The Impact of Property Rights to Fish on Remote Communities in Alaska

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Abstract

Remote communities reliant on natural resource production may be differentially affected by changes in property rights to the resource. We examine the effect on remote fishing ports of the 1995 introduction of individual fishing quotas in the Alaskan halibut and sablefish fisheries, two of the first and largest adoptions. Using a two-way fixed effect difference-in-difference model, we find that affected remote communities see a 5-13% decrease in population and declines in taxable sales revenue of around 20%. Quota allocation and market transfer rules, designed to address social objectives, generally failed to reduce these community impacts.

Appendix materials can be accessed online at: https://uwpress.wisc.edu/journals/pdfs/LE-98-2-Edwards-app.pdf

1. Introduction

Natural resource property rights determine patterns of extraction and production. Policies that change the allocation or definition of these rights can lead to consolidation, new market development, and firm and user entry and exit. The introduction of barbed wire from 1880-1900 in the American West allowed for the enforcement of property rights and increases in grain production (Hornbeck 2010). The deregulation of tobacco production rights that had artificially supported high prices led to the exit of inefficient producers (Rucker et al. 1995; Brown et al 2007). Property rights to fish in British Columbia increased fishery revenue and lowered costs (Grafton, Squires and Fox 2000).

Often a transition to property rights serves to enclose the commons, moving resource allocation from a broad to narrow group of users (Bromley 1991; Baland and Platteau 1998). Rural communities whose local economies are reliant on a resource extraction sector may be adversely affected, for instance due to changes in the pattern or quantity of resource-based employment (e.g. Frank 2020; Abbott, Garber-Yonts and Wilen 2010; Abbott, Garber-Yonts and Leonard 2021).

Issues related to the rural community impacts of transferable resource property rights have received considerable political attention in two natural resources: water and fish. Trades of water property rights from agricultural to urban sectors can affect rural economies, including job losses and environmental degradation (Holcombe and Sobel 2001; Ge, Edwards and Akhundjanov 2021). In California, rural counties have elected to restrict the transferability of water rights with the overriding aim of keeping the water in use in the rural agricultural economy (Hanak and Dyckman 2002; Edwards and Libecap 2015; Bigelow et al. 2019). Similar concerns about the impact on rural communities have been raised in the adoption of individual fishing

quotas (IFQs) (Grainger and Parker 2013; Sutherland 2016; Young et al 2018;). These concerns, although not well-documented empirically, have led to policy decisions to limit or ban the adoption of fishing property rights.[1]

Generally, IFQs allow the holders of the newly created property rights to increase the economic efficiency of their operations, often through consolidation, closure of inefficient facilities, and changes in supply chains and distribution channels (Grafton et al. 2000). Homans and Wilen (2005) suggest efficiency gains after the adoption of IFQs occur due to (i) additional access to high-value markets and (ii) reductions in fixed costs, often through consolidation. Two recent studies of institutionally different property right changes, in the Peruvian Anchovy and Chilean Jack Mackerel fisheries, suggest both saw increases in high-value product and consolidation of the harvesting sector (Kroetz et al. 2019; Kroetz et al. 2017).

These adjustments may lead to differential impacts on rural fishing ports (McCay 1995; 2004; Carothers, Lew, and Sepez 2010). When the Canadian halibut fishery adopted IFQs, landings shifted and dropped as much as 12% in some ports as their freezing facilities became unnecessary and the number of crewmembers employed dropped by 32% (Casey et al., 1995). Rural communities may be differentially affected when the new property rights allow harvesters to pursue high-value product markets, like fresh markets. Rural ports have less transportation infrastructure to access these markets quickly, reducing the relative benefits from delivering fish to small ports (GAO 2004). Additionally, consolidation in fishing boats often favors vessels owned and operated out of large ports (Bromley and Macinko 2007; Soliman 2014).

Prior empirical work on the rural community impacts of IFQs has been conducted using surveys (e.g. Casey et al. 1995), changes in quota ownership (e.g. Carothers et al. 2010; Pálsson and Helgason 1995), and qualitative or aggregate fishery measures (summarized in Olson 2011).

We build on these findings to directly test impacts on community-level outcomes. We examine the 1995 introduction of IFQs in the Alaskan halibut and sablefish fisheries, two of the largest by value in the United States and among the first to adopt IFQs. The proposed adoption drew considerable opposition, often focused on rural community impacts of changes to the broadly accessible halibut fishery (Sutherland 2016).

A comprehensive 20-year review of the Alaskan sablefish and halibut IFQ adoption process confirmed consolidation and the shift to higher-valued markets and suggested evidence of quota moving out of rural communities (NPFMC 2016). The report points to the seminal paper by Carothers et al. (2010), which identified a group of small, remote fishing communities (SRFCs) that appeared to be particularly vulnerable to changes in fishing property rights. A follow-up ethnographic study of the 1995 IFQ introduction, along with subsequent individual harvesting allocations in other fisheries, found that rural community impacts were still a fundamental driver of polarized opinions on the program almost 20 years later (Carothers 2015).

In this paper we examine the immediate effect of the policy change using a difference-in-difference approach with the community as the unit of analysis. We construct a city-level panel from 1990-2000 of taxable revenue, population, vessel owner characteristics, and quota allocations to assess the differential impact on rural ports and their residents. We focus our work on the immediate six-year period following policy implementation, which limits the potential for other changes to affect the results. The 1995 policy created IFQs for both the halibut and sablefish fisheries, but our empirical analysis focuses on halibut. Because the sablefish fishery was more concentrated and consisted primarily of larger vessels, it was not as heavily utilized by SRFCs. However, nearly all sablefish harvesters are active in the halibut fishery and the policies

occur simultaneously, so our results should be interpreted as reflective of the combined result of the introduction of IFQs in both fisheries.

Our results show that post IFQ, remote ports as defined by access to mainland commercial air cargo see less consolidation and sell a lower proportion of high-value product relative to non-rural areas. Relative to other Alaskan cities, SRFCs see population losses in the five years following IFQ adoption of 6-13%. Taxable sales revenue in these communities declines by around 20%, but point estimates are more uncertain due to fewer available data points.

Because there was political concern about community impacts as the halibut IFQ program was being designed, its implementation contained several quota transfer restrictions intended to address social objectives. These restrictions have been shown to reduce resource rent in subsequent market transactions by 25% (Kroetz, Sanchirico and Lew 2015), but their impact on outcomes to SRFCs has not been tested empirically. We develop a framework to assess the extent to which the initial allocation of restricted quota affected SRFC outcomes in the post-IFQ period. This analysis allows us to isolate outcomes of IFQ adoption generally. It also provides a method for evaluating the effectiveness of different types of restrictions to meet the social objectives of reducing consolidation and limiting population and taxable revenue declines in remote communities.

We find that communities predominantly receiving the two most protected types of quota—community development quota (CDQ) and class D quota—see less vessel consolidation. However, we find only limited evidence that these communities see commensurate protection from population declines and taxable revenue losses. Importantly, other restricted quota classes did not limit consolidation or population and revenue declines, indicating these measures failed

to meet the intended social objectives. Our findings suggest that restrictions on market transfers are not a panacea for achieving social objectives in policy design. We turn to this issue in the discussion section, suggesting that additional research is needed to find alternative mechanisms to provide an equitable transition to property rights that avoids the large deadweight losses of transfer restrictions.

2. Empirical Setting

Commercial harvest of halibut in Alaska can be traced back to the early 1900s, and the fishery mostly produced fresh fish until the 1970s (Homans and Wilen 2005). Higher halibut prices in the 1970s and the implementation of limited entry programs for salmon fisheries contributed to the growing number of vessels entering the halibut fishery. During the 1980s, the halibut fishery received an influx of larger crabbing vessels as crab stocks declined. Even as the total allowable catch stayed steady or increased, the season length shortened due to an increasing number of vessels entering the fishery (Willman et al. 2009). By 1992, the halibut season had been reduced to two or three 24-hour openings yearly (Pautzke and Oliver 1997).[2]

Homans and Wilen (2005) develop a model of the ex-vessel price paths and harvest effort of fishers under regulated open access, building on parameters from their analysis of the Alaskan halibut fishery (Homans and Wilen 1997). Using this parameterized model, they derive estimates of outcomes under regulated open access. Their results show that as competition increases, harvesters take fish beyond what can be sold immediately into a high-value market, to store for the low-value market after the season closes. This regulated open access outcome results in a zero-rent condition, high levels of fixed costs, and short seasons.

As anticipated, the implementation of IFQs in the Alaskan halibut fishery brought about large changes. Figure 1 shows the decrease in the number of halibut boats owned by residents of

a city, and the increase in the percentage of catch processed fresh at the port.[3] The fishery was overcapitalized, and the adoption of IFQs allowed fishers to harvest the same quantity of fish with fewer vessels. The observed consolidation is consistent with ex-post analyses that find cost savings were achieved through consolidation (Grafton et al. 2000; Schnier and Felthoven 2013; Reimer, Abbott and Wilen 2014). For instance, the New Zealand quota management system, adopted in 1986, resulted in fleet downsizing with exiting vessels being predominantly small-scale fishers (Stewart, Walshe and Moodie 2006). Consolidation favors larger, more efficient vessels more likely to be owned and operated out of large ports, relative to more family-based fishing firms in rural ports (Soliman 2014; Bromley and Macinko 200;).

While IFQs were expected to increase overall resource rents, there were significant debates on program specifics during the late 1980s and early 1990s. Without substantial free grandfathering, highly skilled fishers could be expected to oppose IFQ programs (Grainger and Costello 2016). Increased flexibility in the timing of landings was expected to reduce storage time and cost for halibut, with fishermen and processors able to take advantage of the year-round market for fresh halibut (NPFMC 1992; Hartley and Fina 2001). Ex-ante analysis typically shows cost savings resulting from IFQ programs attributable to consolidation through the exit of inefficient vessels (Weninger and Waters 2003; Weninger 2008; Lian, Singh and Weninger 2009). These changes could differentially affect rural ports, which have less transportation infrastructure, like commercial air freight, to access high-value markets (GAO 2004). Analysis of nearly 4,000 public comments prior to program adoption indicates large public concern over rural community impacts (Sutherland 2016).

Ultimately, the halibut IFQ program was implemented with modifications reflecting political negotiations. The initial allocation of quota was grandfathered based on average

landings during a qualifying period ending in 1990. Included in the program were a set of policies designed to limit the perceived social costs of the IFQ adoption. These policies included the allocation of quota into four vessel classes, ultimately limiting transfer of Class D quota to vessels 35' or under and Class C quota to vessels 60' or under.[4] In addition to quota classes, a majority of quota was blocked, meaning it had to be sold as a single unit. Limits were implemented as to the number of blocks and overall percentage of quota an individual could hold.

Additional provisions allocated Community Development Quota (CDQ) to certified Alaska Native Claims Settlement Act (ANCSA) villages on the Bearing Sea/Aleutian Island region of Alaska. The CDQ program targeted 56 communities that had not previously received substantial economic benefits through participation in the halibut fishery (Hartley and Fina 2001). Although CDQ shares are non-transferable, communities are permitted to hire fishers to fish their quota (Hartley and Fina 2001). Communities have utilized their rights by either developing fishing economies to generate jobs and revenue, or by selling annual harvest rights to individuals and collecting royalties.

3. Empirical Approach

To understand how the changes in the harvesting and processing sectors affected remote communities, we construct three panels on Alaskan cities for the period 1990-2000.[5] (The cities included in the dataset are shown in figure A1.) The first panel focuses on 42 ports with halibut landings in the pre-period sample (1990-1994) to examine the impact of IFQ introduction on harvest outcomes. The second panel consists of all cities in Alaska for which we have population or taxable sales revenue data to test how IFQ introduction affected community outcomes. The

third panel examines the set of Alaskan cities where residents are allocated quota, and for which we have population and revenue data, to examine the effect of restricted quota on outcomes.

Our primary treatment variable is whether a community is an SRFC using the definition developed by Carothers et al. (2010) based on rural designation, population size, proximity to coastline, and historic participation in the halibut fishery. Participation in the halibut fishery was determined by which cities had residents that received quota in the initial allocation. SRFCs are broken down by three population categories based on their population in the 1990 census: less than 1500 (small), 1501-2500 (medium), and 2501- 7500 (large). Throughout the paper we combine all three types of cities into one group variable that we call *SRFC*.[6]

In addition, we group cities by several other characteristics. We designate a city as *REMOTE* if it lacks a direct commercial flight to Seattle or is outside of a five-hour drive to such an airport. We designate *CDQ* cities from a list of 56 designated communities. We also create five groups based on quota allocation for the set of cities who see more than 50% of their owners assigned quota in *CLASS A*, *CLASS B*, *CLASS C*, *CLASS D*, or *BLOCKED*. Quota ownership data under the IFQ program were obtained from NOAA. We use the first-year allocation to construct our measures of quota class allocations by city. Because there is a large overlap between the *CLASS D* and *CDQ* groups, we create a group that is their union, *PROTECTED*, indicating cities whose owners receive either of these categories of quota.

Panels are constructed using data from the Alaskan Department of Fish and Game (ADFG) vessel registry and fish ticket reporting programs, the ADFG Commercial Operators Annual Report (COAR), port tax and population data from the Alaska Taxable database published by the Alaska Department of Community Economic Development (DECD), and population data from the US Census Bureau (Census).

Measures of port tax revenue and population are constructed using the Alaska Taxable Database produced by the Alaska DECD.[7] This database includes the sales tax rate and sales tax revenue for each year 1990-2000 for Alaskan cities. Populations are estimated by the state demographer for the express purpose of distributing tax revenues.[8] We calculate taxable sales revenue for a city as the tax revenue divided by the tax rate. We also collect data from the US Census Bureau which offers a nearly complete yearly data set of Alaskan city populations. Census and DECD data are highly correlated (0.98) where cities overlap. Throughout the paper we use census data in the figures because the additional cities allow for cleaner estimation, and DECD data in the regressions because this data corresponds to the same source as the revenue data and provides a more conservative set of confidence intervals for statistical inference. We comment in the text on any instances where the results of the two population data sets do not align in magnitude or statistical significance.

Resident boat owners in a city active in the halibut fishery are obtained by linking fish ticket data with vessel owner information by ADFG vessel number. Fish tickets are required documentation for any harvester landing fish in Alaska and provide vessel and catch information including species caught, vessel number, port, date, weight, and landed (ex-vessel) value. We then aggregate these measures by the city listed as the home address of the vessel owner. This allows us to look at number of boats according to the city where the owner lives.[9]

To construct measures of product type at each port, we utilize COAR data, which tracks both ex-vessel landings and price, as well as the wholesale weight, price, and product form of fish sold by processors. For ex-vessel data, we prefer to use the fish tickets because they are more comprehensive than COAR data.[10] However, COAR data is the only source for product type. We aggregate at the port level to track final product mix. We use the ratio of revenue from

fresh product to total revenue to measure fresh-market product types. We do not observe the final product form of the harvested fish, and so this measure is based on product sales from a city and may differ from how the vessel owners in the city participate in the fishery.

Summary statistics for each of the three panels in our dataset—overall, pre-1995, and pre-1995 bifurcated by treatment groups—are provided in the appendix (tables A1-1 to A1-3). We employ a regression strategy to analyze the differential response to treatment for a group, I^G, interacted with treatment. Equation 1 provides the general form of our estimating equation for city j at time t:

$$Y_{j,t} = \lambda \cdot I_t^{\text{IFQ}} \times I_j^G + \tau_t + p_j + u_{j,t} \qquad [1]$$

The specification includes year, τ_t, and city, p_j, fixed effects. We use OLS regression except in the case where we have counts of vessel owner data, for which we employ a Poisson regression. Because of the panel nature of the data, we use robust standard-errors clustered at the city level in all regressions. The coefficient λ shows the differential effect of IFQ introduction. The identifying assumption is of parallel trends: conditional on all control variables, the relationship between the group, G, and counterfactual prior to IFQ introduction would have continued absent the regulatory shock. While this assumption is not directly testable, in the results section we provide evidence on pre-treatment trends as well as the year-to-year dynamics post-treatment via an event-study plot. To do so, we allow the treatment coefficient, γ, to vary each year:

$$Y_{j,t} = \gamma^t \cdot I_j^G + \tau_t + p_j + u_{j,t} \qquad [2]$$

Evidence of an effective difference-in-difference design is provided by a combination of a lack of trend in the point estimates of γ^t, and a lack of statistical significance for point estimates in the period prior to treatment. Post-treatment, the expected outcome of an observed treatment

effect is a discrete jump or change in slope of the point estimates, and point estimates statistically different from zero in some or most post-treatment years.

4. Results

Owners and Product Type

Our first set of results focuses on the changes in fishery structure around the 1995 IFQ introduction. Figure 2, Panel A shows a set of event studies depicting the dynamics of vessel ownership (left) and fresh product (right) for cities without access to a commercial flight to the mainland United States as a proxy for remoteness. Both event studies suggest limited pre-treatment trends, while the vessel owner event study suggests a positive post-treatment effect. Regression results in table 1, specification (5), suggest remote ports see less fresh product and Poisson regression results, specification (1), show more vessel owners post treatment.

To further explore the dynamics, we remove ports that receive the most protected classes of quota from the regressions. This reduces the relative vessel owner effect (specification 2) but not the fresh product effect (specification 6). The left graph of Figure 2, Panel B shows the treatment effect on the protected cities, those receiving CDQ or whose owners receive greater than 50% of quota as Class-D. This is consistent with the regression results and suggests that these protected cities are the reason for the limited vessel consolidation in remote ports.

For communities designated as SRFCs not designated as protected, consolidation occurs at similar rates to other ports, see figure 2, Panel B (right) and specification (4) in table 1. These results inform the remainder of our analysis. If these communities are more reliant on the fishery and more vulnerable, as suggested by Carothers et al. (2010), the design of the program does not appear to have protected them from consolidation. We expect community impacts should be observable in our analysis of population and taxable sales revenue. We look for this effect in the

next subsection. Conversely, cities receiving CDQ or >50% Class-D quota do not see vessel consolidation like other ports, and we test the differential effect of restricted quota in the following subsection.

Population and Revenue

Figure 3 shows visually the evidence that SRFCs saw population and revenue declines as a result of the 1995 IFQ introduction. After treatment, relative population declines are apparent; less apparent but potentially still significant are declines in revenue.[11] The overall trend in the event studies appears in the regression results in table 2, which shows results from equation (1) for treatment group SRFCs. All these regressions are log-level, so regression coefficients, λ, are interpreted as a relative $100 \cdot (e^{\lambda} - 1)$ percent change in the population of SRFCs after IFQ implementation. For cities under 1500 people, specification (1), IFQ introduction led to a 5.1% decrease in population in SRFCs. For the entire sample, the point estimates suggest IFQs led to an estimated population decline of 11.9% (specification 4) and taxable revenue declines of 18.1% (specification 8).

These results suggest economically large and statistically significant (at least at the 90% level in six of eight specifications) changes to SRFCs. Both charts in the figure show that the estimated differences in SRFC and non-SRFC population and revenue prior to 1995 are not statistically significant and do not show any pre-trends. This type of analysis is sensitive to the construction of the counterfactual, dependent variables, and standard errors.[12]

We are limited in constructing the set of counterfactual cities due to Alaska's remoteness and the engagement of most ports in the halibut fishery. While the event study diagrams suggest non-SRFC cities are not trending differently pre-treatment, the existence of parallel trends post-treatment is untestable. Of particular concern is the geographic distribution of treatment (SRFCs)

and control groups, where the former tends to be located in coastal and southeast Alaska locations (see appendix figure A1). In appendix table A2-3 we provide regression results using Conley Spatial HAC standard errors to show that the statistical significance of the results is not driven by geographic correlation of the error terms. Clustering at the city ends up being a more robust method of inference in this case.

Social Objectives

Given the estimated population and revenue declines after IFQ introduction, we next consider how program-specific measures affected outcomes. Specifically, we are interested in the social objectives that were incorporated into quota allocation and transfer rules. For the program evaluation at hand, these policies may have created heterogeneity in outcomes that we can observe. For external validity, we would like to be able to say something generally about IFQ introduction, and potentially about social objective policies, which requires disentangling a baseline IFQ effect from the overall effect including social objective policies.

Our approach relies on the allocation of quota types and CDQ to examine the differential outcomes of cities receiving different types of quota. We can compare the results on protected quota cities with those where more than 50% of their quota was Class C. Although both types of quota are restricted, the rules differ. Class C quota was initially restricted to transfer among boats 35-60 feet in length, and a 1996 amendment allowed "buying down" so smaller boats could use quota from larger classes. Class D quota could only be transferred among boats less than 35 feet, and CDQ could not be transferred at all. Instead, communities are permitted to lease CDQ without restriction (Hartley and Fina 2001).

Figure 2, Panel B (left) showed cities receiving the most protected quota saw significantly less consolidation in vessel ownership. Conversely, cities receiving a majority Class

C quota saw no reduced vessel consolidation relative to cities other than those with protected quota (see appendix figure A4 for a side-by-side comparison). If consolidation drives population and revenue declines, then Class C quota cities should see different population and revenue outcomes.

Figure 4 provides preliminary evidence of a different effect on population of receiving protected versus Class C quota. Relative to other remote cities, protected cities appear to see a population increase post treatment. Conversely, Class C majority cities, relative to remote cities and excluding protected cities, see a decline in population. Table 3 shows Poisson regressions of number of halibut vessel owners (Poisson regressions in this case) and population on a dummy for CDQ or majority class type. These results tell a similar story in terms of consolidation. Cities that receive CDQ or a majority of Class D quota see less consolidation than other cities (specifications 1 and 2).

Excluding these protected cities, regressions on a dummy for majority Class C, Class B, and blocked quota show some protection against consolidation only for Class C quota. However, while CDQ, Class D, and class C quota may limit consolidation, the effect on population is ambiguous. Specifications (6) and (7) suggest a negative effect on population for communities receiving protected quota, relative to those receiving other types.

Regressions using census population, which correspond to the data used in the event study in Figure 4, do show positive but not highly significant estimates for the CDQ and Class D quota cities (see table A3-1, which also shows similar null results for the same regression with revenue as the dependent variable).[13] We draw two conclusions from these results. First, CDQ allocations and quota trading restrictions do seem to limit consolidation but are not as effective at ameliorating population and revenue declines. Second, to the extent that there is any evidence

that these restrictions were effective, it is for the more restrictive types of quota. We return to a discussion of these results in the next section.

5. Discussion

The implementation of IFQs in the Alaskan halibut and sablefish fisheries brought about large efficiency increases, both through the reduction of fleet size and the increase in high-value product (Homans and Wilen 2005; NPFMC 2016). However, these aggregate gains mask significant community-level effects for small and remote fishing communities. Commercial fisheries are an important source of income for coastal Alaskan cities (Watson et al. 2021). Consolidation changes demand for fishing support services, for instance annual repair and maintenance, which for the Alaska fishing fleet are estimated to range from $80 to $100 million per year (McDowell Group 2014). These market shifts disproportionately affect remote populations due to thin labor markets and a lack of flexibility in changing jobs without changing towns (Bromley and Macinko 2007). While studies of other fisheries suggest total crew-hours dedicated to fishing activities remained roughly constant after the adoption of fishing property rights, these hours are generally more concentrated among fewer crew and compensation schemes change to reflect quota costs (Abbott et al. 2010; Abbott et al. 2021).

Some literature on fishing property rights has suggested community impacts are large: "[t]he consequences for these [rural] communities are profound: loss of employment, emigration, loss of traditional fishing culture and a wide income gap between quota holders and non-holders (Soliman 2014)." Wingard (2000) goes further, suggesting severe population disruptions: "Reduction in employment and concentration of harvest privileges in the hands of fewer fishers may lead not only to a reduction in the number of fishers, but also to a reduction in size or even

elimination of some fishing communities (Wingard 2000)." Our results offer an empirical estimate of the magnitude of these effects.

The policy implications of our findings are less clear. If IFQs are framed in the policy debate as a voluntary change that can negatively affect remote communities, there appears to be an option for policymakers to refrain from implementation and avoid these costs. We do not believe this is the case. IFQs currently account for about 5 percent of global fisheries and 25 percent of global fish catch (Costello et al. 2008; Arnason 2012). These fisheries are more successfully managed, with greater economic efficiency and reduced probability of stock collapse (Grafton et al. 2000; Costello et al. 2008). It is apparent that other policies are less effective in increasing aggregate welfare and it is unclear even that such policies would decrease the apparent community impacts, relative to IFQ adoption. When evaluating alternative policies, the benefits and costs of IFQs must be compared to feasible institutional alternatives to avoid the comparison to an unachievable ideal (Demsetz 1969).

The enclosure of the commons is an inevitable aspect of the effective management of any natural resource. Once enclosed, the initial allocation of rights to fish and their reallocation over time has both distributional and efficiency implications. Taking this view, IFQ adoption may be similar to technological changes that disrupt patterns of production.[14] If negative impacts of IFQ adoption on community outcomes are foreseen, policy changes could help alleviate transitional issues. However, such policy tweaks, especially when they reduce aggregate gains, should be evaluated on their benefits and costs, just as for the underlying IFQ policy.

In the Alaskan halibut IFQ adoption, the initial allocation of quota and trading restrictions were designed to preserve the character or the fleet, reward long-term participation, and discourage speculative entry (Hartley and Fina 2001). These goals may not have been entirely

aligned with limiting the effects on coastal communities that we study in this paper, so our results offer only a partial evaluation of the effectiveness of these policies. While Coase (1960) suggests that the allocation of quota would not affect efficiency in the absence of quota transfer transaction costs, the trading restrictions imposed on the quota did affect the efficiency of the program. Kroetz et al. (2015) examined the differential quota prices for Class A, B, C, and D, as well as blocked quota, finding the decreases in resource rents of restrictions as a present value of $117M (in $2012) relative to yearly gross revenues of $205M. Given the costs of the transfer restrictions, it does not appear these types of policies, applied broadly to include a significant fraction of total quota allocations as in this case, are justifiable based on our estimates of their lack of impact on remote populations and taxable revenues.

More research is needed into alternative policies to reduce negative effects on remote communities in the transition to property rights. Watson et al. (2021) suggest that development policy aimed at increasing economic opportunity for local residents should consider the residency of resource and capital owners, not simply the presence of activity. The CDQ program, which we show in conjunction with Class D quota did limit consolidation—and potentially population losses—offers one potential avenue. The program required that communities use the CDQ quota earnings to "further economic development in the community through investment in fisheries-related industries, infrastructure, and education (National Research Council 1999, p.47)." Policies like CDQ work through markets by providing compensation via initial allocation without affecting efficiency (Medema 2014). Compensation could also occur through community development funds via cash transfers without affecting efficiency (Leonard et al. 2019).[15]

6. Conclusion

This paper empirically evaluates claims that IFQs lead to reductions in population and taxable revenue in small, remote fishing communities. Using the 1995 adoption of the Alaskan halibut and sablefish IFQ program, our difference-in-difference estimates suggest three key findings: (1) considerable consolidation occurred in the number of vessel owners harvesting halibut in all cities except those receiving heavily restricted quota; (2) small, remote fishing communities saw 5-13 percent decreases in population and up to 20 percent decreases in taxable revenue as a result of IFQ introduction; (3) quota transfer restrictions appear limited in their ability to mitigate the observed population and revenue declines.

While there is a general consensus that property rights-based management in fisheries offers benefits in terms of cost savings and stock health, the social consequences of IFQs are still disputed (Thébaud et al., 2012). Our results offer evidence of some negative community-level impacts of IFQs. However, we also find that restrictions on market transfers are not a panacea for achieving social objectives in policy design. Additional research is needed into the effects of direct quota allocation or compensation through community development funds as an alternative policy to address the negative impacts of IFQs.

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Tables

Table 1: Owner and Product Type Results

VARIABLES	(1) Owners	(2) Owners	(3) Owners	(4) Owners	(5) Fresh	(6) Fresh	(7) Fresh	(8) Fresh
REMOTE	0.219*	0.114			-0.159***	-0.157***		
	(0.124)	(0.118)			(0.0479)	(0.0446)		
CDQ			0.8686***				-0.05247	
			(0.2910)				(0.08061)	
SRFC				0.109				-0.0751
				(0.118)				(0.0534)
Observations	462	330	462	330	462	330	462	330
R-squared					0.555	0.665	0.546	0.655
Log-Likelihood	-1577	-1012	-1471.8	-1013				
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Port FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protected Included	Yes	No	Yes	No	Yes	No	Yes	No

Notes: Columns 1-4 show Poisson regressions of number of halibut vessel owners on small/remote designations. Columns 5-8 show regressions of proportion (by value) of landed fish sold fresh on small/remote designations. The odd columns show the effect of the treatment group relative to all other cities. Even columns show effect of treatment group to other cities excluding protected cities (CDQ or >50% type-D quota). Robust standard errors clustered at city are in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$).

Table 2: Population and Revenue Results

VARIABLES	(1) Population	(2) Population	(3) Population	(4) Population	(5) Revenue	(6) Revenue	(7) Revenue	(8) Revenue
SRFC	-0.0520**	-0.0411*	-0.107**	-0.127***	-0.172	-0.166	-0.208**	-0.199**
	(0.0252)	(0.0245)	(0.0447)	(0.0448)	(0.110)	(0.101)	(0.0876)	(0.0835)
Observations	1,388	1,432	1,571	1,662	642	674	782	847
R-squared	0.988	0.990	0.892	0.922	0.928	0.941	0.965	0.973
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population	<1500	<2500	<5000	All	<1500	<2500	<5000	All

Notes: Regressions of DECD population (log) and DECD revenue (log) on SRFC designation for different population cutoffs. Robust standard errors clustered at city are in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$).

Table 3: Number of Owners and Population Results by Quota Type

VARIABLES	(1) Owners	(2) Owners	(3) Owners	(4) Owners	(5) Owners	(6) Population	(7) Population	(8) Population	(9) Population	(10) Population
CDQ	1.045*** (0.245)					-0.160* (0.0943)				
CLASS D >50%		0.727** (0.318)					-0.185* (0.107)			
CLASS C >50%			0.383*** (0.144)					-0.0551 (0.271)		
CLASS B >50%				-0.0946 (0.148)					-0.193 (0.122)	
BLOCK >50%					-0.172 (0.127)					0.259** (0.128)
Observations	643	643	457	457	457	643	643	457	457	457
R-squared						0.876	0.876	0.853	0.853	0.853
Log-Likelihood	-1911	-1981	-1358	-1388	-1375					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protected Included	Yes	Yes	No	No	No	Yes	Yes	No	No	No

Notes: Poisson regressions of number of halibut vessel owners (columns 1-5) and regressions of DECD population (log) (columns 6-10), on five types of restricted quota. Each treatment group is bifurcated by >50% of quota falling into a particular category except CDQ, which is a discrete designation. Specifications 3-6 and 8-10 exclude protected cities (CDQ or >50% type-D quota) as comparison cities. Robust standard errors clustered at city are in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$).

Figures Captions

Figure 1: Changes in Effort and Product

Notes: Mean number of vessels per city (left) and mean proportion of fish delivered to that city that became fresh product (right) for 42 ports selected for having deliveries of halibut prior to 1995. Shaded area represents 95% confidence interval.

Figure 2: Event Studies

Notes: Panel A (left) is an event study of number of halibut vessel owners (log) on treatment of being remote for all halibut ports; panel A (right) is an event study of the proportion fresh on treatment of being remote for all halibut ports. Panel B (left) is an event study of number of halibut vessel owners (log) on treatment of receiving protected quota (CDQ or >50% type-D quota) relative to all other remote ports; right is an event study of the number of halibut vessel owners (log) on an indicator for SRFC where all protected communities are excluded from the sample. Event studies are estimated as described in equation (2). Error bars are 95% confidence intervals; solid grey and black markers are statistically significant at the 90% and 95% levels of significance, respectively.

Figure 3: Community Outcome Event Studies for SRFC Treatment

Notes: Left panel shows event study results for census population (logged) on SRFC treatment. Right panel shows event study results for DECD revenue (log) on SRFC treatment. Sample includes all cities with population or revenue data, respectively. Error bars are 95% confidence intervals; solid grey and black markers are statistically significant at the 90% and 95% levels of significance, respectively.

Figure 4: Population Event Studies of Cities Receiving Restricted Quota

Notes: Sample includes remote ports for which we have population and vessel owner data. The left panel shows census population (log) on treated cities receiving protected quota (>50% type D or CDQ) while the right panel shows treated cities that receive >50% of quota in class C, with protected quota excluded from the sample. Error bars are 95% confidence intervals; solid grey and black markers are statistically significant at the 90% and 95% levels of significance, respectively

[1] E.g. General Assembly of North Carolina, Session 2017, Senate Resolution 370 opposing private property rights to fish in the South Atlantic region, citing effects on fishing communities and the coastal economy.

[2] Halibut are a flatfish caught in waters as shallow as 90 feet, allowing vessels as small as skiffs to harvest close to shore, and making the fishery accessible to many entrants, which contributed to the intensive "race-to-fish." The sablefish fishery saw similar problems during the same timeframe, but was typically fished by vessels 60 feet or more in length, enabling them to fish in less-protected areas, such as the Bering Sea and Aleutian Islands (Willman et al., 2009). These natural barriers to entry made sablefish ITQ adoption less contentious from a remote community impact standpoint (Sutherland 2016).

[3] As seen in figure 1, vessel consolidation actually started soon after the program was finalized in 1992 as some owners, having obtained quota allocation, stopped actively fishing.

[4] Class A quota is unrestricted and can be fished on any size vessel and does not require owner on board. Catcher vessel quota is more restricted, requiring owner on board, requiring individual ownership, and with transfers initially limited within vessel length classes: Class B—greater than 60 feet; Class C—less than 60 feet and greater than 35 feet; and Class D—less than 35 feet. Quota sales were initially restricted to vessel classes, in 1996 Amendment 43 passed allowing for "buying down" of quota share. Buying down means that quota can be fished on vessels of the same size class or smaller.

[5] There was at least one delivery of halibut from 1990-1994 to 42 halibut ports.

[6] Although the results are not included in the interest of conciseness, the statistical results remain similar when limiting the definition to only the small, remote communities.

[7] Previously the Department of Community and Regional Affairs.

[8] Because these estimates are used in funding allocations, cities can and often do appeal the numbers using actual headcounts or other methods to override the demographer's estimates. Given this, we take these population estimates to equal or exceeding actual populations.

[9] Focus on resident owners is supported by recent research suggesting larger economic impacts of resident fishery income relative to non-residents (Watson et al. 2021).

[10] For our time period and species of interest, COAR data shows consistently fewer landings than fish tickets, suggesting this dataset is missing some landings.

[11] Appendix figures A2 and A3 provide event studies of an alternative treatment measure, as well as for limiting the sample to remote cities only.

[12] Results for treatment of HALIBUT PORT as well as population measures without logs are shown in appendix tables A2-1 and A2-2.

[13] Tables A3-1 to A3-5 show the results with the same regression framework but limiting the sample by city size.

[14] In southern England in the 1830s a series of social disturbances known as the Swing Riots erupted, in part, because laborers feared new mechanization in the form of threshing machines would displace workers (Caprettini and Voth 2020).

[15] For example, Australia set up an adjustment fund for fishermen and communities impacted by the implementation of a marine protected area on the Great Barrier Reef (Gunn et al. 2010).
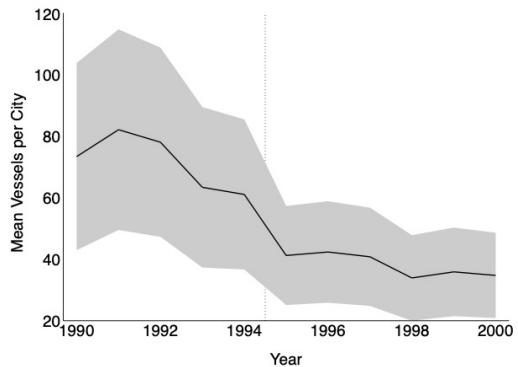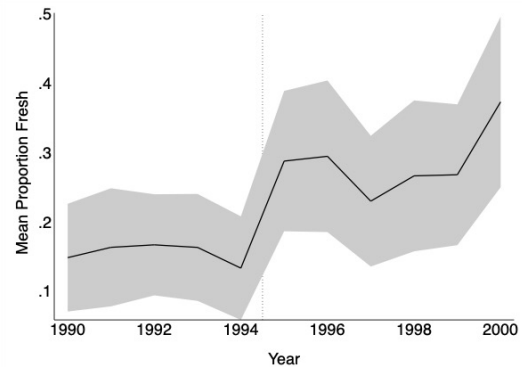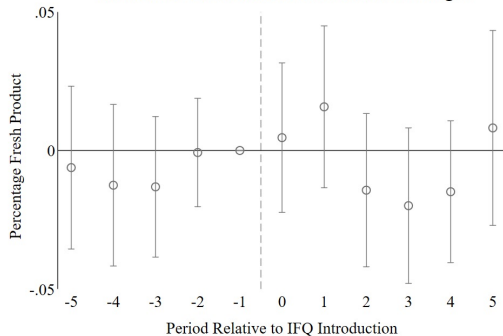
Panel A: Relative Concentration of Owners and Type of Product
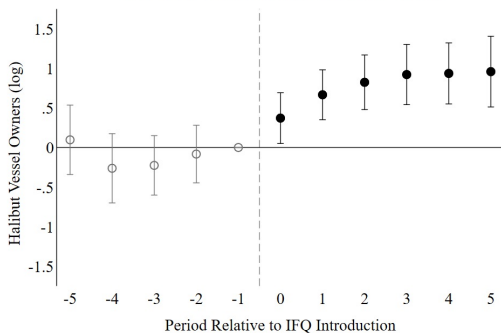
Treatment: No Mainland Commercial Air Freight
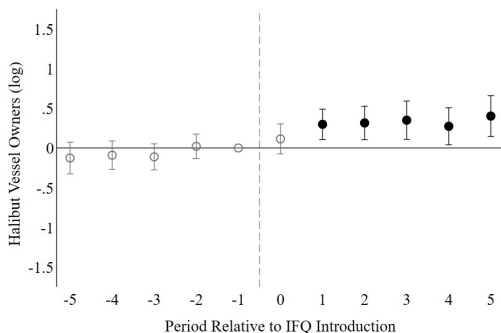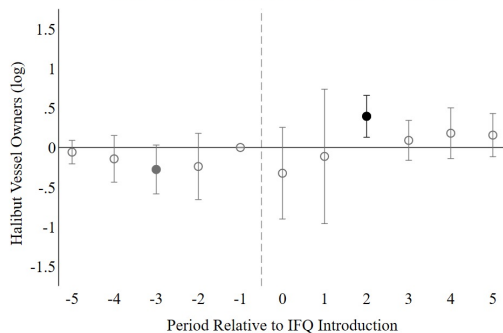
Treatment: No Mainland Commercial Air Freight

Panel B: Changes in Owners in SRFCs and Protected Cities

Treatment: CDQ or Majority Type D Quota
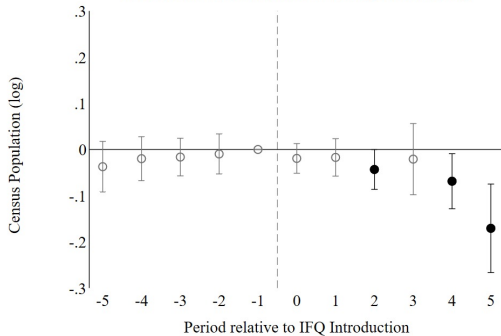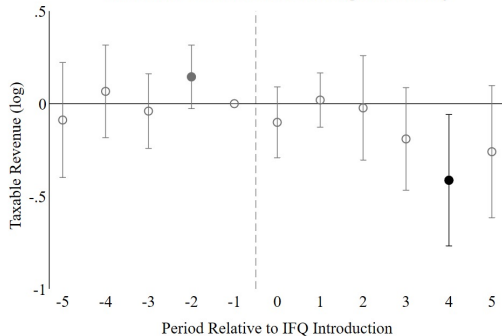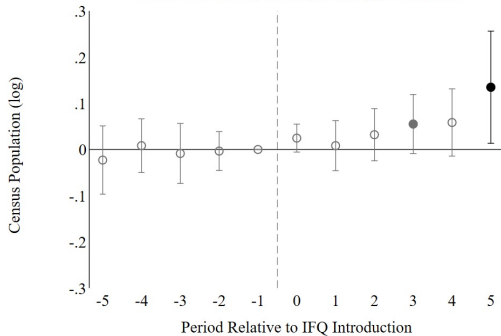
Treatment: Small Remote Fishing Community

Treatment: Small Remote Fishing Community

Treatment: CDQ or Majority Type D Quota

Census Population (log)

Period Relative to IFQ Introduction

Treatment: Majority Type C Quota

Census Population (log)

Period Relative to IFQ Introduction