Technical Efficiency & Capacity Reduction
A case study of vessel buyouts in California

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Motivations

Determine how policy instruments impact decisions of *individual* fishers

— how does policy impact efficiency of the individual?

The Big Groundfish Picture

- Harvest Controls & Uncertainty
- Technical efficiency
- Spatial Dynamics
- Capacity Reduction
- Marine Reserves

Harvest Controls
Fishery Background

- 3rd largest commercial fishery (by value) in California
- 12% of statewide commercial fishing revenues
- Managed to provide year round landings through:
  - Trip Limits (Catch limits)
  - Gear Restrictions
  - Area Closures (RCAs)
Current Study

Goal: to assess the efficiency implications of the groundfish trawl buyback at the vessel level.

Motivation:
Efficiency & Capacity Utilization have been estimated for almost all major fisheries in the U.S. (*National Assessment of Excess Harvesting Capacity in Federally Managed Commercial Fisheries*)...examining how technical efficiency changes as the individual’s choice set changes seems a less popular pursuit.

Notable Exceptions:
- **Fisheries**
  - Felthoven, 2002
  - Pascoe, Andersen & de Wilde, 2004
- **Econ**
  - Millimet and Collier, 2008
How might a vessel buyout impact efficiency?

- Crowding effects (+)
- Competition effects (+, -)
- Stock effects (+)
Buyback Basics

- Fishery declared a federal disaster in 2000
- Pacific Groundfish Limited Entry Trawl Buyback Program instituted in 2003
- 91 limited entry groundfish trawl vessels retired coastwide
- 43 from California
- Bids scored according to landings
- Mostly industry funded –
  - Feds put up initial $43 million
  - $36 million to be paid back

![Map of Zone 1, Zone 2, Zone 3, Zone 4 with ports indicated]
Data

- Tow-level logbook data provided by PacFIN
  - California only
  - Limited entry vessels only
  - Data on: tow location, depth, lbs, value, self-reported target

- Vessel characteristics data provided by NMFS NWR
  - Vessel length, weight and horsepower

- Buyback Info taken from Federal Registrar
  - Sellers versus non-sellers
Schmidt & Sickles (1984) model w/time invariant efficiency:

\[ y_{it} = \alpha + x_{it} \beta - u_i + \varepsilon_{it} \]

Alternative:
- Green (2004): time variant efficiency

Although Green’s model allows time variant inefficiency, it requires inefficiency to be independent across cross-sectional units...ignoring competition effects.
Practical Issues

Multi-species Fishery:
- Use a subsample of data:
  - DTS vessels only (annual DTS revenue > 60% of total vessel revenue)

- DTS is the largest segment of the fishery
  - by volume (roughly 60% of total landings)
  - by effort (70% of total effort)

- DTS landings make up 85% of total landings on DTS tows
Practical Issues

Trip Limits:

- Define dependent variable as DTS catch-limit fulfillment \( y_{it} = \frac{lbs_{it}}{L} \)

Note: only vessels with 2 month DTS landings totals > 20,000 pictured.
Data Summary

Distributions of Dependent Variable

<table>
<thead>
<tr>
<th>Year</th>
<th>Sellers</th>
<th>Non-Sellers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td><img src="image1.png" alt="Boxplot" /></td>
<td><img src="image2.png" alt="Boxplot" /></td>
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<tr>
<td>2001</td>
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<tr>
<td>2002</td>
<td><img src="image5.png" alt="Boxplot" /></td>
<td><img src="image6.png" alt="Boxplot" /></td>
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</tbody>
</table>

N = 38 Sellers
32 Non-Sellers
Capital Inputs

Two sample KS test for equality of distribution functions

HORSEPOWER

<table>
<thead>
<tr>
<th>Smaller Group</th>
<th>D</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sellers</td>
<td>0.184</td>
<td>0.317</td>
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<tr>
<td>~Sellers</td>
<td>-0.111</td>
<td>0.658</td>
</tr>
<tr>
<td>Comb</td>
<td>0.18</td>
<td>0.615</td>
</tr>
</tbody>
</table>

VESSEL LENGTH

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Sellers</td>
<td>0.166</td>
<td>0.390</td>
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<tr>
<td>~Sellers</td>
<td>-0.045</td>
<td>0.933</td>
</tr>
<tr>
<td>Comb</td>
<td>0.166</td>
<td>0.734</td>
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</tbody>
</table>
Variable Inputs

Two sample KS test for equality of distribution functions

\[ D \]  \( p \)

**Smaller Group**

<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sellers</td>
<td>0.131</td>
<td>0.533</td>
</tr>
<tr>
<td>~Sellers</td>
<td>-0.068</td>
<td>0.842</td>
</tr>
<tr>
<td>Comb</td>
<td>0.131</td>
<td>0.912</td>
</tr>
</tbody>
</table>

**Tow Hours**

\[ D \]  \( p \)

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<tr>
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</tbody>
</table>
Estimation

\[ \ln y_{it} = \alpha + \ln x_{it} \beta + _{M}Y + _{P} \phi + _{T} \omega - u_i + \varepsilon_i \]

Where:

- \(X\) = (days at sea, tow hours)
- \(_{P}\) = dummy variables indicating primary port
- \(_{M}\) = month group dummy variables
- \(_{T}\) = yearly dummy variables

<table>
<thead>
<tr>
<th>Model</th>
<th>N</th>
<th>Groups</th>
<th>F-test: Joint significance of vessel-level fixed effects (p-value)</th>
<th>R-sq</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>Within</td>
<td>Between</td>
</tr>
<tr>
<td>Pre-buyback</td>
<td>573</td>
<td>70</td>
<td>2.27 (0.000)</td>
<td>0.524</td>
</tr>
<tr>
<td>Post-buyback</td>
<td>191</td>
<td>29</td>
<td>3.378 (0.000)</td>
<td>0.596</td>
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</tbody>
</table>
Results

- Mean efficiency increases from 69% to 76%
- Mass of efficiency distribution shifts
- Efficiency distribution among non-sellers shifts
- KS-test confirms difference in efficiency among non-sellers significant w/ $p = 0.051$
Summary

Did capacity reduction have a measurable impact on output efficiency of the fleet?
- our results suggest this was the case…however,
- confounding management actions make it difficult to establish causality

Can we determine whether vessel reduction had implications for efficiency at the vessel level?
- again our results suggest yes…however,
- time invariant specification for efficiency makes it difficult to prove this:
  - If the hyper efficient vessel actually became less efficient the rest of the fleet could be no more efficient yet appear to be.
Extensions