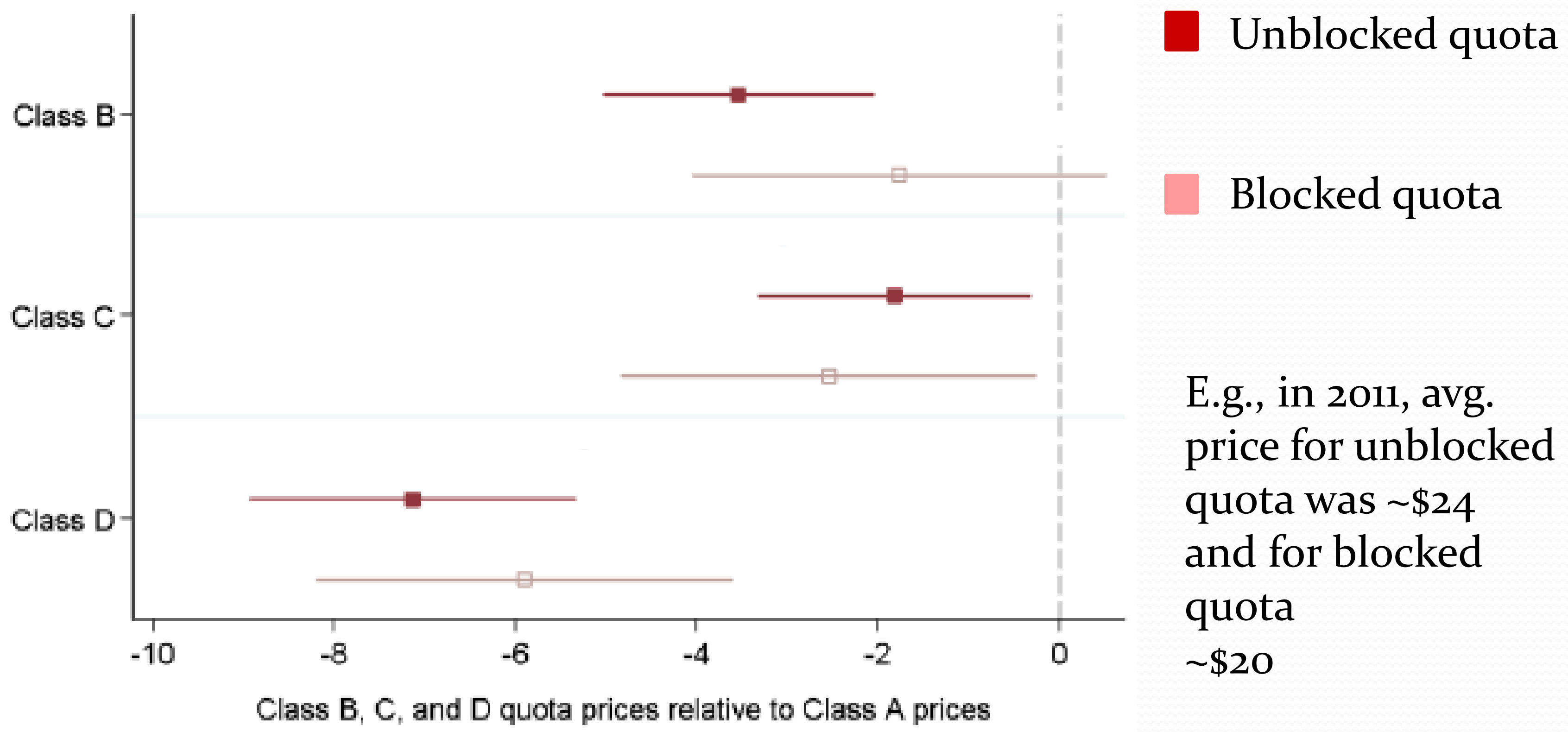


- Avg. across all vessel classes and areas

Estimation procedure

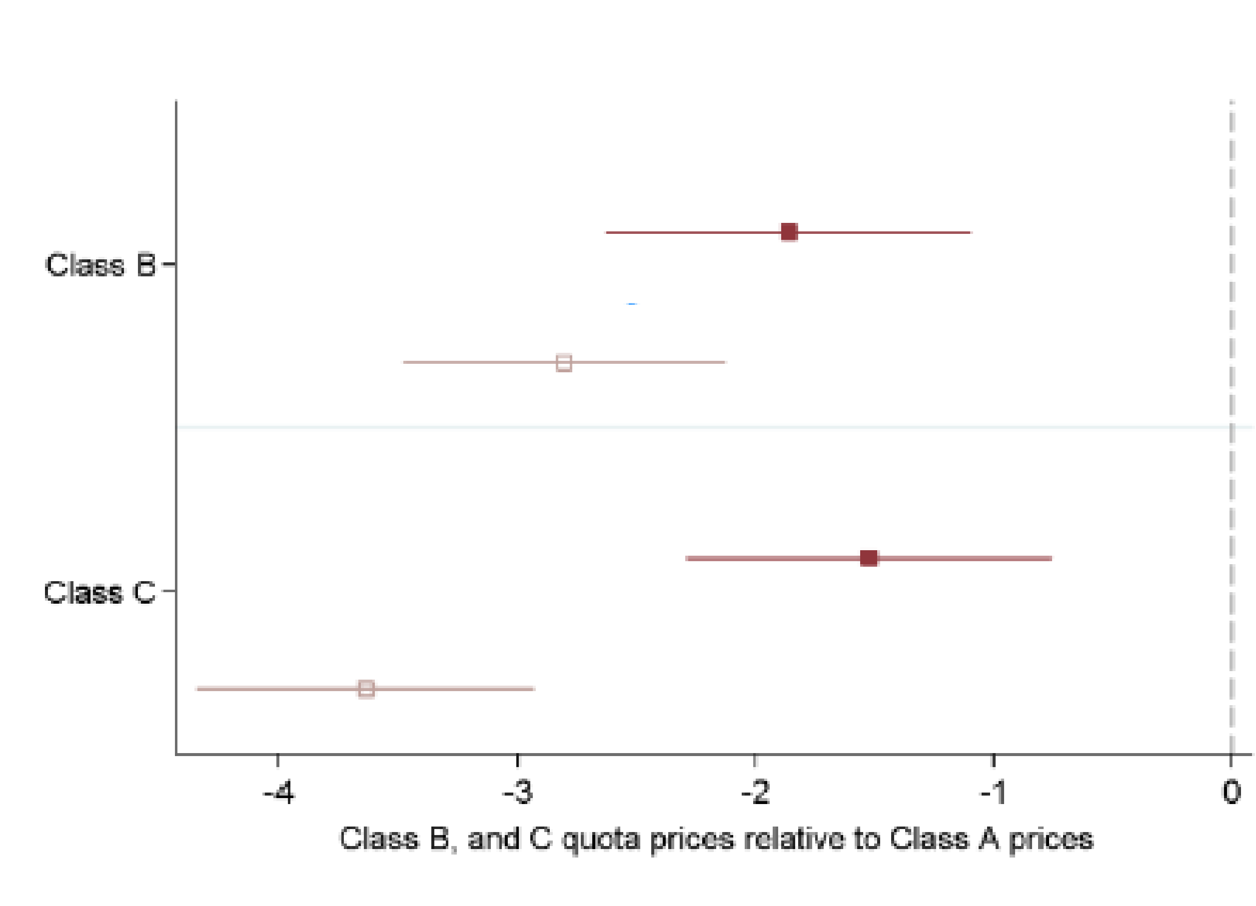
- Construct separate parametric linear regression model for each species
- Model quota price (dependent variable) as a function of submarket (restricted/unrestricted) and other explanatory variables
  - Use a dummy variable for whether quota is restricted or unrestricted
  - Explanatory variables include area, policy changes, year, and season fixed effects
  - Estimate model with quota price in **levels** (LM) and logs (LLM)
- Undertake a set of robustness tests, including parametric and non-parametric analysis on larger markets

Halibut **vessel class** results



E.g., in 2011, avg. price for unblocked quota was ~$24 and for blocked quota ~$20

Sablefish **vessel class** results: unweighted regression

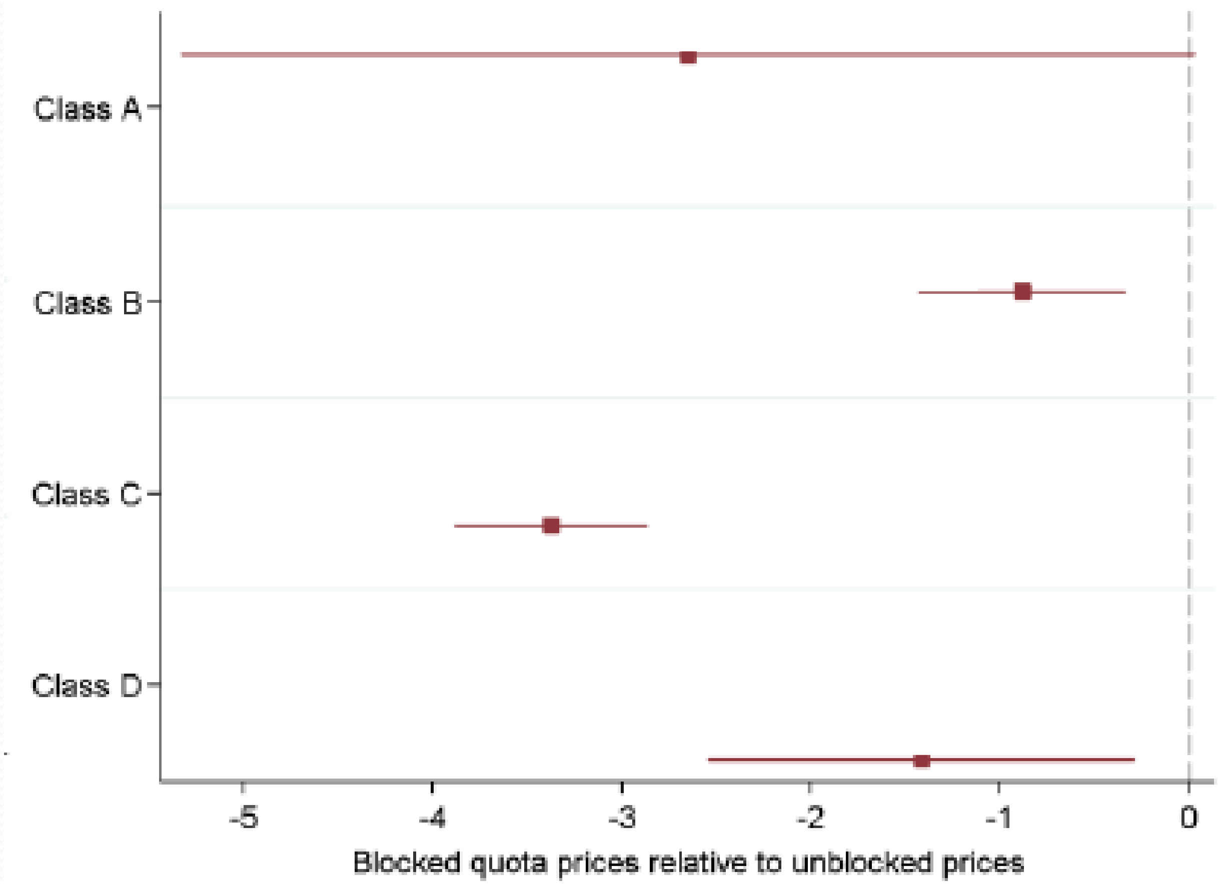


Unblocked quota

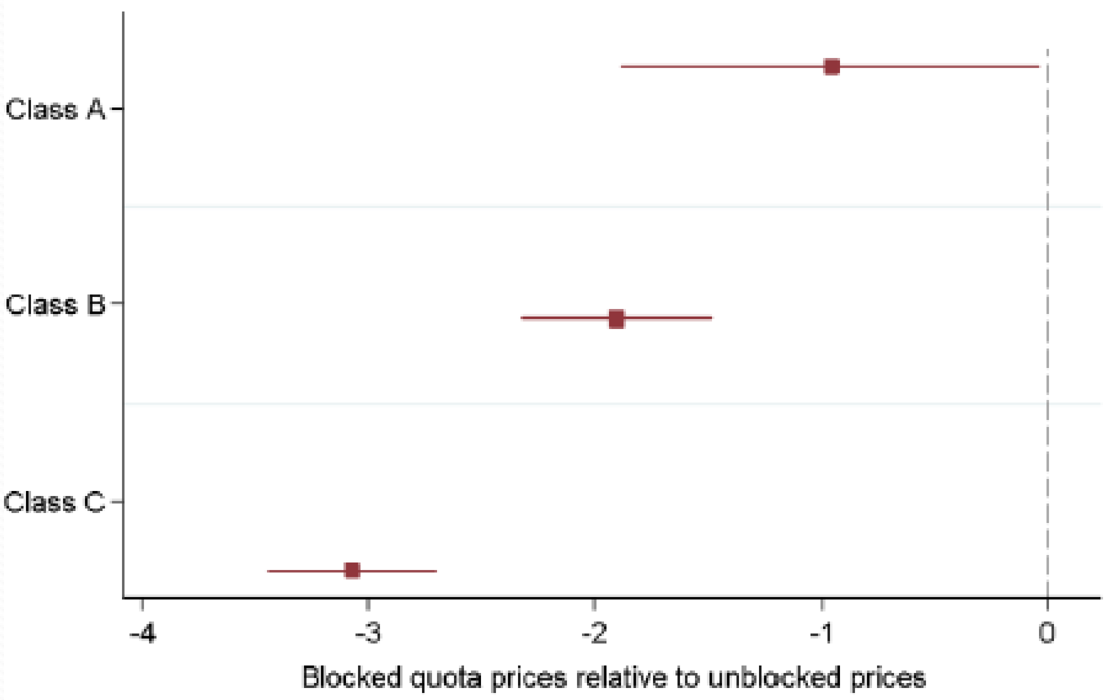
Blocked quota

E.g., in 2011, avg. price for unblocked quota was ~$20 and for blocked quota ~$15

Halibut blocking results



Sablefish blocking results: unweighted

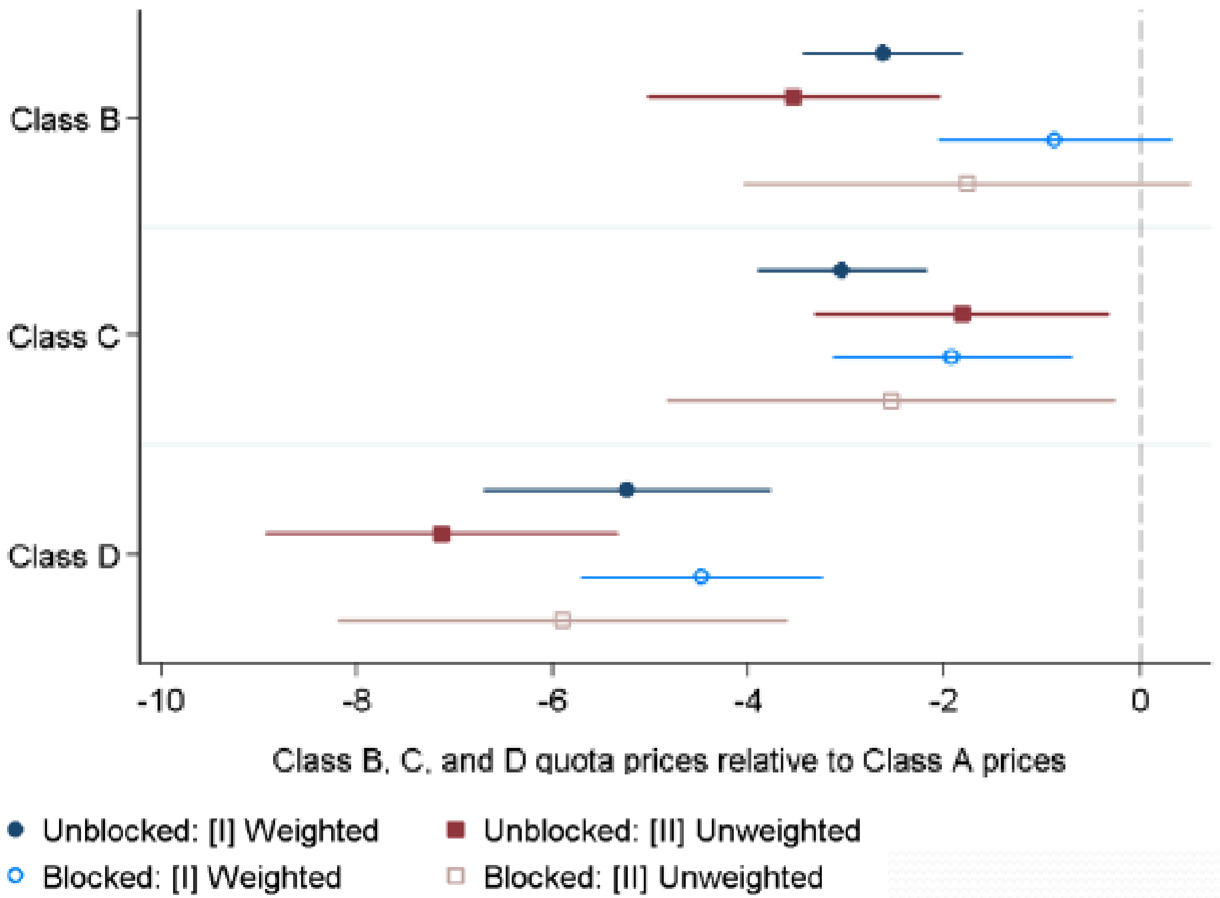


- Recall only 2% of A quota is blocked in Sablefish

Robustness checks: Parametric

- Market size and trade quantity
  - **Assign higher weight in the regression to more-active markets and larger trades (weight by quota volume in submarket (area/blocking/class group))**
- Block size
  - Examine whether potential variation in price/lb based on the size of the block impacts our estimates (weight by pounds)
- We find that
  - Coefficients have similar sign and magnitude
  - Confidence intervals for total costs of restrictions under these different cases generally overlap

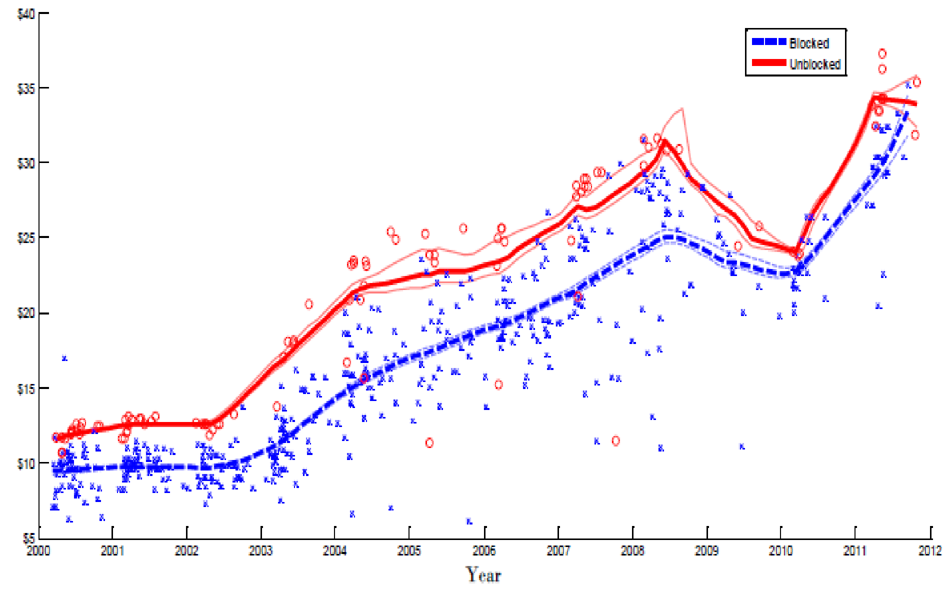
E.g., Halibut vessel class results



Robustness checks: Non-parametric

- Use local linear regression to construct non-parametric estimates of restricted and unrestricted quota prices
  - Epanechnikov weights and fixed window of 12 months
  - Bootstrapped CIs based on re-estimating curves randomly dropping 10% of observations

Halibut Area 3A Class C



Discussion

- ~25% and 9% reductions in resource rent in the halibut and sablefish fisheries, respectively.
  - Vessel class restrictions contribute more to the reductions than blocking in both fisheries (e.g., 40% in halibut)
- **Restrictions to meet non-economic goals could end up being a regressive policy**
  - Quota allocated (wealth transfer) to smaller operations/vessels is worth less than the quota allocated to the larger operations/vessels.

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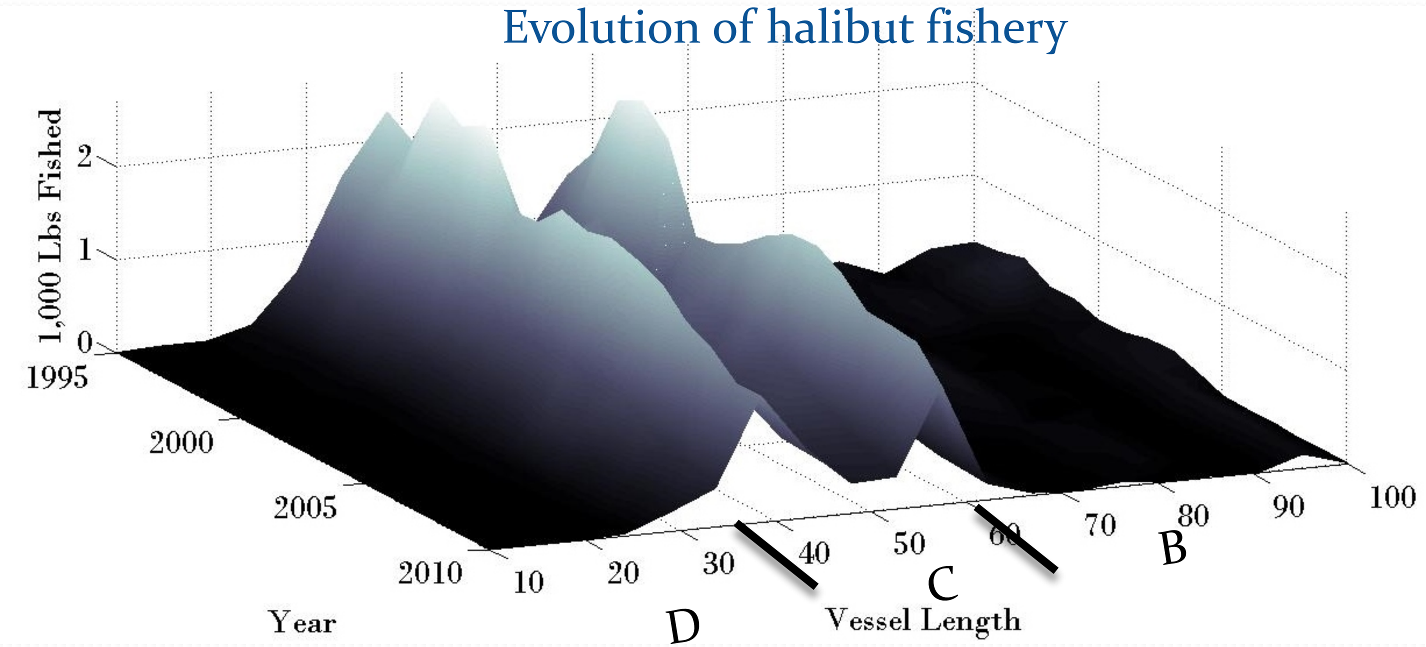
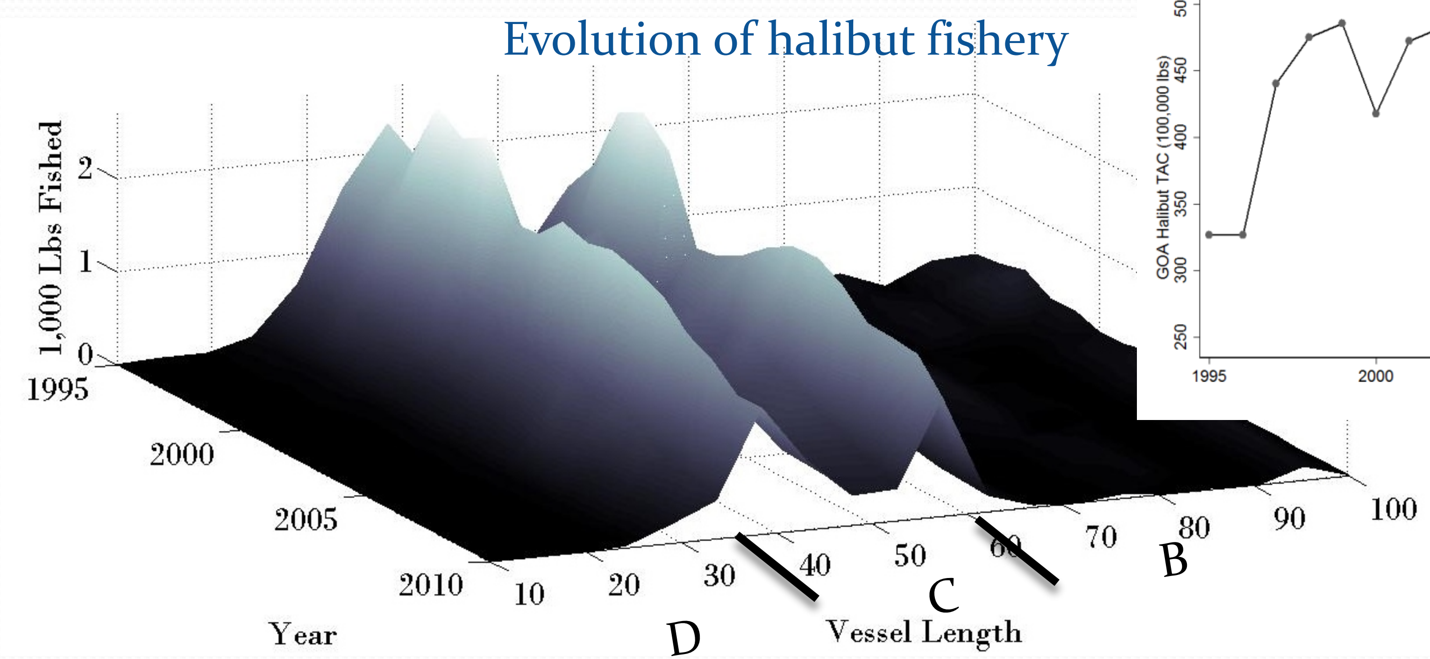
Dynamic impacts of restrictions

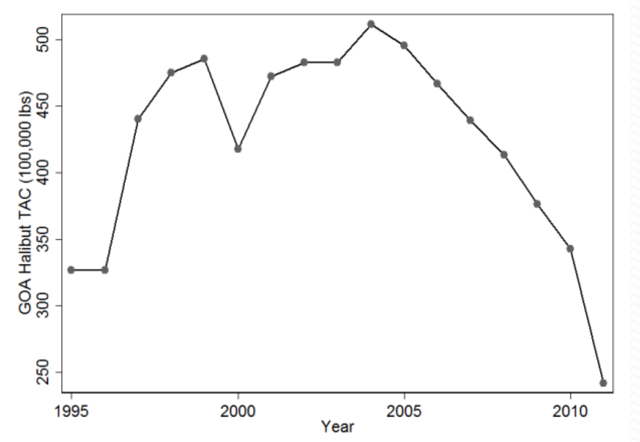
- ***Research question: What are the impacts of trading restrictions on the dynamic adjustments of the industry?***
  - Restrictions can impact
    - the total number of vessels
    - the distribution of vessel lengths
    - the geographic distribution of participants exiting the program over time
  - Adjustment might not be instantaneous even without restrictions due to less malleable inputs

Dynamic impacts of restrictions



Dynamic impacts of restrictions





Dynamic: Methodology overview

- Construct a dynamic model at the vessel level to conduct policy simulations to evaluate program effectiveness
  - How would the fishery develop over time with an unrestricted quota market (counterfactual)?
  - Examine counterfactual outcome in terms of
    - **Economic costs due to the restrictions**
    - **Number of active vessels**
    - **Geographic distribution of vessels**

Dynamic: Methodology overview

- Approach
  - Use observed fishery data to estimate a dynamic structural model at the vessel level that captures the discrete choice in each year on whether to remain in the fishery or exit
  - Recover profit function coefficients
  - Remove restriction(s) and solve for new transition

Dynamic: Methodology overview

- Exit decision each year is binary: in or out
  - Assume a vessel will remain in the fishery if there are non-negative discounted expected profits to be made today and in the future
  - If a vessel decides not to fish, then the owner can sell/rent/use the vessel in another fishery, and sell/lease the quota
    - Timing of exit decision depends on current and expected levels of the TAC, ex-vessel price, fuel price, quota price, and opportunity costs of participating
      - Opportunity costs of participating in the fishery depend on the markets for capital and labor

Dynamic: Data

- **Ex-vessel price** (1995-present): Ex-vessel price data for all landings since the inception of the program
- **Landings data** (1995-present): Location and quantity landed by each vessel
- **Vessel characteristics** (1995-present): Data on vessel characteristics including vessel age, vessel length, vessel horsepower, and vessel tonnage
- **Other publically available data** (1995-present): Include fuel prices, total allowable catch (TAC), stock levels from stock assessments

Dynamic: Data (cont.)

- In the current analysis, we are focusing
  - on owner operators of single vessels (due to matching across the different datasets)
  - on the Gulf of Alaska component of the fisheries (we discard vessels that did not land 80% of their fished pounds in the GOA)
  - on vessels that fished primarily blocked or unblocked quota pounds (80% was cut-off)
- Current sample is
  - 1,100 vessels out of 2000 for the halibut fishery
  - 350 out of 600 vessels for the sablefish fishery

Dynamic: Structural estimation

Five step procedure:

1. Estimate the parameters of the probit policy function, which is used to generate the observed probability of exiting/remaining in the fishery (Huang and Smith, 2010)
2. Estimate the parameters of the variable profit function for each attribute class (lease price is latent variable)
3. Estimate the parameters of transition equations for the stochastic variables, which are ex-vessel prices (own and salmon), stock, **quota price**, fuel price, and demand for capital and labor

Dynamic: Structural estimation

4. Estimate the value function conditional on parameters from steps 1-3 via Simulation-based Conditional Choice Probability
5. Pseudo-Maximum Likelihood estimator to estimate coefficients of a function characterizing the opportunity cost of participating (Aguirregabiria and Mira, 2002)
   - Minimize difference between model predictions and observed exit decisions over time

Dynamic: Counterfactual

- Use profit function estimates for each participant at the start of the program
- Remove one or more of the restrictions (e.g., allow vessels of different sizes to trade)
  - Assume a competitive equilibrium each year in the quota market.

Dynamic: Counterfactual

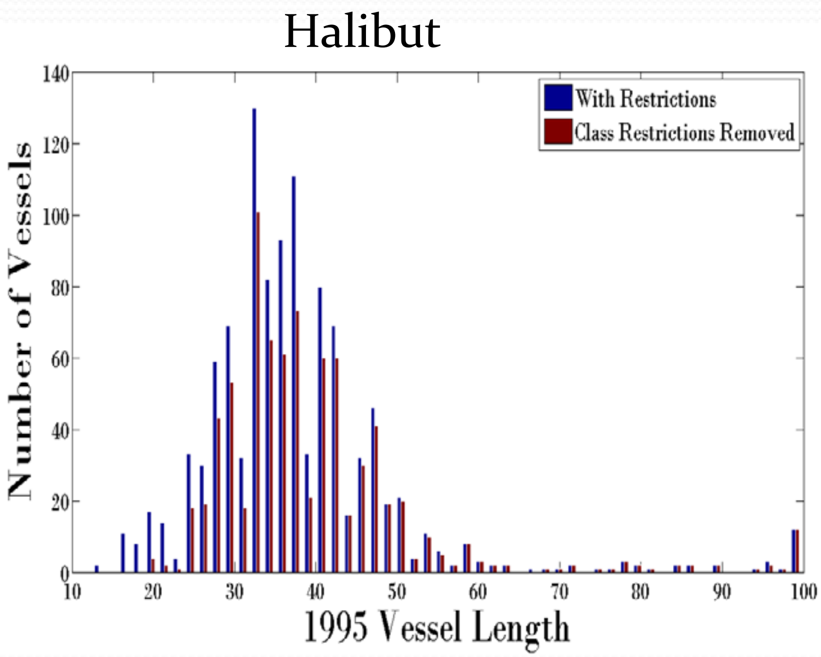
- Solve for the unrestricted outcome allowing the number of vessels exiting and quota prices to differ in the unrestricted and restricted (actual) scenario
  - This requires a stochastic dynamic optimization model where # of vessels and quota prices are chosen each period subject to
    - (1) vessels exit when no longer profitable to fish,
    - (2) the sum of the quantities fished each year equals the TAC
    - (3) restriction is removed

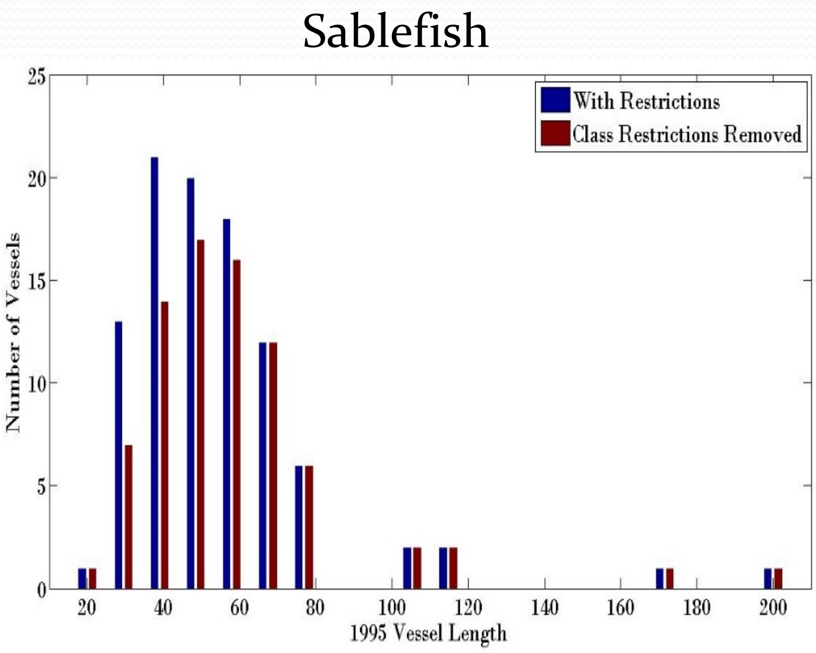
Dynamic: Vessel class removed

- During the early yea… …r the program (1995-1999), we estimate that wi… …ut one of the restrictions (vessel length), the ***a… …age yearly resource rent*** would be
  - ~80% hi… …r in halibut
  - ~60… …gher in sablefish.

Preliminary results

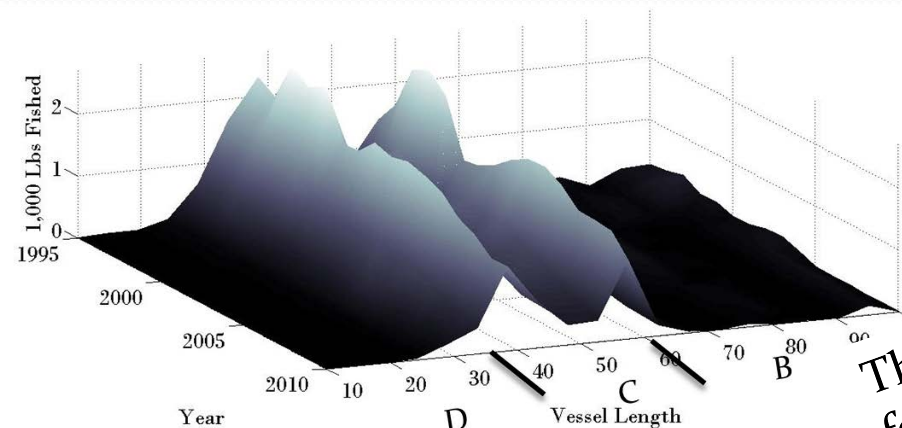
Dynamic: Snapshot of vessel length in 1995 (Preliminary results only)

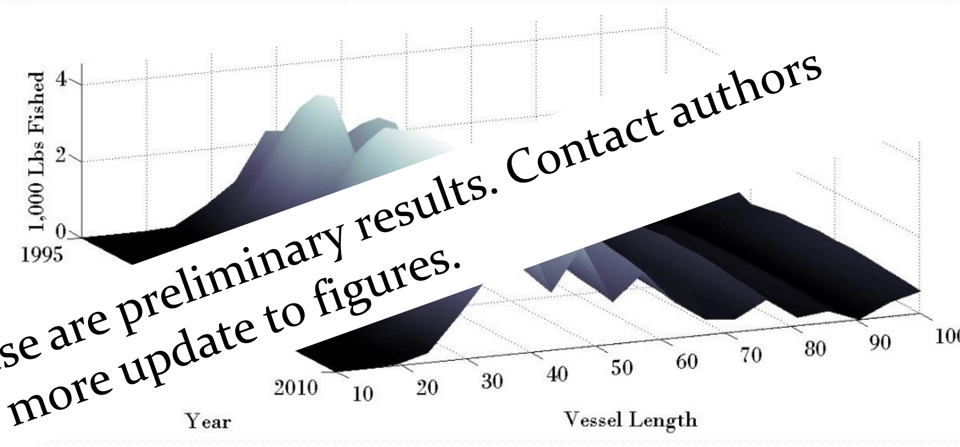




Dynamic: Vessel length distribution

- Actual halibut landings by length over time
- Counterfactual halibut landings by length over time





These are preliminary results. Contact authors for more update to figures.

Geographic distribution of quota owner exit in halibut fishery

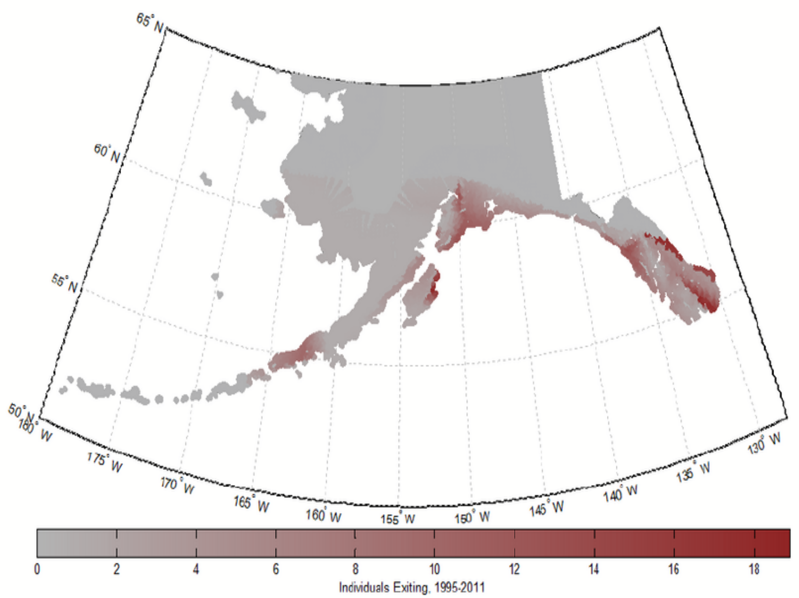


Figure 5.0.1: *Net loss of individuals in the halibut fishery between 1995 and 2011.*

Image removed for confidentiality concerns
Contact authors for more information.

- Loss of individuals between 1995 and 2011

- Counterfactual: Between **1995 and 2000** an additional 44 owners exit
  - In 2011, ~1000 quota owners in halibut

Conclusions

- Economic costs of restrictions can be a significant share of value of the fishery
  - Political economy issues related to implementation of tradable permit programs in practice are complex.
    - Might lead to sooner adoption of program.
    - Might be a regressive policy.
- Quantitative estimates of the costs of restrictions can improve decision-making by allowing for comparisons to potential benefits

Future work

- Additional counterfactual scenarios
  - Exploring impacts of restrictions on capital inputs, divisibility of the permit, and accumulation limits
  - **Interactions between restrictions e.g., relax both the blocking and vessel class restriction simultaneously**
  - Investigate the relaxation of area designations
- Measure the social and equity implications of different restriction combinations
  - What are the characteristics of the communities that we estimate would have lost quota owners?

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