Science, Service, Stewardship

The Impact of Catch Shares on Fishing Income Diversification and Variation in Annual Revenue

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Introduction

- Diversification is a risk reduction strategy that is available to fishermen who often face very high inter-annual variation in income
- Year-to-year variation in fishing revenue has been shown to be lower on average for more diversified vessels and fishing communities (Kasperski and Holland 2013)
- The ability to diversify has been reduced in the last few decades as a consequence of limited entry programs and may have been further reduced by catch share programs
- However, catch shares could provide diversification opportunities for new entrants through purchase or lease of catch shares
- More secure catch privileges under catch shares may also help to stabilize income over time and counter effects of lower diversification
- This study examines these questions empirically using case studies of several US catch share fisheries in diverse regions including Alaska, West Coast, Gulf of Mexico, Southeast, Mid-Atlantic, and the Northeast

Catch Share Fishery Case Studies

Region	Fishery	Catch Share Implemented
North Pacific	North Pacific Halibut & Sablefish	1995
	Bering Sea American Fisheries Act (AFA) Pollock	1999
	BSAI King & Tanner Crab	2005
	BSAI Non-pollock Groundfish Trawl CP	2008
	Central Gulf of Alaska Rockfish	2007
Pacific	Pacific Coast Fixed Gear Sablefish	2001
	Pacific Coast Groundfish Bottom Trawl	2011
	Pacific Whiting	2011
New England	Northeast Multispecies Groundfish	2010
	General Category Atlantic Scallops	2010
Mid-Atlantic	Mid Atlantic Golden Tilefish	2009
South Atlantic	South Atlantic Wreckfish	1992
Gulf of Mexico	Gulf of Mexico Red Snapper	2007
	Gulf of Mexico Grouper and Tilefish	2010

Diversification/Specialization Metrics

- Herfindahl-Hirschman Index: calculated by summing the squares of the percentages of gross annual revenues derived from species group *i* and is defined for each vessel as:

$$HHI = \sum_{i=1}^{S} p_i^{\,2}$$

where p_i represents percent (ranging from 0 to 100) of an entity's total gross revenues derived from species group

The HHI index falls from a value of 10,000 (when revenue is from a single fishery) toward zero as either richness (e.g., number of species) or evenness of revenue distribution (among those species) increases

Methods

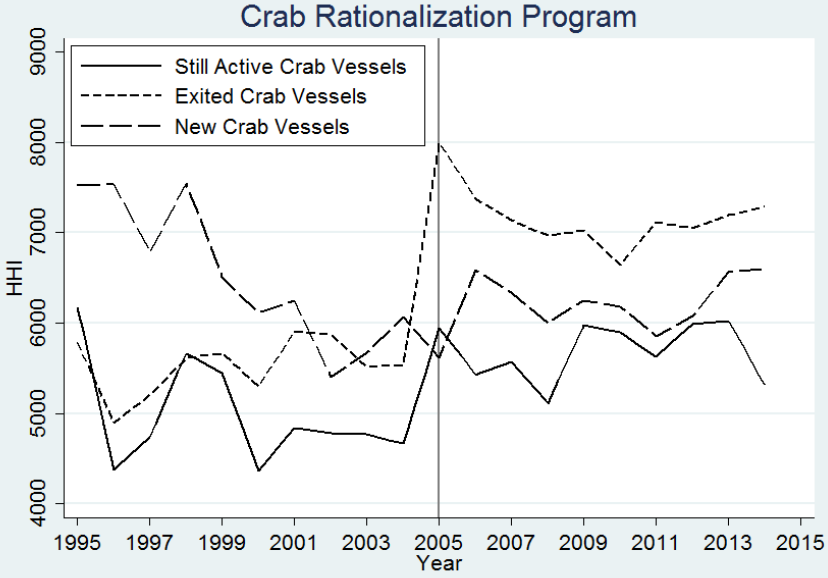
- Fleet Definitions: Out of all vessels that fished in each catch share fishery before implementation, we identify separate fleets of vessels that continued to fish in the catch share fishery (“active pre and post”) and those that exited the catch share fishery but continued fishing in other fisheries (“exited”)
- Describe trends in HHI for fleets over time and test for structural breaks in trends
- Evaluate whether changes in HHI and coefficient of variation (CV) or revenue occurred following implementation of catch shares comparing average levels for equal numbers of years pre and post catch share

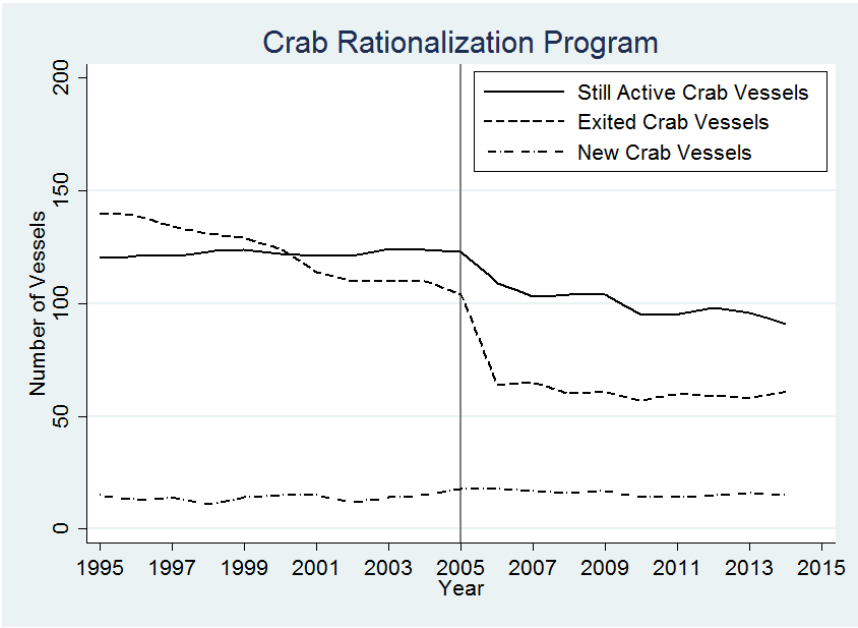
A Battery of Tests

- Fleet level changes in average HHI and CV
- Vessel level (paired) tests of changes in HHI and CV
  - Paired t-tests
  - Wilcoxon matched pairs signed rank test
- Changes in Distribution of HHI and CV
  - Kernel Density Plots
  - Kolmogorov–Smirnov two-sample test
  - SD test for equality of Variance
- Changes in Trends and Structural Break in HHI and CV
  - Supremum Wald test (tests for year of primary structural break)
  - Regression-based Chow tests for structural change
    - $\mathbf{HHI_t = \alpha + \beta trend_t + \gamma D_t + \varepsilon_t}$
    - $HHI_t = \alpha + \beta trend_t + \gamma D_t + \delta trend_t * D_t + \varepsilon_t$

Why so many tests?

- Exit of vessels from IFQ and from fishing all together suggests need to consider overall changes and vessel level changes
- Need to distinguish changes due to changes or continuation of trends vs. changes in average HHI before and after
- Non-normal Distribution of HHI suggests non-parametric tests and attention to changes in distributions





Results

Fishery		Matched Vessels	Change in HHI Paired t-test	Change in HHI Wilcoxon Signed Rank	Regression of HHI Trend Post CS Shift	CV Revenue Paired t-test	CV Revenue Wilcoxon Signed Rank
Alaska Halibut & Sablefish	Active Pre and Post	1843	Increase ***	Increase ***	Increase ***	Not significant	Not significant
	Exited	1695	Increase ***	Increase ***	Increase ***	Not significant	Not significant
	New	734	Not significant	Not significant	Increase ***	Decrease*	Not significant
Alaska BSAI Pollock	Catcher Vessels	111	Increase ***	Increase ***	Increase ***	Increase ***	Increase ***
	Catcher Processors	19	Increase ***	Increase ***	Increase **	Increase ***	Increase ***
Alaska BSAI Crab	Active Pre and Post	124	Increase ***	Increase ***	Increase ***	Not significant	Not significant
	Exited	109	Increase ***	Increase ***	Increase ***	Not significant	Not significant
	New	19	Not significant	Not significant	Not significant	Increase *	Increase *
Alaska BSAI Non-pollock (Amendment 80)		23	Increase **	Increase **	Increase **	Decrease***	Decrease***
GOA Rockfish	Active Cather Vessels	35	Not significant	Not significant	Decrease*	Not significant	Not significant
	Exited Catcher Vessels	6	Increase **	Increase *	Not significant	Not significant	Not significant
	Catcher/Processors	9	Not significant	Not significant	Increase ***	Not significant	Not significant
	Catcher/Processors	3	Not significant	Not significant	Not significant	Not significant	Not significant
Pacific Groundfish Trawl	Active Pre and Post	91	Increase ***	Increase ***	Increase**	Not significant	Not significant
	Exited	96	Increase **	Increase ***	Not significant	Not significant	Not significant
Pacific At-sea Whiting	Active Pre and Post	27	Increase ***	Increase ***	Increase **	Decrease*	Decrease*
	Exited	28	Increase ***	Increase ***	Increase **	Not significant	Not significant
Pacific Shoreside Whiting	Active Pre and Post	26	Increase ***	Increase ***	Not significant	Decrease**	Decrease**
	Exited	90	Increase ***	Increase **	Not significant	Not significant	Not significant
Pacific Sablefish	Active Pre and Post	118	Increase **	Increase **	Decrease** TR	Not significant	Not significant
	Exited	58	Increase ***	Increase ***	Increase ***	Not significant	Not significant
Northeast Groundfish	Acive Pre and Post	454	Not significant	Not significant	Decrease***	Increase ***	Increase ***
	Exited	271	Increase **	Increase **	Decrease**	Not significant	Not significant
Northeast General Category Scallop	Acive Pre and Post	222	Increase *	Not significant	Not significant	Not significant	Not significant
	Exited	55	Increase ***	Increase ***	Not significant	Increase *	Not significant
Mid Atlantic Tilefish	All	18	Not significant	Not significant	Not significant	Not significant	Not significant
Gulf Red Snapper	Acive Pre and Post	444	Increase ***	Increase ***	Increase ***	Decrease***	Decrease***
	Exited	97	Increase ***	Increase ***	Increase ***	Decrease***	Decrease***

* 10% Significance Level ** 5% Significance Level *** 1% Significance Level TR - Trend Reversed

Results Summary

- With few exceptions diversification declined (HHI increased) after implementation of catch share systems both for vessels that stayed in the catch share system and those who exited but remained fishing
- There were significant increase in HHI for over 2/3^{rds} of cases and no consistent evidence of HHI decreasing in any fishery.
- In some cases this was the continuation of pre-existing trends but in many there were distinct increases in HHI around the time catch shares were implemented
- In most cases there were not significant changes in the CV of annual revenue, and where changes were significant the number of fisheries where CV increased was about the same as the number where CV decreased.
- Key Conclusion: While catch shares do generally seem to lead to decreased diversification this doesn't necessarily increase financial risk. Catch shares may have offsetting income stabilizing effects for those who stay in the catch share fishery.

Caveats and Complications

- It's important to consider pre-existing trends and changes in trends as well as differences in mean HHI to evaluate effects of catch shares on diversification and concentration
- Diversification measures (both HHI and Shannon) are affected by both the number of fisheries fished and how evenly revenue is spread across them. Boom years in a particular fishery can increase HHI.
- Many factors outside the control of individual fishermen can influence diversification of a given group of fishermen
  - Changes in TACs
  - Changes in markets
  - Regulatory changes in other fisheries
- Expectations of coming catch share programs may change behavior in advance
- More work needed to determine how catch shares impact income variation
- There may be trade-offs between efficiency and diversification – specialization may increase risk but also profit – are there other ways to reduce financial risk?