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Diversification, Efficiency and Productivity in Catch Share Fisheries

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Selected Paper prepared for presentation at the Southern Agricultural Economics Association (SAEA) Annual Meeting, Birmingham, Alabama, February 2-5, 2019

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DIVERSIFICATION, EFFICIENCY, AND PRODUCTIVITY IN CATCH SHARE FISHERIES

D. Solis,J. Agar,andJ. del Corral

NAPW X Miami, FL June 12-15, 2018

Introduction

Fishing is a risky endeavor.

Fishermen's livelihood face high income variability driven by a combination of biological/ecological, economic, good/bad fortunte, management, and climatic factors.

As with other extractive industries such as agriculture, fishermen may resort to diversification as a means to reduce revenue variability by spreading their fishing activity across fisheries and/or fishing grounds.

Income diversification and risk for fishermen

Stephen Kasperski^{n,1} and Daniel S. Holland^{h,1}

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Edited by Stephen Polasky, University of Minnesota, St. Paul, MW, and approved December 12, 2012 (received for review July 17, 2012)

Catches and prices from many fisheries exhibit high interannual to them beyond adopting less-risky farming strategies. They of-

variability, leading to variability in participants. The economic risk pose some cases if individuals participate particularly if revenues from those vary asynchronously. We construct versification from fisheries at the k versincation from Instenders at the find that the income of the current Coast and in Alaska is less diverse the We also find a dome-shaped relat of individuals' income and income that a small amount of diversificat. but that higher levels of diversific the variability of income from fishi ery strategy to a 50-25-25 split in r coefficient of variation of gross rev for the vessels included in this study tions in many marine fisheries the tion. However, catch share program ermen to build a portfolio of has reduce their income risk. Therefo both threats and opportunit diversified fishing strategies

Fishing is a risky business. Not highest rate of work-related fate a fatality rate more than 30 times face high financial risk as a result o their income (2). In this article we fi High annual variation in income is a variety of occupations depend there has been extensive study of inc particularly for farmers in develop reduction strategies used in agricult fasteries. Crop diversification is a risk in agriculture, taking advantage yield-response and prices to minim Another common strategy in agricular regions with high floe-scale variaregions with high tine-scale varia a number of geographically separa be in access with sufficient rainfall (e-risk reduction was the motivation tering each man's holdings in doze though inefficient, was widely pea-a combination of crops adapted to igate the risk associated with varial outhors been consent that common pathors been consent that common hors have argued that comm tant means of risk reduction that i ization (16-18). This literature reli ization (16-18). This literature rel held in common to protect agains ation in rainfall. Variation in rai private holdings is reduced for he held in common. This advantage w without some reasonably effective sement to avoid overgrazing In the United States and ma farmers have a number of risk-n

2075-2081 | PNAS | February 5, 2013

nature COMMUNICATIONS

ARTICLE

Received 25 Apr 2016 | Accepted 22 Nov 2016 | Published 16 Jan 2017

Fisheries portfolio diversificatio buffer Alaskan fishing commun resource and market changes

Timothy J. Cline¹, Daniel E. Schindler¹ & Ray Hilborn¹

Abrupt shifts in natural resources and their markets are a ubiquitous challcommunities. Building resilient social-ecological systems requires approaches to uncertainty and to regime shifts. Harvesting diverse portfolios of natural adapting portfolios in response to change could stabilize economies reli resources and their markets, both of which are prone to unpredictable shift fisheries catch and revenue data from Alaskan fishing communities over 34 whether diversification and turnover in the composition of fishing opportun economic stability during major ocean and market regime shifts in 1989. A of communities show reduced fishing revenues following these regime st communities with the highest portfolio diversity and those that could opportuthe composition of resources they harvest, experienced negligible or even posirevenue. Maintaining diversity in economic opportunities and enabling turn sustainability of communities reliant on renewable resources facing uncertain

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NATURE COMMUNICATIONS [8:14042] DOI: 10.1028/hcgmm.cl4042[www.returecom/haturecommu

Ocean & Coastal Management SS (2014) 21-30 Contents lists available at ScienceDirect



Ocean &

journal homepage

Metrics to monitor the status of fi of the state retrospective 1980-20

Suresh Andrew Sethia, William Riggs 41, 0 * Allarko Parific University, Department of Environmental Science, 4801 Un * Collifornia Polymetinia State University, Son Luis Olitopo, City and Region "University of Albeita-Anchorogy, Institute of Social and Economic Research

ARTICLE INTO

Available colline 12 December 2013

We outline a r -2010.These o for an elementer dynamics of Au available datab mographics, and trends in detail spatial assessments show permit owners amongst com:

ABSTRA

Commercial fishing is a major source of cultural ide economic benefit for communities in Alaska where approved for communities listed in the 2010 U.S. Census data for (www.census.gov) have fishing rights and fishing income communities; data from the Alaska Commercial Fisher Commission, available atwww.cfec.state.ak.us). While the of Alaska's fisheries cortinue to be biologically sur managed (e.g. Hilborn, 2006; Worm et al., 2009), fishing nities face a range of stressors which include volatile ma ditions, variable catches and stock abundances, changes i regulations redistribution of access rights, and climate ch

happ, 2011; Sethi et al., 2012; Tuler et al., 2008). With increasing aware ress of the disconnect between success and the socioeconomic and cultural viability of co

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Received: 14 July 2017 | Accepted: 20 November 2017 DOI: 10.1111/1365-2664.13058

RESEARCH ARTICLE

Effects of increased specialization on revenue of Alaskan

Eric J. Ward¹ | Sean C. Anderson² | Ar Milo D. Adkison⁴ | Anne H. Beaudreau⁴ © Alan C. Haynie⁶ | Benjamin C. Williams^{3,4}

salmon fishers over four decades

WA, USA; School of Aquatic and Fishery Sciences, University of Washington, Sciences Game, Juneau, AK, USA; "College of Fisheries and Ocean Sciences, University of A Marine Fisheries Service, National Oceanographic and Atmospheric Administration Center, National Marine Fisheries Service, National Oceanographic and Atmosp

Eric J. Ward

Present address Sean C. Anderson. Pacific Biological Nanaimo, BC, Canada

Handling Editor: Andre Punt

Abstract

1. Theory and previo catch across multip and reduced variab diversity of their c targeted, or if they permit can only in

- fishing longer or o 2. Using a large data variance function
- enue and revenu 3. Applying these me range and a variet these fisheries ha ing benefits of sp
- 4. One factor that ha is large-scale hatcl between hatchery dence for a change ery production.
- 5. Synthesis and appl among commercia we find that catch creasing specializa risk, as well as any

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Impact of catch shares on diversification of fishers' income and risk

Daniel S. Holland *1, Cameron Speirb, Juan Agar', Scott Crosson', Geret DePiperil, Stephen Kasperski*, Andrew W. Kittsf,

**Bottome Debene Skene Gene, Netroy Openia and defoundable Administration Seates, W. 168 (1); "Your hower Debenes Edware Contro, National Control and Administration Seates and Ammonphism Administration," and Seates Control, National Control Administration, Moster, S. 21 (1); "Reference for the Seates Seates, National Control Control

Many fishers diversify their income by participating in multiple fisheries, which has been shown to significantly reduce year-to-year variation in income. The ability of fishers to divenify has become increasingly constrained in the last few decides, and out-of share programs could further reduce divenification as a result of conscidetion. This could increase income variation and thus financial risk. However, catch shares can also offer fishers opportunities to enter or increase partidipation in catch share fisheries by purchasing or leasing quote. Thus, the net effect on diversification is uncertain. We tested whether discriffaction and varietion in fishing resonues hanged after implementation of catch shares for 6,782 vessels in 13 US failures that account for 20% of US landings revenue. For each of these fisheries, we tested whether diversification levels, trends, and variation is fishing revenues changed a flar implementation of catch shares, both for fishers that remained in the catch share fishery and for those that exited but remained active in other fisheries We found that diverification for both groups was nearly always reduced. However, in most case, we found no significant change in internanual variation of revenues, and, where changes were significant, variation discussed nearly as often as it increased.

Journal of Applied Ecology

The income of fishers can be highly variable due to natural variation in the productivity and distribution of fish stocks, variation in prices, and fishers' luck at finding and catching fish. variation is pickes, and motive nices in untiling anno caracing the Kasperiski and Holland (1) found that fishing vessels on the US West Const and Alacks had quite high interamual variation in revenue, with an average coefficient of variation (CV) of interamual gross revenue of 0.78. Such large swings in revenues can create risk of business falling and create personal financial criters for fishers who must make loss payments on vessels and permits, as well as cover household expenses with income from fishing. Climate change is likely to shift fisheries spatially and change productivity, which could lead to greater income votatility for fishers and potentially the complete loss of fisheries in areas where they had been present for generations (2, 3). While formal income insurance programs such as crop insurance for farmers do not exist in fisheries, fishers may be able to reduce financial risk by diversifying their fishing activity across a variety of fish-eries or areas (1, 4-10). Kasperski and Holland (1) showed that greater diversification can shot antially reduce variation in in-ternanual revenue and also the risk of having very low revenues. terannia revenue and uso the ink of himmy very two revenues relative to a vessel's own average revenues. Softh et al. (11) found that Alakian communities with larger and/or more diverse fahing portfolios esperienced lower variability of fishing reven-nues. Cline et al. (12) found that Alakian fishing communities with more diversified fishing portfolios were also to maintain or increase fishing revenues in the face of major long-term regime. shifts, while those with less diversified portfolios suffered de-clines in revenues, suggesting that diversification may be a good hedge against dimate change driven shifts in fishesies productivity.

Diversification may also have other advantages. Because many

Devenuence may also more once assumings, because my fisheries are seasonal, participating in a suite of fisheries is often necessary to provide year-round employment of capital and labor. Access to most fisheries in the United States was relatively unrestricted until the 1980s, allowing fishers to assemble a disurrestrated unto the 1980s, attorning instears to assertine a ob-serve portfolio of fishing activities over the counce of a year, but the ability to disensity has become increasingly constrained in the last few denafes (13). For the US West Coust and Alaska, the average level of diversification of fishing vessels has generally defined since the misi-1980s (1). The decline appears to be due in part to the inability of new entraints to enter fisheries, since the discussion levels tend to be higher for vessels that have been fishing longer (1). There is anecdotal evidence of declining diversification in some other US regions, but no systematic studies have yet evaluated this. States began restricting access to some nearshore lisheries as early as the 1970s (13-18), but it was not nearhore fisheries as only as the 1970s (13-18), but it was not used the 1990s that limitod-entry propums and operation mortanisms were implemented in most of the large offstone US finite into cost to 19 or reduce cances capitally (13). License limitation programs and direct catch limit is often faired to ensure constant desired to impute the simple of the control clusive fishing privileges to individuals or groups, have been implemented in 16 US fisheries since 1990 (21) and in hundreds of other fisheries worldwide (22). Catch shares have largely been

Catch share programs, which alloasts a share of a fishery's around earth to fishers, are an increasingly popular mesago-ment approach in the United States and amound the sound-popular mesagon and the state of the state of the state of the fisher of the state of the outlinesses here was stated on and fineral risk. Dish to so productively and distribution of fisher as sating from climat durings may be some the importance of distribution. Our change may increase the importance of divenification. Our evaluation of 1015 fittheries is a large-scale study to evaluate whether catch shares do in fact lead to reduced divenification. We find that diverification was generally reduced after implementation of catch shares; however, in most cases, we found no significant change in income variation.

Author contributions: $D_s H_s \subset S_s \subseteq GD_s \subseteq SK$, and AWK, designed recently $D_s H_s \subset S_s \subseteq S_s$

this article is a PAAS Direct Submission.

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9202-9207 | PNAS | August 29, 2017 | vol. 116 | no. 25

www.pnac.org/coldo/dig-9072/bnac-1702292194

RECENT WORK ON FISHERIES DIVERSIFICATION

US West Coast & Alaskan Specialization rose in last 30 vrs

Fishery

Author

Kasperski & Holland (2013)

Findings

Mixed change rev CV post-CS

Rasperski & Holland (2013)	fisheries	Diversification reduces rev. CV	
Sethi et al (2014)	AK fishing communities	Communities with larger and/or more diversified portfolios have lower rev. variability.	
Cline et al (2017)	AK fishing communities	85% communities had large rev declines following oceanographic regime and market shifts; however, diversified communities saw smaller changes in revenue and had greater opportunities to adapt to changes.	
Anderson et al (2017)	AK fisheries	Specialization rose in last 34 yrs. Permits that fish variety of species lowers rev. volatility, and adding a permits increases revenues and decreases volatility.	
Ward et al (2017)	AK Salmon fisheries	Specialization rose in last 34 yrs. Mean revenue rose w/specialization	
Holland et al (2017)	US "Catch Share"	Specialization rose post-CS	

fisheries

RESEARCH QUESTION

This study investigates the relationship between diversification, efficiency and productivity following the adoption of catch shares.

Because catch shares afford fishing vessels greater flexibility to harvest, process, and market their catch, it is useful to understand whether the technology lends itself to diversification (or specialization), which in turn can influence the potential for efficiency and productivity gains.

FISHERY BACKGROUND

In 2016, 430 vessels landed 6.1 mp of red snapper valued at \$28 m. dockside.

Resource shared with recreational sector (49% of TAC)

Multispecies, multi-gear fishery.

Federal management history:

- Command and control era (1984-2007)
- IFQ era (2007-present): Amendment # 26

COMMAND AND CONTROL ERA

Regulations

1984: Minimum size

1990: Annual quotas

1992: Limited access

1993: Trip limits

1996: Spring and fall quotas

1998: Class 1 and 2 permits

1999: 10/15 day fishing

seasons

Outcomes

Derby fishing (short

seasons, congestion,

market gluts)

Overcapacity

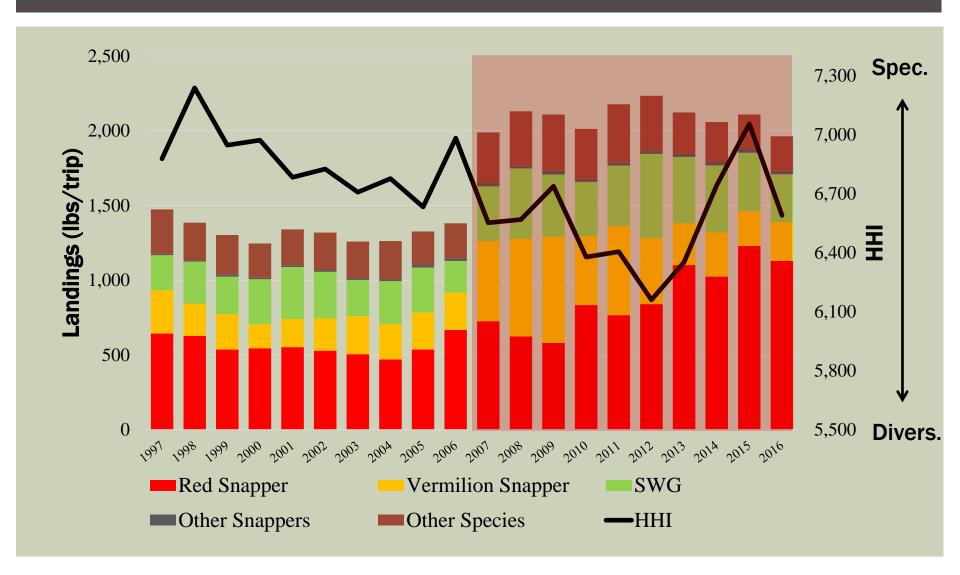
Quota overages

High discard rates

Over-exploitation

Unsafe fishing conditions

CATCH COMPOSITION OVER TIME

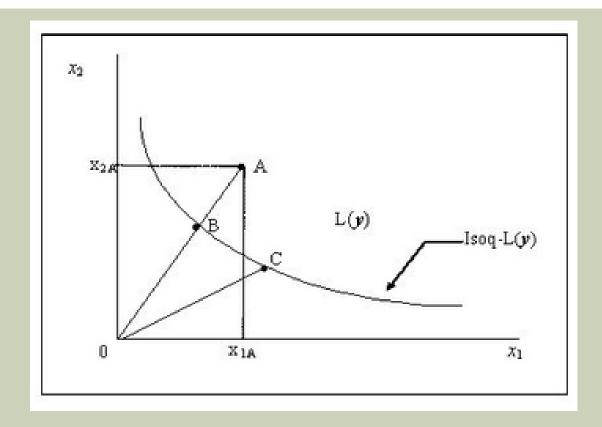


FRAMEWORK

Traditionally, measurements of 'economies of scope' are derived from cost functions. However cost data in fisheries is not readily available.

Hence, we resort to an input-oriented distance function (IDF). The input orientation assesses the proportional reduction in all inputs that would bring a fishing vessel to the frontier isoquant.

FRAMEWORK



The value of the Distance Function is $\rho = 0A/0B$ TE = $1/d_i(x,q)=0B/0A$

DATA

- Analysis period: 1997-2016 (10 yrs. command & control vs. 10 yrs. IFQ)
- Sources: Coastal fisheries logbook, dealer reports and PIMS
- Sample included 1,255 vertical line vessels that landed at least 1 lb. of red snapper/year (N=12,717 quarterly vessel-level observations).

INPUT STOCHASTIC DISTANCE FUNCTION

$$-\ln x_{1i} = \alpha_0 + \sum_{m}^{M} \alpha_m \ln y_{mi} + 0.5 \sum_{m_i}^{M} \sum_{m_g}^{M} \beta_m \ln y_{m_i} \ln y_{m_gi} + \sum_{n}^{N-1} \beta_n \ln \left(\frac{x_{ni}}{x_1 i}\right) + 0.5 \sum_{n_i}^{N-1} \sum_{n_g}^{N-1} \beta_n \ln \left(\frac{x_{n_i}}{x_1 i}\right) \ln \left(\frac{x_{n_gi}}{x_1 i}\right) + \sum_{n}^{N-1} \sum_{m}^{M} \delta_{nm} \ln \frac{x_{ni}}{x_1 i} \ln y_{mi} + \sum_{s}^{S} \omega_s d_s + v_i - u_i$$

 v_i is a random variable reflecting noise and other stochastic shocks, and u_i captures the TE relative to the stochastic frontier.

TECHNICAL INEFFICIENCY (TI) MODEL (CAUDILL ET AL 1995)

Caudill et al. (1995) proposed a framework to analyze the extent to which certain variables influence the inefficiency term u_i . They developed a model in which the determinants of inefficiency are evaluated using a multiplicative heteroscedasticity framework.

$$\sigma_{ui} = \sigma_{u} \exp(Z_{mi}; \alpha)$$

where Z_{mi} is a vector of management interventions (IFQ) and fishing practices (catch diversification, namely HHI and Berger-Parker index)

MODEL

- TL Input-oriented SDF (ISDF) estimate with ML
- Outputs $(5, y_i)$: red snapper, vermilion snapper, shallow water snappers, other snappers, and miscellaneous species
- Inputs $(3, x_i)$: days away, crew size, and vessel length
- Other variables: Red and vermilion snapper biomass, ENSO index, time trends (t and t² for technical change) and quarter and area dummies
- TI equation: f(IFQ, HHI, B-P)

RESULTS

Impact on production

Red & vermilion abundances (SS, +)

ENSO index (NSS)

Area and quarter dummies (SS; LA(+), FL (-), Lenten (+))

 $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2) = >0.54***$ Reject that TI does not exist (frontier is better than regular production function)

 $\lambda = (\sigma_u/\sigma_v) = 1.1*** => implies existence of SDF and skill (efficiency) is more important than randomness explaining landing differences$

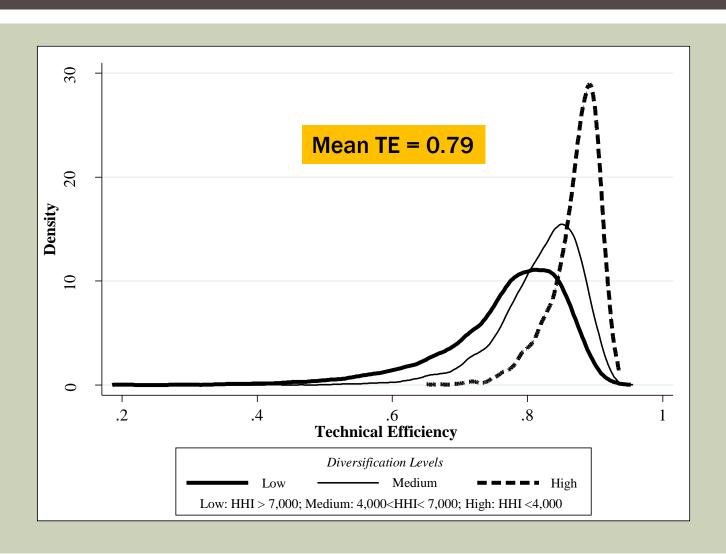
TI model = HHI(+), B-P(+), IFQ(-) All SS.

DIVERSIFICATION ELASTICITIES

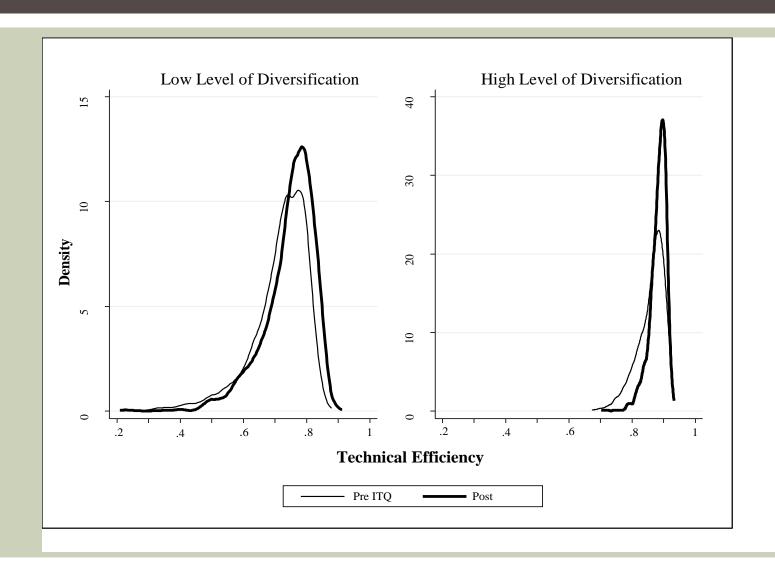
Species	Vermillion	SW	Other	Other
	snapper	Groupers	snappers	species
Red snapper	0.0004***	0.0001	0.0003*	0.0017***
Vermillion		0.0014***	0.0001	0.0013***
snapper				
SW			-0.0001	0.0026***
Groupers				
Other				0.0009***
snappers				

^{* 10%} level of significance, ** 5% level of significance, ***1% level of significance.

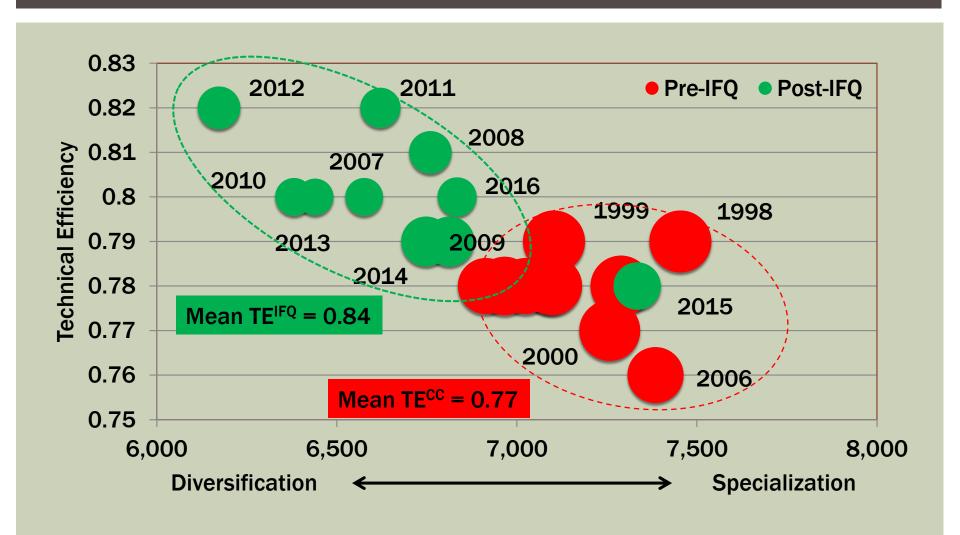
TE VS DIVERSIFICATION (ENTIRE SAMPLE)



TE VS DIVERSIFICATION (CC VS IFQ)



TE VS DIVERSIFICATION



PRELIMINARY CONCLUSIONS

- Preliminary results show that TE increased following the implementation of catch shares (from 74% to 84%).
- There is a positive correlation TE and catch diversification (TI equation).
- Productivity gains due to catch diversification are positive (but low; ED) suggesting that the CS "specialization" trend may be explained by the attributes of the harvesting technology.

