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The Impact of Fisheries Reform: Property Rights Markets and the Drivers of Outmigration in Rural Alaska

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Abstract

The Impact of Fisheries Reform: Property Rights Markets and the Drivers of Outmigration in Rural Alaska

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This dissertation explores the economic effects of management shifts introduced in commercial Alaskan fisheries between 1975 and 2015. The first two chapters use household survey data from rural Alaska to examine the impact of limiting access to Alaskan salmon through transferable fishing permits. The first chapter exploits an eligibility window at the initial allocation of salmon permits to test whether the transferability of permits drove outcomes for rural villagers and their descendants. Results show that the sale of permits generates descendant outmigration and has other impacts on migration, employment, and durable assets that depend on permit type and gender of the initial recipient. The second chapter explores the drivers of permit sale and compares the relative importance of covariate shocks to demand, idiosyncratic shocks to individual productivity, and interventions designed to increase access to credit. Finally, the third chapter discusses the impact of catch shares programs in Alaska more generally and shows that the post-rationalization distribution of revenue from quota ownership has been largely stable across communities of different regions and scales.

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Chapter 1

Fish or Flight:

The Impact of Transferable Access Rights on Rural Alaskan Salmon Harvesters

Abstract

This chapter explores how salmon harvesters in rural Alaska responded to the implementation of a limited access management regime that introduced transferable permits in 1975. In the context of a predominantly subsistence economy, the lump-sum payments from salmon permit sales were significant wealth shocks. Using household survey data collected in nine remote Alaskan villages, I estimate the impact of permit sale on the initial permitholders and their descendants. The eligibility rules used to allocate permits allow me to identify the impact of transferability by comparing the original permitholders to their younger siblings and to applicants given non-transferable permits. Sale of the permit by original permitholders makes their descendants more likely to migrate out of the original village and less likely to participate in commercial or subsistence harvest. Predominantly allocated to men, the higher value drift net permits were leveraged into an immediate increase in the probability of outmigration, an increase in durable assets, but no long run improvements in descendant outcomes. Contrary to the intentions of the permit system, set net permit sales by women diminish the assets of the original permitholder, but make their descendants more likely to be formally employed outside the village. The results suggest that a transition to rights-based management of natural resources will have unintended distributional consequences that undermine the sustainability of rural fishing operations. The magnitude of these effects depends on liquidity, gender norms, and labor market frictions.

1.1 Introduction

As global fisheries transition to rights-based management, there is growing consensus regarding the conservation and efficiency gains from rationalizing access to common-pool resources (Wilen 2000; Grafton, et al. 2006; Costello et al. 2008; Brinson and Thunberg 2016; Birkenbach et al. 2017). Simultaneously, the difficulty of tracking outcomes for harvesters who cease to participate in the fishery means that little is known about the long run distributional impact of limiting access. Oftentimes the goal of limiting access to the fishery is to stabilize fishing revenue and allow local communities to capture resource rents (U.S. Congress,1996); when transferable access rights are implemented it is typically with the additional aims of promoting economic efficiency and flexibility for harvesters. In the context of rural fishing-dependent communities with credit and liquidity constraints, the lump-sum payments from selling access rights have the dual potential to facilitate consumption smoothing while also undermining traditional lifestyles and accelerating outmigration. Particularly when labor markets are thin and financial markets malfunction, traditional economic theories of property rights assignment may fail to predict the impact of these distortions (Banerjee and Duflo, 2005). Constrained by debt, harvesters are vulnerable to shocks and may not liquidate assets optimally. Additionally, if the transition to formal urban labor markets has cultural barriers, then the sale of these assets may not be converted into long run gains which is particularly concerning when credit constraints make re-entry into the fishery unattainable for their descendants.

The 1975 implementation of a limited entry permit system in the Alaska commercial salmon fishery presents a unique opportunity to examine whether transferable access rights altered the location, assets, and employment of rural harvesters and their descendants. While the management shift has indisputably been successful at conserving salmon stocks, there is debate whether the persistent trend of sales by Alaskans (Knapp, 2011) is accelerating the decline of rural communities (Carothers et al., 2010) or attenuating the sustainability of remote livelihoods as salmon permit sales allow rural harvesters to transition into alternate occupations. From a policy perspective, it is imperative to understand the distributional tradeoffs of limiting access through transferable permits so that policymakers concerned with community vulnerability can mitigate their impact.

This paper uses primary survey data to test a model of migration that incorporates transferable access rights and liquidity constraints into the existing theory of rural to urban migration. Additional channels through which the liquidation of access rights may impact long run outcomes for harvesters and their descendants such as durable assets, educational attainment, and labor market outcomes are also explored.

Empirically estimating the impact of transferable access rights is complicated by the lack of existing data on exiting fisheries participants and the endogeneity of asset sale decisions. I conducted household surveys in nine communities across the Bristol Bay region of Alaska and linked the resulting dataset with a permit ownership database maintained by the State of Alaska. The strength of social networks in these predominantly Alaska Native communities facilitated tracking outcomes for original 1975 permitholders and their descendants. Selling a salmon permit is likely to be correlated with unobservables that can also drive outmigration and occupational choice, such as attachment to the village. This will bias any naïve estimates of the impact of sale upwards when those who sell permits are compared to those who passed on the permit to their descendants or who still own the permit. To account for the endogeneity of permit sale and identify the causal impact of permit transferability, I exploit the eligibility window at the initial allocation of salmon permits. The first generation of permitholders are compared to two counterfactuals: members of the same village who were granted non-transferable permits and younger siblings who were ineligible for permits.

I find that being eligible to sell a permit has an ambiguous impact on the first generation of permitholders but increases the probability of descendant outmigration by 30% and decreases the probability that descendants participate in commercial or subsistence harvest by 15%. The first generation of recipients are more likely to use the revenue from permit sale to stay within the village whereas the lack of heritable assets for their descendants makes later generations less likely to remain in the community. Other impacts depend on the gender of the initial permitholder because higher value drift net permits were primarily allocated to men whereas set net permits are a smaller asset[1] traditionally fished by women and children. Drift net permit sales by men generate an immediate increase in the probability of overcoming moving costs for the initial permitholders and increased durable assets for the first generation but have little long run impact on labor market or educational outcomes for descendants. Conversely, set net permit sales are insufficient to promote immediate outmigration and instead make the original female permitholders less likely to accumulate durable assets. Finding the initial sale of these lower value permits insufficient to overcome moving costs, these women exiting the fishery were less likely to engage in conspicuous consumption and instead become 18% more likely to participate in formal employment. Their descendants are also 25% more likely to be formally employed outside the community. In general, it does not appear that permit sales were leveraged into long run investment in higher education, but more likely to occur under duress as liquidity constraints necessitated the liquidation of assets. Permitholders without the legal authority to transfer their permits are more likely to have descendants still living in the village and participating in the fishery but their descendants are less likely to transition to alternate livelihoods. Transferability has destabilized these rural communities while simultaneously allowing a subset of descendants to engage in income diversification.

This study primarily contributes to two existing strands of literature. Firstly, this paper extends the dialog on how to design transferable rights programs to ensure positive social effects in general, and in the fishing-dependent communities of Alaska in particular. Many communities in Western Alaska rely on income from fishing to

[1] Across my sample period, the market value of set net permits was roughly 30% that of drift net permits.

sustain livelihoods while local ownership in these fisheries is declining (Knapp, 2011). Carothers et al. (2010) found that despite provisions designed to prevent consolidation and absentee ownership, during the first five years of the Alaska halibut individual fishing quota (IFQ) program, net transfers of quota occurred from small remote communities and that residents of predominately Native communities were more likely to sell than buy quota. Knapp (2011) shows that local ownership of Alaskan salmon permits has declined as the price of the permits increased and goes on to hypothesize that permit ownership may evolve because non-locals have different discount rates and are willing to pay more than locals. Qualitative data suggests residents believe that maintaining local ownership in the salmon fishery is important and cites obstacles such as a lack of collateral, a desire to diversify outside of commercial fishing, and declining cultural ties to the fishery (Apgar-Kurtz, 2012). This study is the first quantitative analysis of individual survey data that estimates the impact of declining permit ownership in rural communities.

Secondly, within the development economics literature, there is a recent focus on how land rights, and resource rights more generally, affect migration. Generally, these empirical studies find that tradeable property rights increase the probability that labor is reallocated from agricultural to industrial sectors (Boucher et al., 2005; Mullan et al., 2011; Wang 2012; Chernina et al. 2014; Valsecchi 2014; Fernando 2015). However, other studies show that land tenure reform will not promote outmigration when an undeveloped formal banking sector means that most poor farming households are still credit-constrained (Boucher et al., 2005) or when strong inheritance norms mean that the first-born son is expected to stay on the farm (Fernando, 2015). While the majority of the aforementioned studies examine only the short-term impact of property rights reform, Bleakley and Ferrie (2016) track the descendants of those randomly allocated land in the Georgia Cherokee Land Lottery and find no long run change in human capital accumulation from this wealth shock; they conclude that financial barriers are not the primary obstacle to investing in education. Because transferable access rights are rarely allocated in developing country fisheries, there have been no corresponding analyses of the impact of reforming marine resource rights. These land tenure studies primarily attribute the reallocation of labor to a reduced probability of property expropriation reducing the opportunity costs of migration. In the context of the Alaskan salmon fishery, effort restrictions effectively limit exploitation of the resource and harvesters need not reside in the village year-round in order to participate in the relatively short fishing season so transferable access rights are more likely to facilitate outmigration by financing the high cost of relocation from rural to urban locations.

The rest of the paper is organized as follows. Section 2 introduces the background of the Alaskan salmon fishery, the history of the permit system, and describes the target communities. Section 3 models the dynamic migration decision of a rural resident choosing between the resource-dependent rural sector and the urban labor market with the addition of a transferable access right that can be liquidated and used to overcome moving costs. Sections 4 and 5 describe the survey data collected and empirical strategy, including the construction of control groups. Section 6 presents the empirical results. Section 7 concludes by suggesting the policy implications of the results.

1.2 Background on Alaskan Salmon Fisheries and Communities

This section describes the history of commercial fisheries regulation in Alaska with an emphasis on the Bristol Bay salmon fishery. Then it details the demographic context of the Bristol Bay region, the study communities, and existing evidence of the drivers of outmigration from the area.

1.2.1 Bristol Bay Commercial Salmon Fishery

The commercial salmon fishery in Bristol Bay developed in the late 19th century and has historically been dominated by large canning operations originating outside the region. First wholesale value from the fishery was $390 million in 2010, making this the world's most valuable wild salmon fishery (Knapp, 2013). Local harvesters from the communities surrounding the fishery represent an important but declining share of the total harvesting operations (Knapp, 2011). There are two sectors comprised of different harvest technologies. The set net fishery is comprised of harvesters fishing close to the shore, using set gillnets and small skiffs or even picking nets from the beach. Drift gillnet harvesters use larger vessels (a maximum of 32 feet in length) to fish in the open water and account for 70% of the total catch (Knapp, 2013). Tenders employed by the canneries work as middlemen to transport fish from both set and drift operations. Traditionally, due to the intrahousehold division of childcare responsibilities, the set net fishery was dominated by women and children while men were more likely to fish on drift boats.

In 1973, Alaska's Limited Entry Act was passed by the State Legislature. The explicit goals of this legislation were the economic prosperity of the fishery, the biological conservation of the fish, and the protection of local harvesters. Consequently, a limited entry permit system was enacted in Bristol Bay in 1975. This permit system allocated approximately 1,860 drift gillnet permits and 1,100 set net permits to harvesters who could prove a historic record of participation in the fishery between the years of 1969-1972. Qualification for a fishing permit was based on a point system with points awarded for licenses obtained in the qualifying years and additional points awarded if the applicant could prove participation prior to 1969, Alaska residence, or economic dependence on the fishery. Due to cultural and logistical barriers, 29% of eligible rural Alaska residents did not apply for permits and there were claims that their more sophisticated counterparts from out of state had anticipated limited entry and been more likely to accrue the necessary documentation (Petterson, 1983). Concerns about the equity of the distribution system led to a lawsuit (Wassillie v. CFEC) wherein a settlement allocated 275 additional permits to rural Alaskan claimants, with many of these permits having the stipulation that they were unable to be transferred and would expire upon the death of their owner. This eligibility window for the initial allocation of permits will allow for the construction of counterfactuals as explained in Section 4.

The biology of wild salmon reproduction means that annual harvests are highly volatile and there is corresponding uncertainty in ex-vessel prices and permit values (Herrmann et al., 2004). Since 1975, the market price of transferable drift permits has fluctuated around $115,000 while the price of set net permits averaged $35,000 (See Figures 2.1 and 2.2). The Commercial Fisheries Exchange Commission (CFEC) of the State of Alaska initially oversaw the allocation of permits and currently supervises the transfer of permits. While permanent sale of a permit is allowed, temporary transfer or leasing is illegal unless authorized by an emergency medical transfer[2]. Absentee ownership is discouraged by a provision requiring the permitholder to be present when landings are delivered to the post-harvest sector.

In addition to limiting access through the permit system, the state of Alaska manages the sockeye salmon fishery through an escapement goal system wherein the fish moving upstream to spawn are counted by managers and the fishery is only open to participants once the daily escapement goal necessary to ensure maximum sustainable yield has been surpassed. This management system is considered a model of biological success and simultaneous economic failure since low product prices from farmed fish competition, a highly compressed harvesting season, lack of infrastructure, and volatility in returns sometimes cause the fishery to be eligible for federal disaster relief funds (Hilborn, 2006).

A unique community protection measure within Alaskan commercial fisheries is the Western Alaska Community Development Quota (CDQ) Program. The explicit goal of this program is to alleviate poverty and vulnerability in rural, economically depressed, and predominantly Alaska Native communities. Beginning in 1992 with the implementation of catch shares in the Bering Sea pollock fishery, six regional CDQ groups were established based on community proximity to the Western Alaska coastline[3]. Each CDQ group received a portion of the total allowable catch and as

[2] Preliminary evidence suggests that despite being illegal, leasing is relatively common, although the CFEC does limit the number of emergency transfers allowed before a permit is seized.
[3] The boundaries were drawn 25 nautical miles from the coast.

subsequent fisheries rationalized, CDQ groups were allocated quota for additional species. Each individual CDQ group has sovereignty over how they choose to harvest, lease, or invest their quota shares with their various harvesting partners. The regional CDQ group for my study is Bristol Bay Economic Development Corporation (BBEDC). While salmon is not a catch share fishery, the primacy of salmon in the local economy means that BBEDC's commercial fishing interventions are primarily focused on assisting watershed residents who participate in the salmon fishery. BBEDC provides permit brokerage services that attempt to keep permits in local hands. They also provide vessel improvement grants, permit acquisition loans, and fishing education. This study intentionally selected some communities within the CDQ group boundary and others without (see Figure 1.1). Chapter 2 analyzes whether these interventions have been able to effectively curtail rural permit sales and increase the efficiency of local harvesting operations.

Figure 1.1: Map of Bristol Bay Region Highlighting Study Villages

Key: Red= study villages outside the Community Development Quota (CDQ) group boundary
Yellow= study villages inside the CDQ group boundary
Square= regional hub and main population center
Source: Bristol Bay Visitor's Council

1.2.2 Community Characteristics

The mixed cash-subsistence economy of Bristol Bay supports a population of 7,611 that is 67 percent Alaska Native (Duffield et al., 2012). Subsistence salmon harvests play a key role in the diet and culture of rural Alaskans; 73% of Bristol Bay residents reported participation in the subsistence fishery (ADFG, 2015). Despite the importance of subsistence, the commercial fishery's role in the economy is distinct in that revenue from commercial fishing or commercial permit sales is the main source of cash in the region (Duffield et al., 2012). Table 1.1 presents summary statistics within the communities surveyed (details of survey in section 1.4.2). While populations within each village have been stable relative to 1970 census numbers, the recent trend has been an increase in outmigration from the entire region (Alaska Bureau of Labor Statistics, 2016). The initial allocation numbers demonstrate that villages further inland or to the north where women did not have a historical record of traveling to participate in the commercial fishery each season were much less likely to be allocated set permits.

Other interesting differences between study sites can be seen in the increased participation in subsistence among villages with a higher proportion of Alaska Natives and Yupik speakers, indicating increased cultural attachment. Average years of education are low, and number of children are high relative to the rest of the United States. Unemployment is pervasive and a much greater issue outside the regional hubs of Dillingham and Naknek/King Salmon. Durable assets primarily composed of vehicles and property are low compared to national averages but demonstrate a high degree of volatility with some households being much more likely to own homes and others to invest in rural amenities such as snow machines and boats.

Several other studies have looked specifically at the migration decisions of Alaska Natives but have failed to address to impact of the commercial fishery and fishery management changes and rely on US census data that has notoriously low response rates in this region (Edwards, 2007; Berman, 2009; Huskey et al., 2004; Howe et al., 2011). These studies find that Alaska is characterized by high rates of internal migration that occurs gradually as migrants transition to progressively larger and more urban communities across their lifetime. There is evidence that non-income amenities such as the subsistence lifestyle are important in migration decisions. Additionally, they find that low-skilled young workers are likely to temporarily migrate to the largest Alaskan city of Anchorage to obtain human capital and then return to remote villages if employment is available. Prior studies do not incorporate the dynamics of commercial fisheries into their model or make any conjectures as to how the ability to sell permits might factor into the migration decision. This research will address this gap by explicitly modeling migration as a function of commercial fisheries regulations.

Table 1.1: Summary Statistics by Community

		Within CDQ Boundary					Outside CDQ Boundary	
Variable	Total	Aleknagik	Dillingham	Manokotak	Naknek/ King Salmon	Togiak	Iliamna/ Newhalen	Koliganek
2010 Population *(change from 1970)*	5,347 (+2,866)	222 (+94)	2,364 (+1,450)	447 (+233)	374 (+172)	817 (+434)	109 (+51)	209 (+67)
1975 Drift Permits *(% of 1970 pop.)*	510 (20.7%)	44 (34.4%)	206 (22.5%)	41 (19.2%)	92 (17.2%)	83 (21.7%)	26 (17.8%)	18 (12.7%)
1975 Set Permits *(% of 1970 pop.)*	389 (15.8%)	26 (20.3%)	125 (13.7%)	28 (13.1%)	145 (27.2%)	38 (9.9%)	23 (15.8%)	4 (2.8%)
Non-transferable Permits *(% of 1970 pop.)*	127 (5.2%)	3 (2.3%)	48 (5.3%)	20 (9.4%)	38 (7.1%)	12 (3.1%)	0 (0.0%)	6 (4.2%)
Currently own permit	0.258 (0.438)	0.207 (0.408)	0.152 (0.548)	0.281 (0.451)	0.323 (0.469)	0.303 (0.461)	0.099 (0.300)	0.258 (0.440)
Sold 1975 permit	0.231 (0.422)	0.353 (0.481)	0.391 (0.5130	0.259 (0.440)	0.298 (0.459)	0.158 (0.365)	0.231 (0.423)	0.082 (0.277)
Participates in subsistence	0.805 (0.396)	0.817 (0.389)	0.646 (0.412)	0.884 (0.320)	0.590 (0.493)	0.891 (0.313)	0.843 (0.365)	0.927 (0.261)
Alaska Native	0.877 (0.329)	0.795 (0.406)	0.634 (0.295)	0.885 (0.320)	0.707 (0.456)	0.988 (0.110)	0.868 (0.340)	0.969 (0.174)
Yupik Speaking	0.453 (0.503)	0.482 (0.503)	0.278 (0.239)	0.798 (0.420)	0.035 (0.185)	0.878 (0.345)	0.215 (0.412)	0.361 (0.483)
Age	62.509 (19.392)	70.265 (20.539)	67.372 (21.389)	67.230 (18.852)	62.681 (16.542)	62.751 (19.392)	54.430 (20.206)	58.422 (20.267)
Number of children	3.284 (2.634)	3.542 (2.777)	3.129 (1.983)	3.770 (2.670)	2.574 (1.992)	3.461 (2.600)	2.867 (3.004)	4.031 (2.811)
Years of Education	10.105 (4.774)	9.675 (5.480)	11.983 (3.574)	8.259 (5.202)	12.075 (3.290)	8.810 (5.020)	11.066 (4.470)	10.113 (4.294)
Unemployed	0.270 (0.444)	0.256 (0.439)	0.132 (0.354)	0.304 (0.462)	0.157 (0.365)	0.366 (0.483)	0.281 (0.451)	0.284 (0.453)
Formal Employment	0.393 (0.489)	0.373 (0.487)	0.629 (0.521)	0.319 (0.468)	0.563 (0.497)	0.317 (0.467)	0.405 (0.492)	0.284 (0.481)
Durable Assets $USD	19,629.03 (68,966.94)	19,986.75 (34,328.58)	25,931.19 (73,901.45)	12,220.86 (26,399.43)	28,722.22 (44,021.96)	8,742.42 (12,650.87)	35,904.96 (16,172.30)	9,592.87 (10,830.95)

NOTE: Unless otherwise noted, entries are means with standard deviations in parentheses.

1.3 Theoretical Model

This research builds upon models from existing migration theory, including the seminal Harris and Todaro (1970) model which suggests that in a two-sector framework, rural to urban migration is an individual response to obtaining higher expected income. Since the traditional migration models assume that rural workers are engaged in agricultural production, an extension of the model to incorporate resource-dependent communities reliant upon fisheries for income has important implications for situations where common property resources are a key factor in the migration decision. The theoretical implications of changes in the fishery for migration are not obvious and depend upon the expected utility from living in alternate regions and how residents' fishing costs and revenues would be affected by migration.

Because the commercial salmon fishery is effectively managed using escapement goals, each individual harvester lacks the ability to exert additional effort that would deplete the stock (Baker et al., 2006). For this reason, the model developed is an extension of Noack et al. (2017) wherein agents choose between a resource-dependent traditional sector and an urban resource-independent sector. Their model focuses on the economic development implications of initial regulation of open access resources via harvest quotas causing individuals to reallocate to the modern sector whereas mine will take regulation of the resource as a pre-existing condition and place emphasis on an endowment of transferable access rights allowing users to overcome moving costs and leave the traditional sector.

This is an overlapping-generations model where agents can work in the urban sector if they overcome the initial moving costs or human capital investment. The alternative is to remain in the traditional sector and rely on resource rents which are independent of individual effort but depend on acquiring sector-specific capital. This economy is inhabited by a continuum of individuals who live for two periods and have a child born in the second. Individuals are identical apart from inherited wealth, b_t. In the first period of life, t, the individual is born, inherits wealth, and makes an initial investment in capital specific to the traditional or urban sector which determines their location. Within the second period of life, $t+1$, the individual supplies labor to earn income y_{t+1} and invested capital is exhausted. Following Banerjee and Newman (1993), individuals value consumption c_{t+1} and bequest to offspring b_{t+1} according to the utility function:

$$u_{t+1} = (1-\delta) log c_{t+1} + \delta log b_{t+1} \tag{1}$$

In accordance with Galor and Zeira (1993), individuals who migrate to the urban sector will earn positive α which is greater than the moving costs β necessary to work in this sector. In the context of rural Alaska, these moving costs are likely to represent the necessary social network, human capital, and financial assets required to adapt to urban life. Income for each individual j born at time t in the urban sector becomes:

$$y_{t+1}^{u}(j) = \alpha - \beta + b_t \tag{2}$$

In the traditional sector, returns are rival and depend on aggregate effort, individual investment in sector-specific capital k_t (this represents vessels and gear), and exogenous variation in resource abundance. Natural reproduction of the stock evolves in accordance with a logistic growth function and harvesting technology is in accordance with a standard Gordon-Schaefer harvest function (see Appendix A.2). Traditional sector participants must also possess an access right A_t which can be inherited or purchased for price φ. For the moment we ignore variation in access right prices and assume that they are exogenously determined by abundance of the resource and expectations of future earnings. Without an access right, we assume that rural income is limited to bequests which is somewhat realistic in the thin labor markets of rural Alaska. This means that rural income for individual j depends largely on the allocation of access rights:

$$y^r_{t+1}(j) = \max_{k_t(j,\tau)} \int_0^1 \{qX_t k_t(j,\tau) - k_t(j,\tau) + b_t(j)\} d_t \qquad \text{if} \qquad A_t{=}1 \tag{3}$$

$$y^r_{t+1}(j) = \varphi + b_t(j) \qquad \text{if} \qquad A_{t-1}{=}1 \ \& \ A_t{=}0$$

$$y^r_{t+1}(j) = b_t(j) \qquad \text{if} \qquad A_{t-1}{=}0 \ \& \ A_t{=}0$$

Sale of the access right will result in a one period infusion of φ that can be consumed in the current period or used to invest in β in the first period only. When an individual owns an access right, they can harvest according to the technological parameter q that indicates harvesting efficiency and the resource stock size X_t. The assumption that $\alpha \geq \beta$ means that individuals have an incentive and ability to migrate. The tension results from the fact that φ can also become part of a bequest and that sale of the asset may result in permanent inability of descendants to enter the fishery.

Individuals solve

$$\max_{c_{t+1},b_{t+1},k_t,A_t} u_{t+1} = (1-\delta) log c_{t+1} + \delta log b_{t+1} \tag{4}$$

subject to

$$k_t \leq b_t$$

and

$$c_{t+1} + b_{t+1} \leq b_t + \max\{y^r_{t+1}, y^u_{t+1}\}.$$

We assume a complete lack of credit markets that could help finance moving costs or harvest sector capital. The market outcome follows when each individual chooses the location and occupation that that maximizes individual utility subject to initial wealth, possession of an access right, and given the choices of all other individuals. Households who can afford the moving costs β will choose the urban sector so long as urban income is higher and households without this initial wealth will be trapped in the rural resource-dependent sector and rely only on bequests if there is no access right. The total number of invididuals engaged in resource harvesting will evolve according to:

$$n_{t+1} = n_t - \int_0^{n_t} \mathbf{1}_\beta \max\{ y^u_{t+1}(j) - y^r_{t+1}(j), 0\} d_j + \int_{n_t}^1 \max\{ y^r_{t+1}(j) - y^u_{t+1}(j), 0\} d_j \tag{5}$$

where n_t is the number of parents using the resource at time $t+1$ and n_{t+1} is the number of children observing this and making their own investment decision about which sector to engage in at time $t+1$. The number of children who decide to change sectors and outmigrate will be a function of access right liquidation decisions by their parents, expected income in both sectors, and whether their initial bequest is sufficient to make the urban sector attainable which is indicated by the indicator function $\mathbf{1}_\beta$ (that only takes a value of one if $b_t > \beta$).

Proposition 1: The ability to sell access rights will increase the steady-state number of individuals migrating to the urban sector if permit prices are sufficient to overcome moving costs ($\varphi \geq \beta$).

If individuals are incentivized to outmigrate until urban and rural incomes are equal, in steady-state with non-transferable permits, the number of resource harvesters is given by Noack et al. (2017) as:

$$n_{NT}^* = \frac{\rho\kappa}{4(\alpha-\beta)}\left(\frac{q\kappa-1}{q\kappa}\right)^2 \tag{6}$$

which is larger than the number of resources harvesters in steady-state with transferable permits:

$$n_T^* = \frac{\rho\kappa}{4(\alpha-\beta)}\frac{\beta}{\varphi}\left(\frac{q\kappa-1}{q\kappa}\right)^2 \tag{7}$$

so long as $\varphi \geq \beta$ (see proof in Appendix A.2).

Within this framework, there are two consequences of permit sale: rural income is permanently lower, and the large lump sum transaction can potentially overcome moving costs and facilitate outmigration. The impact of permit sale on migration depends on individuals' preferences for bequest and fixed costs of moving (search time for housing, transactions costs of liquidating rural assets, etc…). Selling a permit may make individuals more likely to move to an urban area through two channels: the negative impact on rural wages and the temporary increase in income available to be spent on moving costs. Conversely, permit sale could make outmigration less likely if the revenue is spent on conspicuous consumption items that increase rural utility (snow machines, ATVs, home improvement, etc…) and simultaneously make it less likely that moving costs can ever be negated. If harvesters do invest the permit sale revenue in education or alternate urban opportunities, then their descendants are also more likely to leave the rural community as the steady-state bequest increases.

Proposition 2: The steady-state bequest from individuals choosing the urban sector is more likely to be large enough to overcome moving costs once tradeable permits are introduced. Descendants of those allocated transferable permits are more likely to be able to afford to access alternate livelihoods in the urban sector.

According to Noack et al. (2017), the steady-state bequest in the urban sector with non-tradeable permits is:

$$b_{NT}^{*} = \frac{\delta}{1-\delta}(\alpha - \beta) \tag{8}$$

which is smaller than the steady-state bequest once permits are made transferable:

$$b_{T}^{*} = \frac{\delta}{1-\delta}(\alpha + \varphi - \beta) \tag{9}$$

so long as $\varphi \geq 0$ (see proof in Appendix A.2). For the urban sector to be stable, the bequest from working in this formal labor market must be sufficient for offspring to also afford the moving costs or investment in human capital necessary to be employed in the urban sector. To ensure persistence of this sector, Noack et al. (2017) assume that $\delta\alpha > \beta$. The introduction of tradeable permits with exogenous positive market value φ only makes it more likely that the urban bequest will be sufficient to ensure that children can also transition to formal employment outside the traditional sector. The necessary assumption becomes:

$$\delta(\alpha + \varphi) > \beta \tag{10}$$

and so long as this is satisfied, the urban sector will persist over time. This means that the ability to liquidate the access right makes it more likely that descendants will be able to outmigrate and choose alternate livelihoods, but for bequest preferences that are sufficiently small or moving costs that are sufficiently high, even the introduction of tradeable permits will not permit offspring to transition to the formal sector.

1.4 Survey Data and Fieldwork

From February to June of 2016 I conducted household surveys in the nine communities presented in Table 1.1. The following section describes how villages and individuals were selected and incentivized to participate in the study and describes the resulting dataset.

1.4.1 Sampling

Village Selection

Preliminary qualitative research was done in conjunction with local CDQ group, Bristol Bay Economic Development Corporation (BBEDC). Selecting some villages from within BBEDC's boundaries (25 nautical miles from the coast) and some from without will allow me to test for the efficacy of their interventions that are designed to assist rural harvesters such as permit subsidies, vessel loan programs, permit brokering, fishing education, and scholarships. In addition, villages can set their own policy for alcohol possession and sale and there are several damp (sale banned), dry (possession and sale banned), and wet (no regulation) villages within the region.

As mentioned in Section 2, there are two types of permits for Bristol Bay salmon: a drift gillnet permit is typically fished by a larger boat in open water and sells for roughly five times the amount of a set gillnet permit. A set gillnet is fished by a smaller skiff, attached to the shoreline, and can only be fished at a predetermined site. Although they both primarily target the same large run of sockeye salmon, the large variation in the value of these two permits makes them an interesting comparison, so I decided to target both types of permit holders for my study. To attain an unbiased and representative sample, I first used the CFEC data on permit ownership to identify villages where there were more than 15 drift and 15 set gillnet permits allocated in 1975. Working in partnership with BBEDC, I then eliminated villages that are not accessible by air in the winter or where the year-round 1975 population was below 100 inhabitants because the transportation costs of visiting these remote communities could not justify the number of surveys I would obtain.

Villages above the permit holder threshold as either wet vs. dry/damp and BBEDC community vs. non-BBEDC community and then randomly selected treatment villages from each of the four categories to visit first. There are a small number of communities in the region that were allocated zero permits, but these have a population well below the cut-off. I identified one BBEDC community and one non-BBEDC community that each obtained less than 8 permits and still had a 1975 population near the threshold. These imperfect control villages are an interesting counterfactual for communities that were more involved in fishing, but I will primarily be relying on control individuals within the treatment villages as explained below. Surveys were also conducted in the regional hub of Dillingham because the increased labor market opportunities in this community allow for an examination of differential impacts of permit sale conditional on existing labor market opportunities. In addition, many of the original permitholders or their descendants had migrated to this community so in-person surveys were able to be conducted for a subset of the sample that would have otherwise suffered attrition.

Sample Construction and Control Groups

The CFEC database of permit ownership from 1975 to 2015 was used to construct a random sample of permitholders for each village. In addition, publicly available voting registration records were used to generate a sample frame of residents who had never owned a permit. Randomly chosen individuals were surveyed from one of six groups:

1. Permitholder allocated drift permit in 1975
2. Permitholder allocated set permit in 1975
3. Permitholder purchased/gifted drift or set permit from 2000 on
4. Permitholder allocated non-transferable drift or set permit in 1976-1990
5. Voter present in village in 1975 but never sought permit
6. Voter present in village in 2000 but never sought permit

Given the small population of the survey communities and initial allocation of permits as the exogenous policy change of primary interest, 80% of permitholders in the first two categories were selected for surveys. The third group was included in the study as a measure of descendant outcomes, to provide potential data on more recent drivers of fishery participation, and because it had the potential to include younger siblings of original permitholders who did not qualify for their own permits but later inherited or purchased one.

The within-village control groups also come from the fourth through sixth categories. In 1976, roughly 1100 rural Alaskans sued the CFEC claiming that the permit allocation process had been unfairly biased against Alaska Natives with cultural and practical barriers that made it less likely that they would apply on time. Because of this lawsuit, 60 additional drift permits, and 75 additional set permits were allocated between 1976 and 1990. These additional permits are distinct from the initial allocation in that they are not transferable and thus their recipients make an ideal control group who are similar to original permitholders along most dimensions (See Table 1.2). The exception is that non-transferable permits within the Bristol Bay region were much more likely to be allocated to women in the set net fishery, so they are a more robust control for the impact of set net permit sales. The voter control groups are mainly useful for their inclusion of ineligible siblings because they differ significantly from the original permitholders along several dimensions including Alaska Native heritage, Yupik language skills, and years of education. A subset of these voters were highly migratory professionals who happened to be in a rural community for several years, primarily serving as teachers.

As stated, the final and most important control group could not be assembled prior to surveys because it relies on the elaborate reconstruction of familial relationships. The final column in Table 1.2 presents the summary statistics for the 227 younger siblings that came into the sample through inclusion as new permitholders, NT permitholders, or voters. Collecting data on family trees and asking respondents to identify their relatives who were also in the sample led to matching 61.53% of original permitholders with at least one younger sibling who was less than 18 in 1975 when permits were allocated. An additional 24.39% of respondents were not matched with a younger sibling because they were either the youngest in the family or because they were an only child.

Figure 1.2 demonstrates that 1975 age and gender largely determined the allocation of permits. The requirement that participants prove fishery participation between 1969 and 1972 meant that only a small number of individuals younger than 18 were allocated a permit. The exogeneity of this regulation allows for the construction of a control group that is nearly identical to original permitholders except for the probability of receiving and selling a permit. This figure also demonstrates that women were much more likely to allocated set permits while men received drift.

Figure 1.2: Number of Set and Drift Permits Allocated by 1975 Age and Gender

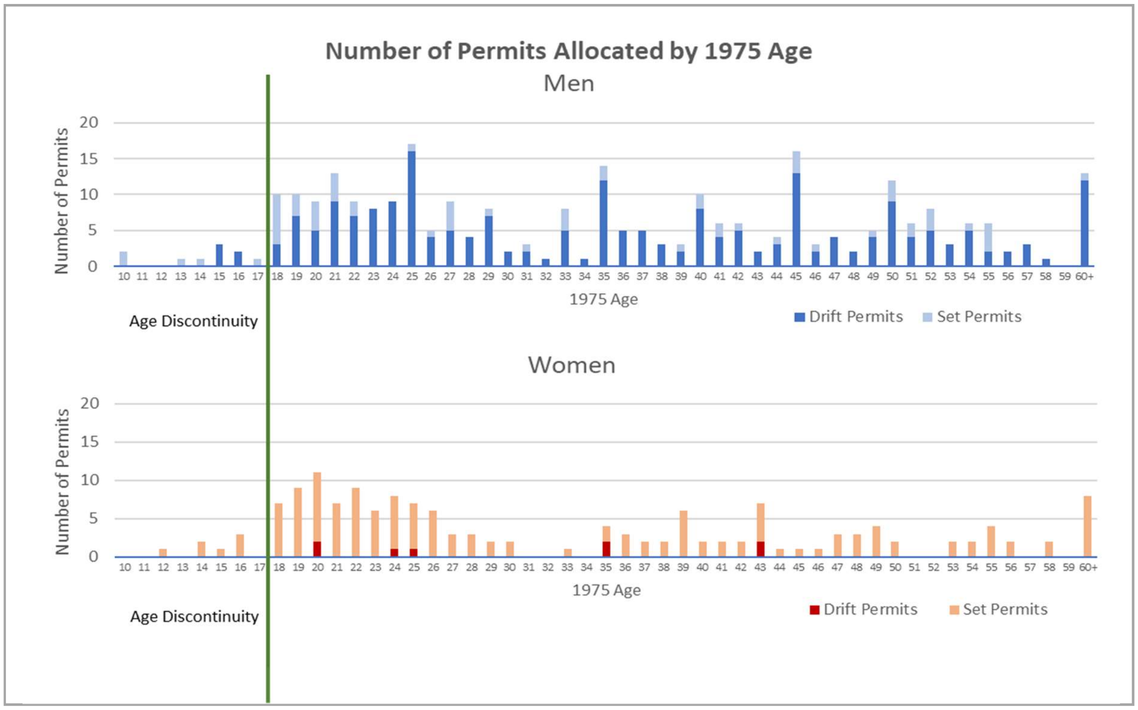

Table 1.2 shows the target sample for each control and treatment group alongside the number surveyed and summary statistics with differences in means highlighted. The strength of social networks in rural Alaskan communities, coupled with effective survey incentives and the employment of local enumerators led to very low attrition rates even though some of the targeted respondents were born in the 19th century. Logistically, the survey protocol was to first obtain consent from community leaders, then announce a $500 heating fuel raffle as an incentive for survey participation and to cut down on selection bias. The survey team visited each study community for roughly one week and conducted in person interviews with all respondents located in the village. For respondents who had left the village, efforts were made to track them down in Dillingham or Anchorage or to conduct a phone survey. When respondents could not be reached themselves or were deceased, the survey was conducted with their closest living relative. Most families were large and had at least one member still in

the village, so the primary source of attrition was from voters or NT permitholders who had few lasting social ties to the community.

Table 1.2: Sampling and Summary Statistics by Group

		Treatment Groups		Control Groups				
Variable	Total	1975 Drift	1975 Set	NT Permit	1975 Voter	New Permit	New Voter	Younger Sibling
Target Sample	1084	236	197	58	144	279	170	*227*
Number Surveyed *(% of Target)*	982 *(90.59)*	216 *(91.52)*	181 *(91.88)*	51 *(87.93)*	127 *(88.19)*	257 *(92.11)*	150 *(88.24)*	*62% of 1975 permits matched*
Currently own permit	0.258 (0.438)	0.157** (0.364)	0.165** (0.372)	0.767** (0.427)	0.007** (0.212)	0.567** (0.497)	0.000** (0.005)	*0.392*** *(0.489)*
Sold 1975 permit	0.232 (0.422)	0.397** (0.490)	0.435** (0.497)	0.116 (0.324)	0.056** (0.231)	0.236 (0.426)	0.009** (0.095)	*0.176** *(0.382)*
Passed on 1975 permit	0.308 (0.462)	0.598** (0.492)	0.624** (0.486)	0.070** (0.258)	0.047** (0.212)	0.241* (0.429)	0.000** (0.000)	*0.118*** *(0.322)*
Male	0.599 (0.490)	0.961** (0.194)	0.376** (0.486)	0.395** (0.495)	0.541 (0.494)	0.721** (0.450)	0.482** (0.488)	*0.569* *(0.496)*
Alaska Native	0.877 (0.329)	0.892 (0.311)	0.900 (0.301)	0.814 (0.394)	0.766** (0.425)	0.902 (0.298)	0.872 (0.335)	*0.941*** *(0.236)*
Yupik Speaking	0.453 (0.503)	0.667** (0.472)	0.512** (0.524)	0.419 (0.499)	0.374* (0.486)	0.402 (0.492)	0.227** (0.421)	*0.461* *(0.499)*
Age	62.509 (19.392)	79.230** (13.439)	76.571** (15.335)	61.279 (13.860)	68.542 (11.101)	51.647** (11.771)	38.354** (9.750)	*53.990*** *(5.551)*
Still Reside in Birth Community	0.719 (0.450)	0.760 (0.428)	0.718 (0.451)	0.627 (0.489)	0.776 (0.419)	0.706 (0.457)	0.673 (0.471)	*0.750* *(0.434)*
Years of Education	10.105 (4.774)	6.990** (5.224)	7.747** (5.521)	10.953 (4.292)	11.290** (4.180)	12.250** (2.476)	12.863** (2.165)	*12.127*** *(2.106)*
Unemployed	0.270 (0.444)	0.119** (0.400)	0.149** (0.357)	0.279 (0.454)	0.290 (0.456)	0.338* (0.474)	0.345 (0.478)	*0.351*** *(0.479)*
Formal Employment	0.393 (0.489)	0.337 (0.473)	0.339 (0.475)	0.442 (0.502)	0.383 (0.488)	0.453* (0.499)	0.491** (0.502)	*0.455** *(0.499)*
Durable Assets $USD	19,629.03 (68,966.94)	18,720.10 (36,660.31)	21,761.76 (99,822.80)	34,802.33 (67,694.79)	25,721.50 (122,100.30)	17,476.98 (23,140.62)	12,122.76 (13,691.67)	*16,001.96* *(25,117.90)*
Number of Descendants	8.979 (12.501)	13.363** (13.769)	14.301** (17.276)	8.884 (8.547)	9.907 (12.808)	4.296** (4.928)	3.573** (4.672)	*5.098** *(5.220)*
% Descendants in Birth Community	0.445 (0.369)	0.392* (0.323)	0.368** (0.300)	0.377 (0.363)	0.423 (0.348)	0.475 (0.418)	0.599** (0.419)	*0.464* *(0.397)*
% Descendants College Educated	0.080 (0.223)	0.076 (0.207)	0.080 (0.217)	0.070 (0.146)	0.108 (0.254)	0.102 (0.281)	0.017** (0.106)	*0.062* *(0.197)*
% Descendants Unemployed	0.317 (0.251)	0.322 (0.239)	0.344 (0.226)	0.270 (0.163)	0.288 (0.252)	0.313 (0.286)	0.252 (0.218)	*0.330* *(0.283)*
% Descendants Formal Occupation	0.246 (0.237)	0.230 (0.214)	0.250 (0.206)	0.290 (0.274)	0.244 (0.235)	0.256 (0.261)	0.217 (0.277)	*0.250* *(0.267)*
% Descendants Commercial Fishing	0.303 (0.331)	0.381** (0.334)	0.362** (0.347)	0.394 (0.373)	0.290 (0.321)	0.313 (0.348)	0.109** (0.223)	*0.316* *(0.346)*
% Descendants with Alcohol or Drug Issues	0.217 (0.271)	0.262** (0.263)	0.277** (0.295)	0.180 (0.243)	0.270** (0.252)	0.171* (0.269)	0.088** (0.193)	*0.224* *(0.296)*

NOTE: Unless otherwise noted, entries are means with standard deviations in parentheses.
**Indicates that group mean is significantly different from the sample mean with 1% confidence
*Indicates that group mean is significantly different from the sample mean with 5% confidence

The summary statistics presented in Table 1.2 suggest that original permitholders are slightly older and less educated than their younger siblings. Once original permitholders without sibling pairs are eliminated from the sample, the difference in means is not statistically significant. The descendants of original permitholders are significantly less likely to still be in the original village which is preliminary evidence to support permit sales being leveraged into eventual outmigration.

1.4.2 Survey Data

The individual survey sought quantitative data on the following variables:

1. Demographics: Tribe, Language, Age, Religion
2. Timeline: Place of Residence and Occupation since birth
3. Household Roster: Location/Occupation of other household members and descendants, Years of Education, Marriage, Fishing Involvement
4. Fishing History: Permit Ownership, Transfers, Purchase/Sale Price, Reason for Sale, Individual shocks, Processor Affiliation, Relationship to Buyer/Seller, Participation in other fisheries, Work as Crew
5. Price expectations and experimentally-derived risk aversion
6. Benefits received from BBEDC membership and Access to Credit
7. Social Capital: Number of close ties outside village, Fishing Network
8. Household Assets: Number and date of purchase for large assets
9. Family Tree: Siblings, parents, spouses and descendants in sample

This survey data was linked with the existing CFEC permitholder database to confirm the timing of permit transfer and average permit prices when respondents were unwilling to indicate the permit sale price. In addition to individual surveys, a back-cast recall survey was also conducted with community leaders to identify any community-level variables that had shifted over time.

1.5 Empirical Strategy

A variety of estimation techniques are employed to identify the impact of permit sale. Important to each approach is the eligibility window at initial allocation described in Section 4. To control for individual, household, and village characteristics, I employ three regression specifications: naïve regressions that compare original permitholders who sold their permits to those who passed them on to descendants or retained them, a reduced form estimate of the impact of transferability that uses village fixed effects to compare the owners of transferable and non-transferable permits, and an alternate reduced form estimate of the impact of permit eligibility that uses household fixed effects to compare older and younger siblings. These estimation methods must address two concerns to identify the impact of permit sale: (1) endogeneity in the selection of individuals into the fishery and (2) endogeneity in the decision to liquidate the access right. The first issue is that fishery participation is an endogenous decision likely to be correlated with unobservables such as cultural norms, alternate livelihoods, and ability that also drive outcomes. Secondly, the probability that an individual sells their salmon permit is potentially correlated with their cultural attachment to the village which simultaneously influences the decision to outmigrate.

To address the first concern, I include controls for individual and parental characteristics, employ village or household fixed effects to control for unobserved differences across the sample, within the sample only include individuals whose family had a record of fishery participation, and eliminate sibling pairs with a more than 10 year age gap. These measures ensure that I am comparing individuals who are equally likely to participate in the fishery before the management change. The second concern is that permit sale is an endogenous choice and those who sell permits may have unobservable characteristics related to attachment to the fishery or unreported individual shocks that drive both outmigration and permit sale. A priori, this means the bias in naïve estimates of the impact of permit sale is expected to be positive for outmigration and reduced form estimates of transferability and eligibility will be a lower bound. The endogeneity of permit sale is addressed by using two different counterfactuals. The first relies on the presence of NT permits and replaces the choice to sell a permit with the possession of a transferable permit. If NT permit allocation was based solely on marginal fishery participation and age prior to rationalization, this should yield unbiased estimates of the intent to treat when outcomes for owners of a transferable permit are compared to those who are unable to sell. Since transferable and NT permits alike cannot be used as collateral, the two assets are essentially identical in their expected value except for the characteristic of transferability. The second counterfactual is constructed using an age eligibility cut-off and the presence of ineligible sibling pairs.

A simple ordinary least squares (OLS) specification to estimate the effect of permit sale on the outcomes of interest is as follows:

$$Outcome_{ihv} = \theta PermitSale_i + X'_i\gamma + PermitType_i + \delta_v + u_{ihv} \qquad (5.1)$$

In equation (5.1) $Outcome_{ihv}$ is the dependent variable of interest for individual i in household h and village v. $PermitSale_i$ is a dummy variable equal to one if the individual sold a permit. X'_i is a vector of individual controls including birth order, age and age squared, marital status, years of education, number of children, and Yupik (tribal) language fluency. Birth order is included in the controls to account for cultural norms that might influence oldest children to either migrate to urban areas to secure financial security for the family or remain in the village to care for aging parents. $PermitType_i$ is a dummy variable for whether the respondent was initially allocated a set or drift permit that allows us to estimate differential impacts of these two very different assets. δ_v is a time-invariant village fixed effect. In the above specification, θ is the primary coefficient of interest, however there is likely to be joint determination of dependent variables and permit sale through unobservables such as attachment to the village, rendering θ biased even if the sample is reduced to only permitholders of the same type within the same village or even household.

To overcome the endogeneity issues with equation (5.1), I estimate the reduced form impact of permit transferability by comparing the original permit holders to those with non-transferable permits. Replacing permit sale with the possibility of permit transfer transforms equation (5.1) into:

$$Outcome_{ihv} = \theta Transferable_i + X'_i\gamma + PermitType_i + \delta_v + u_{ihv} \quad (5.2)$$

Replacement of permit sale with a dummy variable equal to one if permits are transferable, means that θ is now an estimate of the intent to treat. Regardless of whether the permit holder actually transferred the permit, θ captures the influence of permit transferability and is an unbiased lower-bound predictor of the impact of sale. First stage regressions suggest that permit transferability increases the probability of permit sale by 40% but since we cannot rule out that the possibility of permit transfer may transform the asset, an instrumental variables approach may fail as the instrument of transferability fails the exclusion restriction, making the reduced form estimate less likely to be biased.

The sample of NT permitholders is small which renders household fixed effects infeasible and the estimates less robust. For these reasons, an alternate control group of younger siblings unlikely to receive their own permits is also utilized. This transforms equation (5.1) into:

$$Outcome_{ihv} = \theta AgeEligible_i + X'_i\gamma + Gender_i + \eta_h + u_{ihv} \quad (5.3)$$

When the sample is restricted to households with sibling pairs on either side of the 1975 age eligibility cut-off of 18, this means that θ is now a lower-bound estimate of the intent to treat and an unbiased predictor of the impact of permit ownership and any corresponding permit sale. Because households are predominantly located within the same village, village fixed effects become redundant. Households in rural Alaska often include more than 10 children which means generational time trends could influence unobservables, so the sample is further restricted to include only households where siblings are no more than 10 years apart.

First stage regressions in Table 1.3 indicate that age and gender in 1975 are effective predictors of permit possession and sale. To isolate the differential impact of drift vs. set permit sales, gender is included in equation (5.3) since being 18 and female in 1975 is a strong predictor of set net permits whereas being 18 and male in 1975 is a strong predictor of drift permit possession. To avoid confusing the impact of gender with the impact of permit sale, regressions are restricted to only compare siblings of the same sex in the same household. The large family sizes in rural Alaska allow estimates to maintain robustness even with this modification. When there are multiple siblings of the same gender, the comparison is the difference in average outcomes for siblings above the age eligibility threshold from those below.

While 40% of younger siblings also own permits (see Table 1.2) either through inheritance, purchase or ambiguity around the permit allocation process, they are much less likely to sell than their older siblings. This can be attributed to strong inheritance norms demonstrated by qualitative responses to a survey variable that asked about intention to sell. Younger siblings denied their own permits in 1975 were much less likely to indicate any intention of selling the permit, largely because of the social shame connected to liquidating an inherited asset and because their parents had selected them as the descendant most likely to be successful in the fishery. The fact that age ineligibility makes permit sale much less likely means that in equation (5.3) θ can be interpreted not as the impact of owning a permit but as a lower-bound on the impact of permit sale.

Table 1.3: First Stage Regressions of Sibling Age at Permit Allocation and Probability of Permit Ownership and Permit Sale

PANEL A:	**Drift Permits:** all regressions compare older male siblings to their younger brothers		
Variable	(1) Logit *Men*	(2) Logit *Men*	(3) Logit *Men*
Dependent Variable	Ever Own Permit	Ever Own Drift Permit	Drift Permit Sold
18+ Male in 1975 *(Instrument)*	3.121*** (0.837)	3.891*** (0.501)	4.415*** (0.431)
Marginal Effect	0.509	0.581	0.684
Observations	286	286	286
Pseudo R^2	0.285	0.398	0.239

PANEL B:	**Set Permits:** all regressions compare older female siblings to their younger sisters		
Variable	(4) Logit *Women*	(5) Logit *Women*	(6) Logit *Women*
Dependent Variable	Ever Own Permit	Ever Own Set Permit	Set Permit Sold
18+ Female in 1975 *(Instrument)*	1.092** (0.489)	3.152*** (0.646)	3.741*** (0.706)
Marginal Effect	0.239	0.432	0.603
Observations	172	172	172
Pseudo R^2	0.178	0.442	0.154

NOTE: Clustered standard errors at the household level are in parentheses.
***Significant at 1% **Significant at 5% *Significant at 10%

1.6 Empirical Results

Using the proposed empirical models, I find a robust impact of permit sale on the probability of dependent outmigration and declining commercial and subsistence fishery participation. Other impacts depend on the type of permit and the gender of the initial permitholder. Drift net permit sales result in an immediate impact on the probability of outmigration for the original permitholder and no long run change in employment or educational outcomes for descendants. Set net permit sales decrease the durable assets and formal employment of original permitholders whereas their descendants are more likely to be formally employed outside the village.

1.6.1 Outmigration

As discussed in the theoretical model in Section 1.3, the impact of transferable permits on outmigration of the first generation of permitholders is ambiguous since liquidating the access right simultaneously makes overcoming moving costs more likely while also generating the potential for increased rural amenities that increase the opportunity cost of urban migration. Table 1.4 shows the estimates of key coefficients from equations (5.1) - (5.3) with an indicator variable equal to one for first generation permanent outmigration as the dependent variable. Columns (2) and (3) indicate that regardless of whether permitholders are compared to those holding NT permits or younger siblings those eligible to own and sell drift permits are 20% more likely to outmigrate. The consistency across the transferability and eligibility coefficients is evidence that the empirical strategy is identifying the causal impact of a drift permit sale since both counterfactual groups are much less likely to sell permits. Conversely, columns (5) and (6) indicate that the impact of selling a set net permit is not statistically significant which is interpreted to mean that while high-value access rights can surmount moving costs and make urban outmigration more likely, lower value assets do not have the same impact and are insufficient to generate investment in urban capital. Multinomial logit regressions were also performed where the categorical outcome variable was no outmigration, migration to another Western Alaskan village, migration to an urban Alaskan center, and migration outside of Alaska. These regressions confirmed that drift permitholders were more likely to migrate to urban centers within Alaska where moving costs and human capital requirements in the labor market are high, rather than to other Western Alaska villages. The results offer support for Proposition 1 since we only observe a decline in the number of rural harvesters and an increase in outmigration when the access right price was large. This suggests that the higher market value of drift permits was sufficient to overcome moving costs and decrease the steady-state number of rural harvesters whereas, even when transferred, the lower valued set net permits did not induce the initial permitholders to transition to the urban labor market. This could be driven by financial barriers to moving or a high preference for bequest leading set net permitholders to pass on a greater share of the permit sale revenue to the next generation.

The empirical evidence also suggests that while education makes both men and women more likely to outmigrate, additional children only negatively impact a woman's probability of leaving the village. In this cross-sectional analysis, the impact of children on migration cannot be disentangled from possible reverse causation since the opportunity cost of raising children in the village is also much lower. Interestingly, marriage does not play a large role in influencing migration decisions which can be attributed to cultural norms around exogamy and the fact that single respondents are equally likely to outmigrate seeking a mate regardless of gender.

Table 1.4: Impact of Permit Sale on First Generation Outmigration
Dependent Variable: Leave 1975 Village Permanently

	Drift Permits			Set Permits		
Variable	**(1) Logit**	**(2) Logit**	**(3) Logit *Men***	**(4) Logit**	**(5) Logit**	**(6) Logit *Women***
Counterfactual	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	1.606** (0.476)			0.146 (0.506)		
Permit Passed to Descendant	-0.070 (0.488)			-0.240 (0.494)		
Permit Transferable		1.173* (0.787)			0.614 (0.527)	
18+ Male in 1975			0.972** (0.342)			
18+ Female in 1975						0.664 (1.242)
Married	-0.118 (0.484)	-0.314 (0.460)	-0.705 (0.708)	-0.169 (0.477)	-0.642 (0.402)	-1.049 (0.963)
Years of Education	0.077 (0.217)	0.070 (0.058)	0.361** (0.146)	0.294** (0.090)	0.240*** (0.073)	0.167* (0.071)
Number of Children	-0.032 (0.093)	-0.058 (0.091)	0.078 (0.161)	-0.166* (0.099)	-0.167** (0.080)	-0.284* (0.163)
Fixed Effects	Village	Village	Family	Village	Village	Family
Observations	306	332	259	273	310	172
R^2	0.212	0.204	0.204	0.278	0.192	0.162

NOTE: Clustered standard errors at the village level are in parentheses. Each regression also includes controls for birth order, Yupik language speaker. Controls for age, age squared, gender, parents' education and tribal affiliation are included in columns 1, 2, 4, 5.
***Significant at 1% **Significant at 5% *Significant at 10%

While set net permit sales may not immediately impact the migration choices of the first generation of permitholders, the intergenerational bequest dynamics outlined in the theoretical model may still influence the decisions of their descendants. After a permit is sold, ensuing generations of rural residents may be more likely to relocate due to diminished rural income or unable to migrate due to insurmountable moving costs if permit revenue is spent on illiquid and transient rural assets.

Table 1.5: Impact of Permit Sale on Descendant Outmigration
Dependent Variable: Number of Descendants Living Outside Original Village

	Drift Permits			Set Permits		
Variable	**(1) Poisson**	**(2) Poisson**	**(3) Poisson *Men***	**(4) Poisson**	**(5) Poisson**	**(6) Poisson *Women***
Counterfactual	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	0.402*** (0.119)			0.390** (0.184)		
Permit Passed to Descendant	-0.108 (0.157)			-0.041 (0.218)		
Permit Transferable		0.744*** (0.207)			0.319** (0.135)	
18+ Male in 1975			0.348** (0.149)			
18+ Female in 1975						0.361** (0.148)
Married	-0.654*** (0.339)	-0.683*** (0.122)	-0.363 (0.266)	-0.154 (0.184)	-0.242 (0.186)	-0.299 (0.194)
Years of Education	0.012 (0.018)	0.016 (0.011)	0.090*** (0.032)	0039 (0.024)	0.013 (0.017)	0.094*** (0.026)
Fixed Effects	Village	Village	Family	Village	Village	Family
Observations	281	305	241	257	291	151
Pseudo R^2	0.459	0.464	0.469	0.495	0.477	0.454

NOTE: Clustered standard errors at the village level are in parentheses. Each regression also includes controls for total number of descendants, birth order, Yupik language speaker. Controls for age, age squared, gender, parents' education and tribal affiliation are included in columns 1, 2, 4, 5.
***Significant at 1% **Significant at 5% *Significant at 10%

Table 1.5 shows the estimates of key coefficients from equations (5.1) - (5.3) with a count variable equal to the number of descendants permanently located outside the village. Specification tests showed that the data had a distribution skewed towards zero (see Appendix A.1) and the literature confirms that in this context zero-inflated Poisson regression with robust standards errors is less likely to bias coefficients than log transformations (Manning and Mullahy, 2001 and O'hara). Columns (2) and (3) of Table 1.5 indicate that drift permit sales cause a net outflow of descendants relative to those with NT permits and to younger brothers. Additional poisson regressions on the number of descendants in specific locations confirmed that these descendants are likely to migrate to the same urban Alaskan centers as their fathers. However, the effect is robust even when limited to the sample of descendants whose parents sold but remained in the village which indicates that this is not solely the impact of parents migrating, but also a long run income diversification strategy for descendants without a heritable permit.

In the case of set net permits, columns (5) and (6) show that the eventual impact of set net permit sale is an increase in descendant outmigration. These initial results suggest that women who were allocated set net permits may have been more likely to invest in long run assets or human capital that did not immediately remove them from the village but eventually increased their descendant's ability to outmigrate. An alternate explanation is that set net permit sales were intentionally timed to facilitate the outmigration of descendants but not their mothers who had a cultural attachment to the village. Marginal effects computation indicated that both set and drift permit transfer results in a nearly identical 30% increase in the probability of descendant outmigration. When the average number of descendants is considered, this is equivalent to 3 additional descendants per family who no longer reside in the village.

1.6.2 Employment and Fishery Participation

As discussed in the theoretical model in Section 1.3, the impact of transferable permits on fishery participation and employment outside the fishery should be unambiguous as long as the access right sale price is sufficient to overcome moving costs. Permitholders who liquidate their access right should be much more likely to participate in formal employment in the urban sector once the possibility of harvest within the rural traditional sector is restricted. Table 1.6 shows the estimates of key coefficients from equations (5.1) - (5.3) with an indicator variable equal to one for first generation permanent formal employment as the dependent variable. Surprisingly, columns (2) and (3) indicate that drift permit sales do not correspond to a significant increase in formal employment outside the fishery. This could be attributed to labor market frictions not present in the model or to a preference for conspicuous consumption over human capital accumulation. If, as discussed in Section 3, moving costs are both financial and cultural, it is possible that the revenue from drift permit sales is sufficient to overcome financial moving costs but insufficient to generate investment in the skills necessary for participation in the urban labor market.

Table 1.6: Impact of Permit Sale on First Generation Occupation
Dependent Variable: Formal Employment

	Drift Permits			Set Permits		
Variable	**(1) Logit**	**(2) Logit**	**(3) Logit *Men***	**(4) Logit**	**(5) Logit**	**(6) Logit *Women***
Counterfactual	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	0.189 (0.439)			0.148 (0.475)		
Permit Passed to Descendant	-0.171 (0.4592)			-0.307 (0.483)		
Permit Transferable		0.666 (1.099)			0.500 (0.534)	
18+ Male in 1975			0.419 (0.449)			
18+ Female in 1975						1.517** (0.292)
Married	-0.365 (0.542)	-0.276 (0.496)	0.520 (0.491)	0.776* (0.469)	0.940** (0.417)	0.690 (0.863)
Years of Education	0.120** (0.053)	0.123** (0.058)	0.567*** (0.161)	0.305*** (0.082)	0.292*** (0.070)	0.898** (0.356)
Number of Children	-0.022 (0.089)	-0.021 (0.048)	-0.034 (0.138)	-0.122 (0.095)	-0.085 (0.076)	-0.006 (0.207)
Fixed Effects	Village	Village	Family	Village	Village	Family
Observations	304	328	263	271	308	167
Pseudo R^2	0.248	0.239	0.298	0.242	0.209	0.372

NOTE: Clustered standard errors at the village level are in parentheses. Each regression also includes controls for birth order, Yupik language speaker. Controls for age, age squared, gender, parents' education and tribal affiliation are included in columns 1, 2, 4, 5.
***Significant at 1% **Significant at 5% *Significant at 10%

Columns (5) and (6) give weak evidence that set net permit sales make the first generation of permitholders 18% more likely to be involved in formal employment but only when considering eligibility and not transferability. Since set net permit sales are not being leveraged into immediate outmigration, this means that women who sell set net permits are more likely to be formally employed within the village than their younger sisters. This is evidence that rural labor market barriers are less significant for men than for women and is reinforced by qualitative evidence that the most common alternate livelihoods such as nursing, teaching, or administrative work are more likely to be pursued by women. These results also suggest that older siblings eligible to obtain and sell their own permits unencumbered by inheritance norms were more likely to seek alternate occupations once the permit was liquidated and less likely than their male counterparts to invest in rural amenities that rendered labor market participation unnecessary. These results do not fit with our theoretical model wherein we assumed that formal sector employment was impossible in the rural location but they do demonstrate that moving costs could be more realistically represented as twofold. There is an initial financial cost to liquidate rural assets and physically relocate (which is high in the context of rural Alaska) and then an additional cost of obtaining the human and social capital necessary to obtain employment in the new location. It appears that the price of drift permits was sufficient to overcome the former and not the latter.

Even if permit sale does not universally increase the probability of first generation formal employment, according to the theoretical model reduced rural incomes should still drive descendants to seek employment outside the fishery. Table 1.7 shows the estimates of key coefficients from equation (5.3) with count variables equal to the number of descendants formally employed, unemployed, attaining college graduation, and engaged in commercial and subsistence fishing. Panel A explores the impact of drift permit sales by comparing age eligible men to their younger brother while Panel B focuses on set permit sales and makes a similar comparison between age eligible women and their younger sisters (note that similar regressions were conducted using the NT counterfactual and the results were consistent).

Table 1.7: Impact of Permit Sale on Descendant Occupation, Fishery Participation, and Education: Age Eligibility with Sibling Controls

PANEL A:	**Drift Permits:** all regressions compare older male siblings to their younger brothers				
Variable	(1) Poisson *Men*	(2) Poisson *Men*	(3) Poisson *Men*	(4) Poisson *Men*	(5) Poisson *Men*
Dependent Variable	#Descendants Unemployed	#Descendants Formal Occupation	#Descendants Graduate College	#Descendants Commercial Fish	#Descendants Subsistence Fish
18+ Male in 1975	-0.074	0.026	0.077	-0.188*	-0.149*
	(0.153)	(0.175)	(0.470)	(0.101)	(0.809)
Observations	249	249	261	257	257
Pseudo R^2	0.187	0.291	0.178	0.390	0.395

PANEL B:	**Set Permits:** all regressions compare older female siblings to their younger sisters				
Variable	(6) Poisson *Women*	(7) Poisson *Women*	(8) Poisson *Women*	(9) Poisson *Women*	(10) Poisson *Women*
Dependent Variable	#Descendants Unemployed	#Descendants Formal Occupation	#Descendants Graduate College	#Descendants Commercial Fish	#Descendants Subsistence Fish
18+ Female in 1975	-0.151	0.438**	0.332	-0.281*	-0.171*
	(0.225)	(0.215)	(0.341)	(0.175)	(0.102)
Observations	164	164	173	157	157
Pseudo R^2	0.285	0.261	0.163	0.339	0.334

NOTE: Clustered standard errors at the household level are in parentheses. Each regression also includes controls for total number of descendants, birth order, marriage, years of education, and Yupik language speaker.
***Significant at 1% **Significant at 5% *Significant at 10%

As anticipated, transfer of permits outside the family make descendants less likely to participate in the commercial fishery. Marginal effects analysis calculated a 15% reduction in the number of descedants drift gillnet fishing and a 30% reduction in the number who participate in set gillnet fishing. While our model assumed that once the asset right was liquidated, all descendants would be forced to choose the urban labor market, this did not account for the possibility that descendants could be employed as crew which explains why there was not a larger decrease in participation. The increase in descendant outmigration corresponds to a 13% reduction in subsistence fishing. While 20% of respondents who had relocated outside of the village indicated that they return to the village to fish every summer, the results in columns (5) and (10) show that descendants of those eligible to own and sell permits are less likely to report any subsistence fishing once the potential for participation in a family commercial fishing enterprise is removed.

Interestingly, the increased probability of outmigration generated by drift permit sales was not leveraged into increased educational and employment opportunities for descendants while set net permit sales do make descendants more likely to be formally employed. This contradicts Proposition 2 which asserted that the transferability of permits would increase the bequest of those choosing the urban sector. Proposition 2 relied on the assumption that the bequest from participating in the urban sector would be sufficient to finance the investment needed for offspring to emulate this choice. Hence, low preferences for bequest or high non-physical moving costs in the form of cultural or educational barriers to employment could mean that the urban sector does not persist and if descendants are unable to buy their way back into the resource sector then they will be in a poverty trap. Another possibility that could block the descendants from entering the urban labor force is time-varying moving costs that change between generations, which is likely in the context of modern economies where educational requirements change over time.

The results in column (7) show that 25% more of older sisters' descendants are formally employed. These result for women more likely to own and sell set net permits could come through two channels. As we saw in the first generation, women selling set net permits were more likely to engage in alternate occupations themselves, thus lowering the barriers for their descendants. Women selling permits could also be more likely to invest in productive assets that increase the employability of their descendants even though the positive impact on college graduation is not statistically significant. In the context of our model, their higher preferences for bequest ensure that even if the lower value of their asset was insufficient to finance their own physical moving costs, their descendants are better off.

The alternate explanation is that despite lower barriers to entry in the set net fishery, permit transfer makes descendants much more likely to seek alternate employment outside the community. The sale of a drift net permit may not have a corresponding impact on employment decisions because the large capital investment necessary to successfully participate in this fishery is equally unattainable for rural descendants regardless of permit ownership. Capital depreciation in rural Alaska is accelerated by the lack of infrastructure and support services. Thirty percent of drift permit owners surveyed reported not owning a drift boat that was seaworthy and of these, the majority either partner with family members who own boats and benefit from a regulation that allows two permits to fish additional gear on the same vessel or contract their services to a captain from outside the village in exchange for a share of the catch. In general, it does not appear that sales of either drift or set permits significantly impacted college completion and additional regressions confirmed that the outcomes for alternate measures of educational attainment were also insignificant. This indicates that in accordance with drift permit sellers' inability to convert asset sale into formal employment, they also fail to convert the sale into long term investments in human capital. Again, this can be attributed to a preference for immediate consumption or cultural barriers to educational attainment that are insurmountable.

1.6.3 Assets

In Section 3, the long run impact of permit transfer on durable assets is positive if the market price is sufficient to allow sellers to invest in the capital necessary to participate in the higher productivity urban labor market. Since we know that the impact on formal employment is not positive, a change in durable assets may also be an indication that permit sale increases consumption of rural amenities such as homes, automobiles, and boats. The frictions inherent in low infrastructure rural asset markets make it likely that once purchased, such assets are illiquid and although they retain some value for the initial permitholder they cannot be leveraged into increased productivity in either sector. Table 1.8 shows the estimates of key coefficients from equations (5.1) - (5.3) with a continuous variable equal to the market value of durable assets. Specification tests showed that the data had a distribution skewed towards zero and the literature confirms that in this context zero-inflated poisson regression with robust standards errors is less likely to bias coefficients even when the data is continuous (Manning and Mullahy, 2001).

The impact of permit sale on long run asset accumulation clearly depends on permit type. Sale of drift permits results in a significant 10% increase in durable assets (Columns 2 & 3) while set permit sales correspond to a 15% decline in similar assets (Columns 5 & 6). These empirical results give support to the theory that the proceeds from the sale of drift permits are used to surmount moving costs and then converted into illiquid durable assets that are not leveraged into increased employment or education. The measure of durable assets used includes home values and market values of vehicles or vessels. After selling a set net permit, women are less likely to leave the village and more likely to be formally employed, but it appears that they may be substituting away from durable assets towards investment in less tangible productive assets that make their descendants more employable outside the village.

While educational attainment is an important predictor of asset accumulation for women, it does not increase male assets. This can be attributed to characteristics of the Alaskan economy wherein intense manual labor jobs offered mainly to men have low education requirements and the high-skilled occupations that exist in rural villages are more likely to be in the medical services or education fields that are dominated by women.

Table 1.8: Impact of Permit Sale on First Generation Assets
Dependent Variable: Durable Assets $USD

	Drift Permits			Set Permits		
Variable	(1) Poisson	(2) Poisson	(3) Poisson *Men*	(4) Poisson	(5) Poisson	(6) Poisson *Women*
Control Group	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	0.030 (0.320)			0.067 (0.358)		
Permit Passed to Descendant	-0.290 (0.292)			0.279 (0.547)		
Permit Transferable		0.382* (0.214)			-0.721*** (0.233)	
18+ Male in 1975			0.502*** (0.162)			
18+ Female in 1975						-0.492* (0.292)
Married	-0.306 (0.339)	-0.324 (0.305)	0.553** (0.218)	1.093*** (0.302)	1.088*** (0.234)	0.404* (0.258)
Years of Education	0.002 (0.033)	0.017 (0.058)	-0.032 (0.032)	0.111*** (0.039)	0.104*** (0.033)	0.164* (0.091)
Number of Children	-0.010 (0.068)	-0.015 (0.061)	-0.002 (0.053)	0.091** (0.045)	0.066* (0.038)	0.043 (0.077)
Fixed Effects	Village	Village	Family	Village	Village	Family
Observations	286	302	239	253	290	152
Pseudo R^2	0.220	0.208	0.621	0.690	0.703	0.649

NOTE: Clustered standard errors at the village level are in parentheses. Each regression also includes controls for birth order, Yupik language speaker. Controls for age, age squared, gender, parents' education and tribal affiliation are included in columns 1, 2, 4, 5.
***Significant at 1% **Significant at 5% *Significant at 10%

1.7 Discussion and Conclusion

This paper uses primary survey data to evaluate the impact of transferable fishery access rights on rural outmigration, labor market outcomes, and durable assets. The initial implementation of the Alaska salmon permit system involved a participation eligibility window that provides two counterfactuals: non-transferable permits and younger siblings. Two different types of permits were allocated. Men were more likely to receive high value drift permits whose sale led to increased outmigration by the first generation of permitholders, accumulation of durable assets, and no long run changes in educational or employment outcomes for descendants. Women were more likely to be allocated lower value set net permits whose sale had no impact on the probability that the first generation left rural communities, but decreased durable assets and increased formal employment for both the first generation of permitholders and their descendants. The sale of both permit types generated increased rural to urban migration by descendants and lower levels of participation in commercial and subsistence fisheries.

These results allow us to evaluate the social impact of both the initial allocation of access rights and the transferability of these assets. We are unable to make conclusions regarding the relative merit of a limited access regime in general since we lack data on the counterfactual of what local earnings and participation would be if the fishery had remained open access. We can assume that the biological gains from conserving the stock through limiting access outweigh most social concerns since the global plight of less well-managed salmon fisheries is well documented. However, we can conclude that the initial allocation of rights wherein the value of the asset was largely determined by the gender of the participant facilitated the dual outcomes we observe. There is also evidence that policymakers who seek to slow rural outmigration should reconsider the transferability of permits, especially those with large market values. If permits were not universally transferable, but instead could only be passed on via inheritance or through a local market that ensured their economic rents would remain in the community then the declining rural populations and fishery participation rates facilitated by the permit system could have been abated. The transition to formal employment that was facilitated by set net sales could have been possible within a NT permit system with a simultaneous focus on making alternate rural livelihoods robust and accessible. Our results cannot decisively say that rural livelihoods goals would have been better obtained with open access or universally NT permits since the program could have caused village level economic changes that we cannot control for here.

As fisheries around the world transition to right-based management, policy makers remain uncertain about the social impact of fisheries enclosure upon undiversified fishing-dependent communities. The empirical evidence presented in this paper has important policy implications focused on the importance of liquidity constraints, gender norms, and labor market frictions.

In the absence of physical and financial infrastructure, rural harvesters are constrained in their ability to access capital, to borrow and to smooth income. The introduction of tradeable access rights represents an infusion of liquidity that makes outmigration probable and threatens rural livelihoods. The high degree of volatility, uncertainty, and externalities inherent in the context of a salmon fishery make asset sales more likely to occur under duress than through forward-looking optimization. Chapter 2 highlights the drivers of permit sale and examines whether the community protection measures implemented by the regional CDQ group have been effective.

Prevailing economic theory claims that the transferability of access rights promotes efficiency as it incentivizes the highest productivity agents to acquire ownership. This theory may break down in the presence of labor market frictions and cultural barriers that make employment outside the fishery unattainable for rural residents. In the context of these frictions, low efficiency agents may remain in the fishery and exiting harvesters may be left in a poverty trap wherein their descendants are unable to participate in either sector. Policy makers concerned with making rural harvesting operations sustainable should promote the proliferation of alternative livelihoods that can supplement revenue from fishing.

A key aspect of this study is that gender largely determined the value of the transferable access right and the magnitude of its impact; women were culturally more likely to participate in a sector of the fishery that was allocated permits with significantly lower market value. Concerns about gender equity and inclusion should make policy makers sensitive to existing cultural norms around inheritance and fisheries participation. This is particularly pressing since there is evidence that mothers are more likely to invest the revenue from fishing permit sales into the long-run well-being of their offspring of both genders. An additional application of this dataset is to intrahousehold bargaining and joint decision making regarding asset sale. The results suggest that in inland communities where women were unlikely to qualify for commercial permits, the bargaining power of women was diminished and permit sales were more likely to translate into consumption than investment.

Chapter 2

Drivers of Access Right Sales:

The Role of Resource Volatility, Individual Shocks, and Risk Aversion in the Alaska Salmon Fishery

Abstract

This paper explores why salmon harvesters in rural Alaska choose to sell their transferable permits. Constructing an artificial panel from back cast recall survey data collected in nine remote Alaskan villages, I estimate the relative importance of covariate shocks to resource markets, individual productivity shocks, and preferences for risky behaviour. I also exploit an arbitrary geographic boundary to examine the role played by additional access to training and credit offered by the local Community Development Quota (CDQ) group. Using a system of equations estimation strategy, I isolate the component of salmon permit price that is exogenously determined by covariate shocks and apply this to the individual decision to supply a permit to market. Drift permitholders are more likely to sell their permits when average permit prices are low due to volatility in salmon runs or competition from farmed salmon. This corresponds with evidence that these participants in the capital-intensive sector of the fishery are more likely to be in debt. Conversely, set net permitholders are less likely to be affected by covariate shocks and more likely to liquidate their assets following individual shocks to productivity such as the birth of a child or a divorce. For both types of permitholders, covariate shocks to salmon runs and prices are more important predictors of sale than individual productivity within the fishery. Risk preferences and the credit, grants, and training provided to residents within the CDQ boundary appear to have minimal impact on the decision to sell access rights.

2.1 Introduction

In limited entry fishery management regimes, shifts in the ownership of access rights away from local residents have significant economic and social implications, particularly when the fishery is a dominant economic activity. Recent focus on the efficiency gains from rationalizing access to resources often assumes that exiting harvesters are less efficient and fails to examine outside factors that may make locals more vulnerable to covariate and idiosyncratic risk. Understanding the factors that cause local harvesters to liquidate their access rights will assist policymakers who seek to ensure that the economic multipliers from local participation in harvest remain intact in the remote fishing dependent communities of rural Alaska.

Due to the 1975 implementation of a limited access permit system in Alaska's Bristol Bay salmon fishery, the surrounding villages are an ideal context to test hypotheses regarding the drivers of access right sale in the presence of credit constraints and uncertainty. While cultural and physical barriers prevent access to formal credit, volatility in salmon runs and prices exerts external pressure on harvesters to smooth assets and consumption. Sophisticated data collection systems ensure that idiosyncratic shocks to individual landings are known and my household survey provides insight into additional drivers of sale such as dissolution of marriage, birth of children, existence of heirs, and risk preferences. Two different types of permits (drift and set net) with very different capital requirements allow me to test whether permit sale is more likely to be driven by changes in market value or by increased debt burden. The efficacy of policy interventions from the local Community Development Quota (CDQ) group that target local residents with access to credit, grants, and training can be tested due to an arbitrary geographic boundary that excludes some respondents from these benefits.

Joint determination of permit supply and permit demand complicates the estimation of permit sale drivers, so a system of equations strategy is used to isolate the impact of random shocks to permit prices on the individual supply decision.

Household survey data on individual characteristics is matched to Alaska Department of Fish and Game (ADF&G) individual landings data to separate out the impact of harvester productivity.

I find that permitholders with the higher valued drift permits are more likely to sell their permits when average permit prices are low due to volatility in salmon runs or competition from farmed salmon. This corresponds with evidence that these participants in the capital-intensive sector of the fishery are more likely to temporarily finance their operations with loans from processors that must be repaid at the end of the fishing season. Conversely, set net permitholders are less likely to be affected by covariate shocks and more likely to liquidate their assets following individual shocks to productivity such as the birth of a child or a divorce. For both types of permitholders, covariate shocks to salmon runs and prices are more important predictors of sale than individual productivity within the fishery. Risk preferences and the credit, grants, and training provided to residents within the CDQ boundary appear to have minimal impact on the decision to sell access rights.

This study primarily contributes to two existing strands of literature. Firstly, this paper extends a specific dialogue on the drivers of permit sale by rural Alaskans. Knapp (2011) shows that overall local ownership of Bristol Bay drift net salmon permits has declined 17% and shows that across 24 different Alaskan salmon fisheries (differentiated by gear and area), there is a negative relationship between permit prices and local ownership. Knapp (2011) hypothesizes that this trend is driven by market forces of reallocation as outsiders with lower discount rates and greater access to credit are willing to pay more than locals.

Since the limited entry system was established in 1975, several qualitative studies have sought to understand the factors that lead to diminished local participation. Langdon (1980) reported that lower average earnings drove sales by rural residents and "systemic disadvantage" through lack of access to capital prevented rural residents from buying into the fishery. More recent interviews suggest that residents believe maintaining local ownership in the salmon fishery is important and cites obstacles such as a lack of collateral, a desire to diversify outside of commercial fishing, and declining cultural ties to the fishery (Apgar-Kurtz, 2012). Focht and Schelle (1984) detail early unsuccessful legislative efforts to subsidize commercial fishing loans, make fishing permits usable as collateral, and target credit programs to rural villages. The authors attribute the low participation rates in these programs (less than 5 loans total) and the lack of impact on impoverished rural Alaskans to provisions that required familiarity with and access to formal lending institutions (Focht and Schelle, 1984). Since the 1980s the trend in declining local ownership amongst Bristol Bay salmon harvesters has been well-documented but there have been no quantitative studies of the causes of changes in permit distribution. Knapp (2011) is an exception that relies on cross-sectional variation in permit prices across Alaskan salmon fisheries but lacks individual data to test hypotheses about access to credit and fishery productivity.

Formal models of the Alaskan salmon permit markets rely on the assumption that permit prices will reflect the expected present value of future net earnings from the permit. Karpoff (1983) shows that theoretically permit prices should reflect the expected valuation of the marginal permitholder, and empirically 1978-1981 average permit prices do respond strongly to fish run forecasts by ADF&G. He goes on to use this theoretical model to show that a commercial fishing loan subsidization program increased permit transfer volume by 22% but does not examine the regions that were the primary source of additional permits to the market or the implications for rural residents (Karpoff, 1984). Lastly, the same data from early in the permit program is used to show that non-pecuniary benefits from fishing attenuate the participation of low-income fishermen even when their expected value of retaining the permit is less than its market value (Karpoff, 1985). Huppert et al. (1996) extend this model to show that Alaskan salmon permit price trends are consistent with simple asset pricing theories and once costs are forecasted, the average rate of return on a permit for gill net fisheries across the state is 11% annually. Such models of asset pricing may function well when transactions costs are low and participants are forward-looking, financially literate and not credit-constrained. In the context of rural Alaskan harvesters, it may be more appropriate to rely on models of land and livestock liquidation in the presence of poverty traps from the development literature.

Development economists have a long tradition of considering farmers' decision to sell assets such as livestock and farmland in the context of credit constraints, subsistence thresholds, and uncertainty. While these dynamic structural models are well-equipped to examine the role of microinsurance (Janzen and Carter, 2018) and technological innovation (Rosenzweig and Wolpin, 1993), they are limited to examining assets that differ from a fishing access right in important dimensions. When farmers engage in asset smoothing by incrementally selling off livestock (Rosenzweig and Wolpin, 1993; Janzen and Carter, 2018; Zimmerman and Carter, 2003; Carter and Lybbert, 2012) they are engaging in fundamentally different behavior from a harvester selling the lumpier asset of a salmon permit. Although both assets are productive and therefore the decision to sell should be based off future expected revenue, the salmon permit is not only a larger asset with the capacity to determine descendants' ability to participate in the fishery, it is also unable to be incrementally transferred and is thus even more likely to be vulnerable to shocks that put permitholders below a subsistence level of consumption. Farmers may also engage in consumption or asset smoothing by selling land (Zimmerman and Carter, 2003; Boucher et al., 2005) which is a lumpy asset akin to a salmon permit but with less geographic flexibility. Salmon harvesters can retain their permit and migrate to an urban area, returning to harvest only seasonally whereas most migration theory assumes that farmers in developing countries are unlikely to migrate and retain ownership due to insecure property rights. This means that understanding the role of a transferable access right in the context of rural harvesters subject to credit constraints contributes to an understanding of how property rights distribution evolves when assets are large, lumpy, and portable.

The rest of the paper is organized as follows. Section 2 introduces the background of the Alaskan salmon permit market and presents summary statistics from the household survey relative to fishery-wide averages. Section 3 develops a dynamic model of consumption and access right liquidation in the presence of shocks and debt constraints. Sections 4 and 5 describe the survey data collected and empirical strategy. Section 6 presents the empirical results. Section 7 concludes by suggesting the policy implications of the results.

2.2 Background

For an extensive background of Bristol Bay commercial salmon fishery regulations and household survey community characteristics, refer to chapter 1.2. This section will focus on describing the market for salmon and salmon permits, alternatives to sale, and detailing the interventions designed by the CDQ group.

2.2.1 Bristol Bay Salmon Permit Markets

First wholesale value from this fishery was $390 million in 2010, making this the world's most valuable wild salmon fishery (Knapp, 2013). Local harvesters from the communities surrounding the fishery represent an important but declining share of the total harvesting operations (Knapp, 2011). Since the late 1980s, farmed salmon production has surpassed wild Alaskan harvest as the primary source of salmon for global consumers (Knapp, 2001). Knapp (2007) asserts that "salmon farming exposed a natural monopoly to competition, benefiting consumers by expanding availability, lowering prices, spurring innovation and market development, and leading to a more efficient wild salmon industry more focused on meeting market demands." While there are no counterfactuals available to quantitatively determine the impact of aquaculture on rural Alaskan salmon harvesters, covariate shocks to global farmed fish abundance will drive ex-vessel prices for Alaskans in Bristol Bay since farmed fish is the main substitute product.

There are two sectors of the Bristol Bay salmon fishery comprised of different harvest technologies. The set net fishery is comprised of harvesters fishing close to the shore, using set gillnets and small skiffs or even picking nets from the beach. Drift gillnet harvesters use larger vessels (a maximum of 32 feet in length) to fish in the open water and account for 70% of the total catch (Knapp, 2013). Tenders employed by the canneries work as middlemen to transport fish from both set and drift operations. Traditionally, due to the intrahousehold division of childcare responsibilities, the set net fishery was dominated by women and children while men were more likely to fish on drift boats.

The biology of wild salmon reproduction means that annual harvests are highly volatile (Knapp, 2001) and there is corresponding uncertainty in ex-vessel prices and permit values (Herrmann et al., 2004). Since 1975, the market price of transferable drift permits has fluctuated around \$115,000 while the price of set net permits averaged \$35,000 (See Figures 2.1 and 2.2). The Commercial Fisheries Exchange Commission (CFEC) of the State of Alaska initially oversaw the allocation of permits and currently supervises the transfer of permits. While permanent sale of a permit is allowed, temporary transfer or leasing is illegal unless authorized by an emergency medical transfer. Due to transaction costs, permit transfer is often facilitated through online brokers, or for local residents, through the CDQ group whose goal is to keep the permit in local hands. Although officially illegal, leasing is one alternative to outright sale that anecdotally occurs rather often. The CFEC will seize a permit once it has been emergency transferred more than 3 times, although they regularly show leniency for cases of financial hardship from rural Alaskans. Absentee ownership is discouraged by a provision requiring the permitholder to be present when landings are delivered to the post-harvest sector.

At the time of transfer, the CFEC collects data on individual permit sale prices and aggregates them across the fishery. In addition, they use ADF&G data on aggregate revenue to estimate average revenue per permit type in each season. Figure 2.1 shows how average set net permit prices, seasonal revenue, and volume of trades evolve over the course of my sample. Firstly, this figure shows that average permit price does appear to follow the trend in revenue from prior seasons with periods of low average earnings followed by declining permit prices. Using CFEC data there is no way to disentangle the relative impact of increased supply of permits due to credit-constrained harvesters forced to liquidate their assets and the decreased demand for permits as expected revenue falls. Interestingly, the total number of set net trades does not appear to have a high correlation with permit prices. Aside from an overall decline following 1993 (a change to the way emergency transfers were recorded in the CFEC database), there are two spikes in set net trades corresponding to periods of declining average revenue in 1996 and 2013.

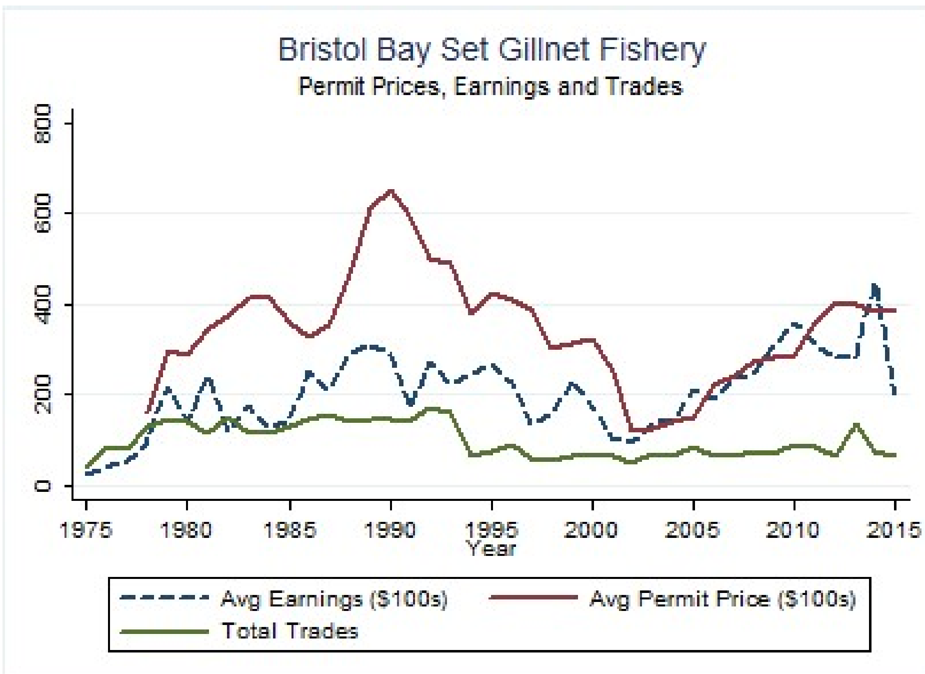

Figure 2.1: Bristol Bay set net permit prices, average earnings and the volume of trades

Data Source: CFEC database, 2015

Figure 2.2 examines trends in similar variables for the drift net fishery and shows that while permit prices tend to echo average revenue trends in both fisheries, there is much more volatility in the volume of drift trades. Again, there is an overall decline in trade volume following the 1993 clerical revision to the reporting of emergency transfers. There are two periods where the volume of trades was high despite permit prices being relatively low. The first from initial allocation to 1988 could be explained as the resorting of marginal individuals who had been assigned permits and quickly took advantage of transferability in order to reallocate their labor away from fishing. The second period from 2000-2010 is more likely to be evidence that drift net permitholders are primarily responding to variables other than price (such as the prolonged period of low average earnings from 1997-2005. When earnings and permit prices first began to decline around 1995 there is evidence that drift permitholders did not immediately respond with increased sales which indicates that any measure of covariate shocks may impact the liquidation decision with lag.

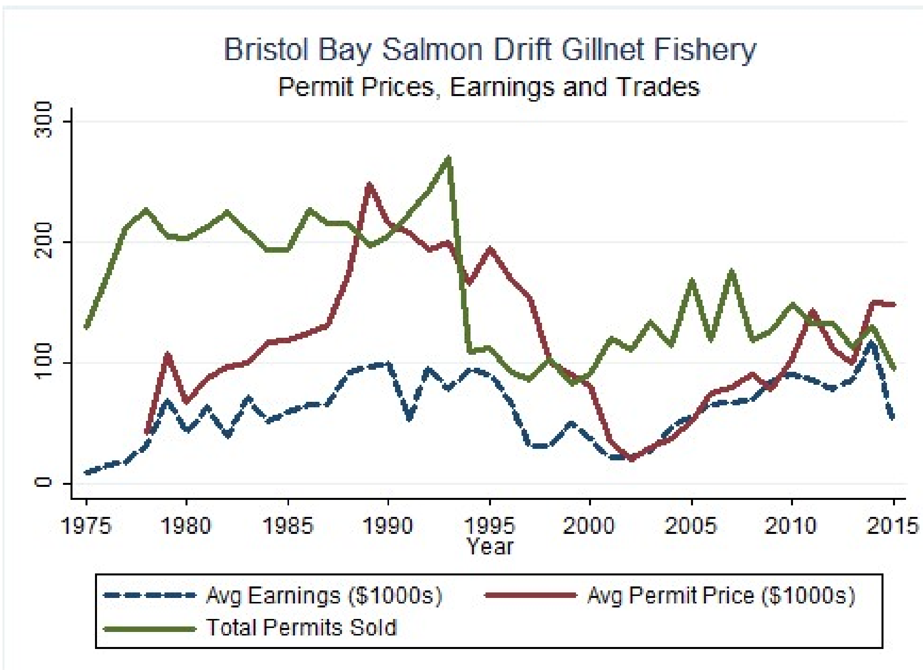

Figure 2.2: Bristol Bay drift net permit prices, average earnings and the volume of trades

Source: CFEC database, 2015

Table 2.1 builds on the existing CFEC database to examine how the sample of rural Alaskan respondents from my household survey differs from the average participant in these fisheries. Sample permit prices are constructed from self-reported sale price and are significantly lower than the average sale price reported to the CFEC. This sale data does not include inheritance transfers that were recorded as $0 sales. The significantly lower prices within my sample could be attributed to transactions costs forcing rural Alaskans to accept the first buyer or to rural Alaskans being more likely to be credit-constrained and to sell when permit prices are low.

The remaining variables are constructed for the sample by matching Alaska Fisheries Information Network (AKFIN) data from fish tickets collected from tenders and processors that record the pounds and permit number from each landing of an individual harvester and report it to ADF&G. Ex-vessel prices are constant across both groups because final ex-vessel price is not determined by the canneries until after the season is over so AKFIN fish ticket data relies on standardized CFEC estimates of price. I was unable to collect recall survey data on individual prices in each time period and so must assume that harvesters within my sample largely earn the same amount per pound with some quality premiums if they have refrigerated sea water equipment on their vessels or if they are consistently high performers for the cannery.

Table 2.1: Summary Statistics by Sample and Fishery Average

Variable	Total	Sample	Fishery Average
Drift Permit Price *(2015 dollars)*		$89,281	$114,938
Set Net Permit Price *(2015 dollars)*		$21,029	$35,310
Sockeye Ex-Vessel Price ($/lb)		$1.07	$1.07
Annual Drift Revenue *(2015 dollars)*		$48,228	$79,200
Annual Set Net Revenue *(2015 dollars)*		$15,296	$23,400

NOTE: All figures are individual averages. All fishery averages come from the household survey and matching AKFIN fish ticket data. All fishery averages come from the CFEC database (1975-2015)

Lastly, Table 2.1 shows evidence that within this fishery there is wide variation in average earnings between permitholders, with the rural respondents targeted for the survey earning significantly less than the fishery average. The difference is larger for the drift fishery where vessels of larger horsepower catch significantly more due to the overcapitalized nature of the fishery.

A unique community protection measure within Alaskan commercial fisheries is the Western Alaska Community Development Quota (CDQ) Program. The explicit goal of this program is to alleviate poverty and vulnerability in rural, economically depressed, and predominantly Alaska Native communities. Each individual CDQ group has sovereignty over how they choose to harvest, lease, or invest the quota shares allocated to them under various catch share programs. The regional CDQ group for my study is Bristol Bay Economic Development Corporation (BBEDC). While salmon is not a catch share fishery, the primacy of salmon in the local economy means that BBEDC's commercial fishing interventions are primarily focused on assisting watershed residents who participate in the salmon fishery. A 2009 report commissioned by BBEDC found that Bristol Bay residents are losing permits faster than other Alaskan regions (a decline from 28% of residents reporting permit ownership to 11%) and as a heavily fishing-dependent region, this decline in local ownership represents a $225 million loss to the region (Northern Economics, 2009).

Established in 2008, BBEDC's Permit Loan Program requires year-round residency in the CDQ region, at least 3 years of crew experience, and provides financial counseling and business training to participants to help rural residents gain fluency in formal credit markets. These provisions, coupled with subsidized down payments and interest rates, have made the Permit Loan Program more successful that the state of Alaska's initial attempts to relax credit constraints. At the moment there are 35 active participants. BBEDC also created a Vessel Acquisition Program in 2014 that provides down payment grants, interest subsidies, equity assistance, and financial training to participants who desire loans to purchase either drift or set vessels (in 2016 there were 9 participants). There are additional programs that give grants to finance vessel improvements (such as onboard refrigeration), emergency transfer fees (that allow non permitholders to effectively lease a permit temporarily), shore fish leases (that give set net harvesters certainty of access to a site), and community block grants that can be spent on physical or fishing infrastructure. BBEDC provides permit brokerage services that attempt to keep permits in local hands and help local residents comply with regulatory requirements for permit renewal. Lastly, BBEDC focuses on creating opportunities for alternate livelihoods by providing scholarships for university or vocational training, internships with seafood harvesting partner corporations outside the region, seasonal employment in infrastructure projects or on pollock boats.

This study intentionally selected some communities within the CDQ group boundary and others without (see Figure 1.1) to analyze whether these interventions have been able to effectively curtail rural permit sales and increase the efficiency of local harvesting operations. Unfortunately, 30% of the respondents to our survey, despite living within the CDQ boundary and after its establishment in 1992, reported receiving no benefits from BBEDC membership. A further 55% reported receiving minimal assistance with tax preparation, energy assistance, vocational education scholarships, or free slush bags and totes for icing fish. Only 15% of eligible respondents indicated that they had benefited from any of the loans, grants, or training programs specifically targeting salmon harvesters and there was a sentiment in the more remote villages that benefits tended to accumulate around BBEDC's headquarters in Dillingham.

2.3 Theoretical Model

In this section I present a dynamic model of consumption and fishery investment in the presence of risk and credit constraints. Consider a dynamic household model where each household has an initial endowment of assets, A_0, where the subscript denotes time. In the context of fishing dependent communities, these assets are largely determined by the initial allocation of permits, and for ensuing generation, by harvest efficiency and continued permit ownership. Households maximize intertemporal utility by choosing c_t in each period and thus the problem can be written as follows:

$$\max_{c_t} \quad \mathbb{E}_{\theta,\epsilon} \sum_{t=0}^{\infty} \beta^t u(c_t) \tag{1}$$

subject to:

$$A_{t+1} = \begin{cases} A_t + H(\theta_t, \epsilon_t) - c_t & if Permit_t = 1 \\ A_t + Price_t - c_t & if Permit_t = 0 \\ A_t - c_t & if Permit_{t-1} = 0 \end{cases}$$

$$H(\theta_t, \epsilon_t) = qX_t\theta_t\epsilon_t$$
$$A_t \geq 0$$

The access right enters the model by affording access to productive harvest and its sale can finance current or future consumption as liquidation yields exogenously determined $Price_t$. The model assumes that fishing harvest is subject to covariate shocks θ that are common to all harvesters in the same period (salmon run size, farmed salmon production, …) and idiosyncratic shocks ϵ that are specific to each household (accidents, childbirth, …). Both shocks are exogenous and only realized for all households after the decision of permit ownership in the current period and before the decision to liquidate the permit in the following period. Harvest is also a function of aggregate harvesting efficiency q, stock size X_t and is assumed to be independent of individual effort since this model's primary interest is not the labor-leisure tradeoff or externalities based on aggregate effort. The third constraint reflects the lack of available credit markets and implies that current consumption cannot exceed current production and assets.

When shocks are distributed i.i.d. so that the most recent shock does not yield any insight into future shocks, the only state variables are permit ownership and assets. Under these assumptions, the Bellman Equation is:

$$V(A_t) = \max_{c_t} u(c_t) + \beta \mathbb{E}_{\theta,\epsilon}[V(A_{t+1} \,|c_t, A_t, Permit_t, Price_t)] \tag{2}$$

The first order condition is:

$$u'(c_t) = \beta \mathbb{E}_{\theta,\epsilon}[V'(A_{t+1})] \tag{3}$$

which captures the intertemporal tradeoff between consumption and fishery investment faced by the consumer. A household will consume until the marginal benefit of consumption today is equal to the discounted expected value of assets carried into the future. Carter and Lybbert (2012) show that in the presence of a poverty trap, the future value of assets will increase around an asset threshold that allows households to transition to a stable high equilibrium. In similar fashion, fishing households who are credit constrained and vulnerable to maintaining a subsistence level of consumption will experience a diminished value of future assets when in proximity to the credit constraint. Uninsured and unable to allow their current assets to temporarily fall below zero, they may trade off future expected assets for current consumption. The credit constraint means that the expected future value of the permit is low relative to the marginal utility from immediately receiving the sale price. An exogenous increase in permit prices makes permit sale more likely when expected future earnings from permits are less than the marginal utility from immediate consumption. This leads to the following hypothesis.

Hypothesis 1: An increase in permit prices will be more likely to induce sale when expected future earnings are valued less than current consumption and households in the vicinity of the zero-asset threshold will be more likely to liquidate permits.

2.4 Survey Data and Fieldwork

For detailed explanation of sampling and survey methodology, refer to Chapter 1.4. This section will describe the additional data that was assembled to test hypotheses around individual productivity, covariate shocks, and risk attitudes.

Sample of Permitholders

Using the CFEC database of permitholders, a random sample of drift and set net harvesters was compiled, incentivized to participate, and surveyed with 90% compliance. As the primary aim of the study was to analyse the impact of the initial allocation of permits by exploiting the 1969-1973 eligibility window, the sample is biased towards older respondents with only 39% of respondents with transferable permits acquiring a permit after 1975 and the remaining 61% with permits that date back to initial allocation.

Table 2.2: Permit Transfer by Permit Type

Group	Drift	Set	TOTAL
Sold permit	119	105	224
Permit Bequest (Inheritance)	160	140	300
Still own permit	108	90	198
TOTAL	*338*	*283*	

Table 2.2 shows the number of surveyed respondents who sold, passed on (via inheritance), or still own their permit and is broken down by permit type. These figures demonstrate a clear preference for bequeathing permits to descendants which aligns with qualitative responses to questions about permit transfer. The proportion of permits sold, inherited, or still owned is relatively constant across drift and set net permits. There is no preliminary evidence that drift permits were more vulnerable to shocks and more likely to be sold.

As stated in Section 2.2, individual survey responses to demographics, family tree, marital status, fishing history and access to credit were pooled with AKFIN fish ticket landings and an artificial panel from 1975-2015 was constructed. Individual variables that were able to be transformed for time series analysis were: location, employment, marital status, birth of children, age of descendants, fishing participation (as permitholder and crew), permit ownership, self-reported shocks to fishing productivity, educational attainment, and age. Self-reported permit sale price is also known for each time period where the individual sold a permit, but obviously missing for other periods. Certain time in-varying characteristics such as tribal affiliation, religion, access to credit, and language will drop out of any specification with individual fixed effects. This panel of individual controls and the dependent variable of permit ownership was combined with total individual salmon fishery landings by matching each respondent to the AKFIN data by name and location.

Risk Experiment

A total of 344 respondents from the larger communities of Dillingham, Naknek, and King Salmon participated in an additional module designed to elicit their attitudes towards risk. Throughout the sample, respondents were given a raffle ticket towards a lottery of $500 worth of fuel oil, to be repeated within each community. Three communities were large enough to contain grocery stores that could issue gift certificates. In these three communities, respondents were also given raffle tickets and then told that they could choose between an additional ticket to the raffle or an immediate $10 gift certificate to the grocery store. We gave respondents an expected value of raffle tickets[4] in each large community. With these odds, individuals who exhibit a preference for raffle tickets over gift cards display risk-loving behaviour by choosing the incentive with a lower expected value. They may also possess higher

[4] [$500*1/(targeted # of respondents in village)] or roughly $3

discount rates since they exhibit a preference for delayed consumption smoothing in the form of fuel oil over immediate consumption from the grocery store.

2.5 Empirical Strategy

Permit price and permit sale are jointly determined as the aggregate number of permits on the market in any time period will affect the price for all sellers. To correct for the endogeneity bias arising from the interlinked supply and demand equations, I first estimate the inverse demand for permits empirically and then use the predicted willingness to pay for permits as an unbiased estimator in the individual supply decision.

When market assumptions are satisfied, the separate markets for drift and set net permits will be composed of the following equations:

$$Q_D = \beta_1^D Price + \beta^{D'} \boldsymbol{X^D} + \varepsilon_D \tag{5.1}$$

$$Q_S = \beta_1^S Price + \beta^{S'} \boldsymbol{X^S} + \varepsilon_S \tag{5.2}$$

$$Q_D = Q_S \tag{5.3}$$

In equations (5.1) and (5.2) $\boldsymbol{X^D}$ is a vector of controls that influence the demand for permits while $\boldsymbol{X^S}$ is a corresponding set of variables that impact individual's decision to transfer a permit but have no impact on the quantity demanded. Estimation of β_1^S is complicated by the market equilibrium condition given by (5.3) which joins the quantities as an endogenous system and biases the coefficient downwards. In order to obtain an unbiased estimate of the impact of permit price on individual permit transfer decisions and test the hypothesis from Section 2.3, I will first estimate the inverse demand equation separately:

$$Price_t = \beta^{D'} \boldsymbol{X^D} + \varepsilon_t \tag{5.4}$$

In this inverse demand equation, average permit price after season t (as reported to CFEC) is only a function of a vector of time-varying controls $\boldsymbol{X^D}$ that influence aggregate demand for permits: farmed salmon production (FAO, 1980-2015), total harvest in the most recent season (ADF&G, 1975-2015), and forecast for next season (ADF&G, 1975-2015).

We observe self-reported permit prices in year of sale only, so as a robustness check we use self-reported permit price in an alternate specification to test whether our findings are robust to using this alternate measure of price. This measure of price may be a more precise measure of the willingness to pay for rural Alaskan permits (minus transactions costs) but it contains missing data from respondents unwilling to share price at sale and may be biased if survey participants were more likely to underreport sale price in a voluntary survey relative to mandatory government reporting.

Once equation (5.4) is estimated, predicted values $\widehat{Price}_t$ are inserted into the individual supply function as:

$$PermitSale_{it} = \beta_1^S \widehat{Price}_t + \beta^{D'} \boldsymbol{X^S} + \delta_i + \theta_v + \varepsilon_{it} \tag{5.5}$$

where an individual i's decision to sell a permit after season t is a function of the predicted price from equation (5.4) and controls $\boldsymbol{X^S}$ that cannot influence aggregate permit demand but will influence the supply decision of individuals. The predicted price represents all exogenous variation in permit prices that is driven by covariate shocks that affect the entire fishery and not influenced by the quantity for sale. This means that β_1^S should now yield an unbiased predictor of individual price elasticity of supply. Since the salmon fishing season occurs from June-July, I use the predicted price from the most recent season when permits are sold between July-Dec of the same year and Jan-May of the next year. The time component of the regressions should be interpreted as season-level for all regressors driven by fishery dynamics (total harvest, forecast, individual harvest).

The controls can be time-varying such as average individual revenue over the past 5 years, marital status, birth of children, educational attainment, existence of an adult descendant, and age. When the principal controls of interest are time-varying then the more robust individual fixed effects model can be used and δ_i will replace village fixed effects θ_v in the regression. However, interest in time invariant controls such as self-reported access to formal credit, risk attitudes, tribal affiliation, religion, and language necessitates the village fixed effects specification. To ascertain the impact of CDQ group interventions, we include a dummy variable equal to 1 if the respondent is in a CDQ village after 2008 (the year that loan programs specifically targeting salmon harvesters were introduced). To exploit cross-sectional variation between CDQ and non-CDQ villages, we include this dummy in the controls for a specification where neither individual nor village fixed effects are used. Although data was collected on individual participation in CDQ interventions, self-selection bias means that reduced form estimates of eligibility for CDQ programs will yield an unbiased lower bound for the impact of these programs.

2.6 Empirical Results

Using the proposed empirical models, I find that permit prices respond to covariate shocks and are particularly sensitive to pre-season forecasts of salmon runs. Drift permitholders are more likely to be affected by variation in permit prices and tend to sell when permit prices are low. Presence of a male descendant and high individual productivity also make drift permitholders more likely to retain their permits. Conversely, set net permitholders are less responsive to changes in permit price, but there is weak evidence that they sell optimally when permit prices are high. Set net permits are more likely to be liquidated following idiosyncratic shocks such as divorce by male permitholders and childbirth by female permitholders. There is no evidence that access to credit, risk attitudes, or CDQ interventions drive permit sale decisions.

2.6.1 Determinants of Permit Price

Prior studies (Karpoff, 1983; Huppert et al., 1996) show that Bristol Bay drift net permit prices follow an adaptive expectations pricing model wherein the prices respond to changes in expected revenue. Table 2.3 uses CFEC average permit price from the drift and set net fisheries between 1977 and 2015 alongside self-reported permit sale prices from the household survey to predict the permit price in each period according to equation (5.4). Column (1) indicates that drift net permit prices are driven upwards by high observed harvest in the past season, low farmed salmon production in the past season (corresponding to high ex-vessel prices), and particularly, by next season's forecast. These covariate shocks to demand also affect the self-reported prices obtained by rural Alaskan survey respondents in column (2) but do a poorer job of predicting the price obtained. This could be due to noise in our self-reported permit price data or because transactions costs and thin markets mean that rural Alaskans are more likely to be isolated from price signals and, lacking full information, prices are more likely to be determined by individual bargaining power or other unobservables. Respondents from more remote villages were 20% more likely to report selling to an acquaintance and this figure falls over time with penetration of the internet making the use of formal permit brokers more common.

Table 2.3: Impact of Covariate Demand Shocks on Salmon Permit Prices
Dependent Variable: Real Salmon Permit Price 1977-2015 *($2015)*

	Drift Permits		Set Permits	
Variable	(7) **OLS**	(8) **OLS**	(9) **OLS**	(10) **OLS**
MEASURE OF PRICE	Fishery Average	Self-Reported	Fishery Average	Self-Reported
Total Harvest Last Season *(Millions of Lbs)*	1,623*	1,197*	281*	193
	(1,843)	(1,187)	(155)	(499)
Next Season Forecast *(Millions of Fish)*	1,912***	819**	529**	328*
	(3,144)	(2,190)	(718)	(175)
Farmed Salmon Production Last Season *(100Millions of Lbs)*	-1,091*	-912	-398	-141
	(583)	(1,209)	(562)	(216)
Observations	38	96	38	93
R^2	0.329	0.204	0.251	0.162

NOTE: ***Significant at 1% **Significant at 5% *Significant at 10%

Similarly, columns (3) and (4) show that average set net permit prices also respond to covariate shocks whereas self-reported permit prices are more idiosyncratic apart from pre-season forecasts. Shifts in farmed salmon production are not significant predictors of self-reported drift permit prices or set net permit prices in general. Qualitative focus groups prior to the household survey showed that rural Alaskans were familiar with competition from farmed fish but largely looked to the run forecast and past revenue in the fishery when forming their expectations of permit price.

The results in Table 2.3 are robust to alternate specifications including different lags of prior harvest or aquaculture yield and use of prior season's revenue in place of harvest. Additional controls such as exchange rates with major trading partners and fuel prices (as a proxy for cost) were insignificant. The CFEC does not report average permit prices from 1975-1976 so we also dropped self-reported sales from this time period. This should not bias our data since early sales are likely not representative of forward-looking or asset-smoothing behaviour and instead reflect the initial adjustment away from an inefficient allocation of permits.

2.6.2 Drivers of Permit Sale

As discussed in the theoretical model in Section 2.3, the impact of permit prices on an individual's decision to sell their permit will depend on their proximity to the debt constraint. Unencumbered by debt, harvesters will be more able to sell optimally and wait for permit prices to rise. Following equation (5.5), Table 2.4 uses predicted permit price based on the covariate shocks outlined in Table 2.3 to determine the drivers of drift permit sale. In all of the regressions shown in Table 2.4, the predicted permit price is based on average permit prices but these results are also robust to using average self-reported permit prices for the entire sample as a proxy for individual price in each time period. Column (1) shows the results of a naïve regression with actual permit price in place of predicted price. These results are expected to be biased downwards through endogeneity since during periods of demand shocks with correspondingly low permit prices, low demand could mean sellers are unable to match with a buyer.

Columns (2) through (5) use predicted price and demonstrate that drift permitholders are much less likely to sell when permit prices are high. Within the capital-intensive sector of the fishery, permitholders are unable to ride out catastrophic seasons and when asked about their reason for sale, 48% of drift permitholders mentioned pre-season debt for boat repairs, fuel, or boat improvements as a determining factor in their decision. Without insurance or other liquid assets that would allow them to smooth over seasons, they are forced to liquidate the permit sub optimally and flood the market with increased supply of permits following covariate shocks. Contrary to Hypothesis 1, they are much less likely to sell when permit prices are high. This is because, divergent to the assumptions of the model, permit prices are endogenously determined by covariate shocks. Permit prices are high after positive covariate shocks and in years when harvesters are further from the zero-asset threshold. Prices and assets drop in negative shock years which drives the result. In accord with Hypothesis 1, they are much more responsive to changes in permit price than set net permit holders who are less likely to make large capital investments prior to the season's start (see Table 2.5).

The impact of idiosyncratic shocks to individual productivity is more ambiguous. When individual fixed effects are used in column (2), a five-year period of high individual productivity does not make drift permitholders any less likely to sell. However, once individual fixed effects are eliminated in columns (3) through (5), it does appear that a decline in individual revenue drives permit sale. This indicates that individual unobservables outside of past revenue (experience, ability) may drive the individual response to low revenue years so that within a village, some low productivity harvesters are driven out of the market but individual harvesters respond more to covariate shocks to expected earnings, independent of realizations of their productivity. Marginal effects calculations for the coefficients in column (3) show that although individual harvesting efficiency matters, shifts in permit price are more important. A drop in permit prices by $10,000 makes individuals 12% more likely to sell their permits whereas a drop in average annual earnings by $10,000 increases the probability of sale by 5%. These results are robust to alternate measures of lagged earnings, but specification tests showed that a longer lag fit the data better. One low revenue season was insufficient to drive exit, but an extended period of low revenue was a better predictor of permit sale.

Table 2.4: Drivers of Drift Permit Sales
Dependent Variable: Individual Sells a Drift Permit at Time t

Variable	(1) Logit	(2) Logit	(3) Logit	(4) Logit	(5) Logit
Permit Price	-0.631*** (0.121)				
Predicted Permit Price from (5.4) ($10,000s)		-0.526** (0.241)	-0.702*** (0.221)	-0.695*** (0.301)	-0.781** (0.316)
Average Individual 5yr Lag Revenue ($10,000s)	-0.213 (0.190)	-0.141 (0.175)	-0.239* (0.128)	-0.228* (0.108)	-0.183* (0.118)
Divorce	0.139 (0.431)	0.062 (0.379)	0.084 (0.137)	0.073 (0.305)	0.041 (0.128)
Child Born	0.028 (0.273)	0.016 (0.371)	0.026 (0.429)	0.047 (0.239)	0.039 (0.371)
Male Descendant			-0.138** (0.063)	-0.142** (0.070)	-0.201** (0.081)
Access to Formal Credit			-0.028 (0.391)	-0.046 (0.117)	-0.142 (0.283)
Risk Lover				-0.027 (0.926)	
CDQ Resident Post 2008					-0.039 (0.051)
Fixed Effects	Individual	Individual	Village	Village	None
Observations	7098	7098	7098	3927	7098
Pseudo R^2	0.739	0.683	0.477	0.481	0.254

NOTE: Clustered standard errors at the village level are in parentheses. Each regression also includes controls for age, age squared and years of education. Controls for gender, parents' education, number of descendants and tribal affiliation are included in columns 3 and 4.
***Significant at 1% **Significant at 5% *Significant at 10%

Other idiosyncratic shocks outside of fishing performance, such as divorce and childbirth do not drive drift permit sales which is unsurprising since drift fishing is largely done by men and unlikely to be held jointly. When time invariant individual characteristics are introduced in columns (3) through (5), the existence of at least one male descendant is a very important predictor of permit sale. This is consistent with cultural norms in these villages that generate social shame around sale when bequest is possible and also dictate that drift net fishing is too hazardous for women. Drift permitholders with a male heir are 20% less likely to sell their permits relative to others in their village. Survey respondents were asked whether they had access to formal credit if they wanted to upgrade their fishing operation and results show that this was not an important predictor of permit sale. Only 15% of the sample said that they had access to loans (from banks, CDQ groups, or the state of Alaska) and a mere 9% indicated that they would be willing to take a loan if one were offered. This reflects a resistance to formal banking that is both cultural and reinforced by early experiences with loan programs from the 1980s. Targeted at rural Alaskan residents, these subsidized loans resulted in several well-known defaults wherein boats and nets were seized and many respondents expressed both distrust and discomfort with the formal banking sector. For the subset of respondents who participated in the risk experiment in column (4), risk-loving behaviour is insignificant. Permitholders who chose raffle tickets over gift cards are no more or less likely to sell permits. This can be attributed to a small sample size, failure to elicit a true measure of risk aversion, or simply reflect that tolerance for uncertainty does not drive permit sale decisions.

Contrary to their intentions, the interventions of permit loan programs and vessel improvement grants that the CDQ group has targeted towards its salmon harvesting residents do not appear to be having a significant impact on drift permit sales. In column (5), village and individual fixed effects are dropped so that we can look across the entire sample and compare individuals within CDQ villages after 2008 to those outside the boundary and to the period before BBEDC actively engaged in the provision of credit. The coefficient on the post 2008 within CDQ region dummy is negative but insignificant and this result is robust to using different years (1995 when CDQ established or 2012 when enrolment in programs began to increase) and to using a difference in differences specification. In the village fixed effects specification, there is evidence that residents of Dillingham are much less likely to sell permits than surrounding villages. This is consistent with either unobservables stemming from a regional hub effect, or a positive impact from BBEDC that is limited to its headquarters. Statistics on program participation provided by BBEDC indicate that

59% of permit loan program participants and 38% of vessel acquisition program participants are from Dillingham which could be assumed to mirror the participation rates across its programs. Respondents from other CDQ villages were less likely to be aware of BBEDC programs and expressed a sentiment that the benefits from membership did not appear fairly distributed. This could be unfounded resentment from participants who exited the fishery and face social shame for doing so, elite capture within villages, or the remoteness and low education levels in these villages making extension services difficult and take-up rates low.

Table 2.5 shows similar results for the drivers of set net permit sales. Contrary to drift permitholders, columns (3) through (5) show that set net permitholders are more likely to sell when predicted price is high which is consistent with these participants being further from the debt constraint. The impact of permit price is insignificant in the most robust specification using individual fixed effects, so we cannot conclusively say that set net permitholders are able to sell optimally but we can conclude that they are less vulnerable to covariate shocks than drift permitholders. Set netters also appear to be less driven by individual productivity, with lagged average revenue not being a significant driver of sale. These results are consistent with qualitative interviews wherein respondents indicated that participation in the set net fishery was a key part of their cultural identity and vital to sustaining subsistence levels of salmon for consumption. Since set net permits have a lower outside opportunity cost of sale and require much less capital investment (34% of respondents reported not owning a skiff and picking their set nets from the beach) so respondents are able to fish with low investment and not pushed to sell by shocks.

The most important determinants of set net permit sales are idiosyncratic shocks outside the fishery: divorce and childbirth. Separate regressions show that for male set net harvesters, divorce makes sale 26% more likely which is consistent with set permits being initially allocated to women due to cultural norms that made fishing from the shore more socially acceptable for women rearing children. After the initial allocation, over capitalization within the drift fishery made drift net fishing less profitable for capital-constrained harvesters from rural villages and many men who had been fishing in drift boats transitioned to set nets. Permits initially allocated to their wives and mothers were transferred to their names and although permits cannot be held jointly in official CFEC paperwork, it appears that the dissolution of marriage made these men holding set net permits more likely to sell (the effect is insignificant when the sample is limited to women). This is consistent with permits that were effectively joint property needing to become solvent in divorce settlements or with men choosing to liquidate a smaller asset in order to pay the costs of divorce. For female set net permitholders, childbirth makes them 29% more likely to sell a permit which corresponds with qualitative interviews wherein women, particularly from villages up river far from the set net fishing sites, cited children as the primary obstacle to continuing in the fishery. Some villages, such as Manokotak, have a strong tradition of entire families running set net sites together and women from these villages were less likely to be affected by the birth of a child.

Table 2.5: Drivers of Set Net Permit Sales
Dependent Variable: Individual Sells a Set Net Permit

Variable	(1) Logit	(2) Logit	(3) Logit	(4) Logit	(5) Logit
Permit Price	0.142 (0.124)				
Predicted Permit Price from (5.4) ($10,000s)		0.170 (0.148)	0.192* (0.116)	0.187* (0.102)	0.142* (0.079)
Average Individual 5yr Lag Revenue ($10,000s)	-0.328 (0.195)	-0.274 (0.161)	-0.150 (0.122)	-0.162 (0.151)	-0.130 (0.104)
Divorce	0.174 (0.130)	0.193* (0.105)	0.162* (0.085)	0.174* (0.096)	0.165** (0.080)
Child Born	0.582** (0.259)	0.472*** (0.208)	0.381** (0.187)	0.363** (0.174)	0.481*** (0.205)
Female Descendant			-0.052 (0.193)	-0.072 (0.279)	-0.049 (0.091)
Access to Formal Credit			0.049 (0.285)	0.033 (0.110)	0.088 (0.175)
Risk Lover				-0.095 (0.061)	
CDQ Resident Post 2008					-0.099 (0.068)
Fixed Effects	Individual	Individual	Village	Village	None
Observations	5943	5943	5943	3276	5943
Pseudo R^2	0.627	0.531	0.393	0.406	0.284

NOTE: Clustered standard errors at the village level are in parentheses. Each regression also includes controls for age, age squared and years of education. Controls for gender, parents' education, number of descendants, and tribal affiliation are included in columns 3 and 4.
***Significant at 1% **Significant at 5% *Significant at 10%

While male heirs were a key predictor of drift permit sales, set net permitholders with at least one female heir were not less likely to sell. This can be attributed to changing cultural norms and capital barriers in the drift fishery that made set net fishing more accessible to men. Having any descendants at all (regardless of gender) did make set net permitholders significantly less likely to sell as they also exhibit a preference for inheritance over liquidation. Similar to drift permit sales, attitudes towards risk, access to credit, and CDQ interventions are not significant predictors of sale.

2.7 Policy Implications and Conclusion

This paper uses primary survey data to evaluate the drivers of fishery access right sale in the context of rural Alaska. The prevalence of shocks to salmon runs and ex-vessel prices coupled with precise data on individual productivity allows us to isolate the relative importance of covariate and idiosyncratic risk. Results show that participants in the capital-intensive drift fishery are largely driven to sell permits by communal shocks to abundance and markets. They are forced to sell when permit prices are low and after prolonged periods of low individual productivity. Strong preferences for bequest also make them more likely to sell when no male heir exists. With lower debt burdens, participants in the set net fishery are more likely to sell when permit prices are high and are primarily driven out of the fishery by personal events such as divorce and childbirth. Risk attitudes are not an important predictor of sale. Efforts to retain permits held by locals through the provision of credit have been largely unsuccessful which is correlated with scepticism about formal credit.

As fisheries around the world transition to right-based management, policy makers remain uncertain about the social impact of fisheries enclosure and the vulnerability of fishing-dependent communities. The empirical evidence presented in this paper has important policy implications focused on protecting harvesters from volatility and providing alternate livelihoods.

The vulnerability of over-capitalized drift net permitholders implies that programs designed to keep permits in local possession must focus protecting these harvesters from covariate shocks. Because falling permit prices are more likely to drive exit than idiosyncratic shocks to individual productivity, such schemes will be difficult to devise because any provision of insurance cannot rely on random idiosyncratic risk and must yield large pay-outs in years when all harvesters are struggling. Because salmon runs across the state of Alaska are largely independent between ecosystems, if harvesters across regions could pool risk then it would be less likely that plummeting demand for permits would also correspond with high bouts of permit sale. Rural participants' attitudes towards formal credit may not illicit high take-up of formal fishing insurance products so the establishment of a safety net to lift harvesters to solvency in poor fishing years will most likely be the purview of large organizations such as the CDQ groups. There is evidence that expectations of permit price respond rationally to market signals and that set net permitholders are less vulnerable to shocks so efforts to reduce overcapacity in the fishery through capital limitations and permit buyback schemes could also reduce the impact of volatility.

Drift permitholders selling under duress when prices are low is consistent with the results from chapter 1 wherein they were also more likely to invest the proceeds of these sales in durable assets that did not increase the education or employment of their descendants in the long run. Set net permitholders appear to be more forward-looking and sell strategically when prices are high; either to smooth consumption and shield themselves from shocks in their personal lives or to invest in nontangible durable assets that eventually increase their descendants' access to alternate livelihoods (as seen in Chapter 1). These results reinforce the urgency of quelling permit sale under duress since there is evidence that the proceeds from such sales are not invested in assets that are productive in the long run.

Unfortunately, there is evidence that even well-intentioned agents such as BBEDC have been unsuccessful in their efforts to address barriers to credit for rural harvesters. The results of this study do not demonstrate an easy path forward as some of the largest determinants of sale such as existence of heirs, divorce, and childbirth will remain outside the control of policymakers. One suggestion is that random and gradual rollout of their programs would make impact assessment more feasible and allow them to disentangle which of their wide set of interventions is most effective. Another is that despite being eligible, many residents of more rural villages do not take advantage of the assistance so the benefits are limited to residents of the central hub. Focusing on penetrating the smaller villages and working closely with the local communities to understand barriers to take-up would increase their reach.

At the moment, BBEDC is focused on lobbying the state of Alaska to allow them to establish regional permit banks that would buy up a subset of local permits and only allow locals to purchase them. Local economic spill overs from continued permit ownership are high with 78% of survey respondents who work as crew reporting that they work for a permitholder from within the region. Simultaneously, it does appear that BBEDC's permit brokerage efforts have been successful at maintaining local ownership as nearly all respondents who had used this service reported selling to a resident of the local region. If the only consequence of local permit banks is to ensure that permits are held locally even when a direct descendant is not present or interested in fishing, then this study suggests they will be an effective deterrent from permits leaving the region. However, if they impact the price of salmon permits and drive prices down by limiting the market to only local buyers, then this will have unintended consequences and may lower the returns and simultaneously the access to alternate livelihoods for those exiting the fishery.

Chapter 3

Distributional Trends in Revenue from Alaska's Catch Share Fisheries

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Abstract

Catch share programs often include quota transferability provisions that could lead to a transfer of shares out of fishing-dependent communities in Alaska. To investigate the possibility of such changes in ownership we analyze the geographic distribution of quota ownership from six Northern Pacific fleets between 1995-2014. We do not find evidence in any individual fisheries that the regional distribution of quota has significantly shifted. We also look beyond fleet characterizations to examine quota holdings according to community size and find that medium size communities have been more likely to lose share than large or small-scale communities. We attribute the relative geographic stability across catch share programs to the influence of pre-existing groundfish cooperatives in the large communities and to community development quota (CDQ) groups in the small communities.

3.1 Introduction

The United States fisheries of the North Pacific Ocean generate ex-vessel revenues approaching $2 billion annually from the waters off Alaska. However, the annual statistics reported for these fisheries (e.g., Fissel et al., 2015) have historically reported total earnings in each fishery without details regarding the distribution of these earnings across the wide range of communities in Alaska and around the country in which the participants reside. While the North Pacific Fishery Management Council (Council) has a long record of sustainable management in achieving biological goals, newer management programs have focused on achieving economic, social and allocative goals, and on aligning incentives within a fishery to achieve bycatch reduction. For the most valuable North Pacific fisheries, this has involved implementing catch share programs. These programs allocate secure shares of the annually determined total allowable catch to individuals or cooperatives, and typically allow transfers of either permanent shares or the annual quota pound allocations the shares beget (or both). Transfer of the shares or can allow more efficient operations to capture greater value from the fishing privilege, but there is wide concern that these programs can facilitate a geographical shift in those who maintain ownership or participate in the fisheries. In the North Pacific, the Council and fishery stakeholders have expressed concerns about fishing-dependent communities in Alaska being adversely impacted if a large percentage of fishing quota is transferred to regions with greater ability to access capital and markets.

In this report we examine the evolution of the geographic distribution of quota ownership following the implementation of the North Pacific's catch share programs.[5] Many of the catch share fisheries we analyze in this paper allow quota owners to lease quota to other vessels, and thus a considerable portion (and it is sometimes argued, too large a portion; see Himes-Cornell, 2015) of the fishery earnings may accrue to the

[5] In another ongoing manuscript we examine the geographic distribution of landings revenues using vessel owner residence data for nearly all Alaskan fisheries, in contrast to the quota-based examination in catch share fisheries undertaken here.

owners of the quota and be spent in their community, rather than to the communities of participants who lease the quota and fish it. For example, if quota holders lease their quota to another party and move out of fishing communities or sell quota to individuals who live outside those communities, the flow of income generated through traditionally place-based fisheries can be exported through the management change.

We focus on six catch share programs in the North Pacific: halibut, sablefish, crab, rockfish, the American Fisheries Act, and the Amendment 80 cooperative. The halibut, sablefish and crab programs allocate quota among large, competitive fleets of relatively small vessels, while the American Fisheries Act (AFA) and Amendment 80 (A80) groundfish programs allocate quota among mostly industrial scale catcher vessels and catcher-processors.[6] The rockfish program includes both a catcher vessel and catcher-processor component but uses smaller vessels than the AFA and A80 fleets. See Table 3.1 for summary statistics on the fleets. Across these programs, we do not find strong evidence of geographic changes in the patterns of fishery quota ownership. However, the regional Community Development Quota (CDQ) groups, developed as a social protection measure for the catch share programs, have played an important role in the continued and increasing prominence of western Alaska. They have increased the ownership share of rural western Alaska through both the designated CDQ allocation and subsequent purchase of additional quota shares, particularly in the crab and sablefish fisheries.

The next section of the paper reviews the global experience with community impacts arising after introduction of catch share programs, while the following describes the Alaska programs studied and highlights the features added by the Council to mitigate geographic redistribution. The next section explores the geographic distribution of ex-vessel revenue associated with quota ownership in each program, as

[6] The American Fisheries Act, among other things, created an exclusive allocation for a group of mostly pollock-targeting catcher vessels, catcher-processors and motherships. The "Amendment 80" fleet is a fleet of specifically named trawl catcher-processors that was authorized by the 80th amendment to the Bering Sea and Aleutian Islands Fishery Management Plan to form cooperatives to harvest an allocation of six groundfish species including Atka mackerel, Aleutian Islands Pacific ocean perch, flathead sole, Pacific cod, rock sole, and yellowfin sole, and a prohibited species catch (PSC) allowance for halibut and crab.

well as the distribution of revenue by community scale with an aim to identify any changes in the pathways of fishery benefits. We conclude with some synthesis of effects of these catch share programs on patterns of ownership and identify where gaps remain that are obstacles to implementing new programs.

3.2 Potential Effects of Catch Share Programs on Communities

The US Magnuson Stevens Fishery Conservation and Management Act's National Standard 8 requires that fishery management actions "take into account the importance of fishery resources to fishing communities … to (a) provide for the sustained participation of such communities, and (b) to the extent practicable, minimize adverse economic impacts on such communities." Achieving this standard requires that regional fishery management councils be attentive to whether management actions are likely to dramatically shift fishery benefits away from historic participants and their communities. Although catch shares provide a secure access privilege that ensures some portion of the benefits continue to flow to historic participants (and often to their communities), when transfers of quota are entirely unrestricted, catch share programs may provide mechanisms through which the redistribution of benefits can occur. As such, catch share programs often include some degree of community protection measures.

In simplest form, a catch share program allocates shares of allowable catch among a group of eligible users (Christy, 1973). Each year, managers determine the biologically permissible catch based on scientific information, and distribute annual quota pounds, to users in proportion to their shares. Depending on the program details, users may trade the permanent quota shares ("sell quota"), or the annual quota pounds ("lease quota"), or both (details by program are given below, and discussed in even greater detail in Holland et al., 2015). Economic theory dictates that under standard conditions those selling quota receive a price reflecting the expected net present value of future profits, while those leasing quota receive compensation reflecting the expected return from the current year's harvest. The market mechanism reallocates quota from one party to another who can derive greater value from it, leading to an increase in efficiency and net benefits derived from the fishery. Often such efficiency gains lead to exploitation of economies of scale, through longer fishing seasons for fewer vessels, leading to consolidation that can alter the nature of crew positions (Abbott, Garber-Yonts, and Wilen, 2010). But decreasing participation, windfall allocations, and changes in the regional composition of fisheries can destabilize communities and create a class of disaffected former fishers, as Yandle and Dewees (2008) identified in the small-scale New Zealand fishery and Eythorsson (2000) observed in Iceland. Alternatively, Brandt (2005) found fewer vessels participated in harvesting surf clams, but the former harvesters emerged as a class who participated as quota lessors. Harvesters can appreciate this system (cf. Knapp, 2007) or feel that it has altered their region's cultural landscape (e.g., Shivlani and Milon, 2000).

However, even in the absence of effort consolidation, unrestricted transferability may increase the likelihood of historic participants leaving the fisheries (McCay, 1995). For example, quota owners may experience personal shocks (e.g., death, divorce, large expenses) that require them to liquidate their salable assets; they may not have access to financial capital to scale their businesses; or they may not have political capital to maintain their position in the fishery (Sumaila and Watson, 2002). Further, communities are additionally exposed because the crew employment that is often associated with ownership stakes in the fishery does not typically have a say in the sale of quota. Similarly, in fisheries where local ownership is associated with local landings, the community benefits of processing the fish are not represented in the quota owners' decision to sell (cf. Shivlani and Milon, 2000). With knowledge of these substantial risks, communities dependent on fisheries considering a transition to catch share programs often seek to implement social protection measures alongside the new program, to ensure the quota market does not provide an unintended pathway for collapse.

3.3 Alaska's Catch Share Programs

The Council has implemented five major catch share programs in six fisheries. In each case, the Council identified specific goals it believed were best accomplished through a catch share program. In order to limit potential adverse effects on communities, they designed the programs with additional "bells and whistles" (McKay, 2005), or community protection measures that are designed to safeguard the sustained involvement of fishing communities. An overview of the histories and regulations of these programs is provided in Brinson and Thunberg (2013, 2016) and Holland et al. (2015), but key provisions are presented here in brief.

Table 3.1 summarizes the distinct fisheries, identified by the management plan that created their catch share systems, sorted by annual landed value. Each program was developed with specific goals and objectives, as evidenced by the various "purpose and need" statements expressed by the Council, but all sought to achieve some of the common results of catch share programs such as reductions in fishing capacity and gear conflicts, increased efficiency and safety, and initial allocations reflecting historic participation.

The North Pacific's first program, implemented in 1995, was designed to reduce overcapacity and increase efficiency in the halibut and sablefish fisheries. These two species are harvested by large fleets of predominantly family-owned boats fished out of Alaskan communities. Halibut fishing, in particular, had become a fishing derby characterized by extreme overcapacity and dangerous working conditions. The primary objectives of the catch share program were to decrease overcapacity and improve safety and product value, goals which are widely considered to have been achieved (NPFMC, 2016). However, being relatively early in the development of ITQ programs globally, the primary mechanisms for limiting community effects were low consolidation cap limits, vessel size class designations to prevent big boat owners from buying small boat owners' quota, and active participation requirements (see Syzmkoviak and Felthoven, 2016). More recently, the introduction of owner-on-board provisions for new entrants has slightly increased the number of owner-operators, who are more likely to live in regions close to the fishery than individuals who lease their quota (NPFMC, 2016 Figure 2.5-8). Additional special loan programs such as the North Pacific Loan Program and the Community Quota Entity (CQE) program are designed to encourage fishing-dependent communities, new participants, and participants with small holdings to acquire additional quota shares.

After seeing the success of rationalization in mitigating the halibut derby, the crab industry developed a proposal aiming to reduce overcapacity and lengthen fishing seasons to improve safety; the fisheries were rationalized (by Congress) in 2005. Many participants in the crab fishery were residents of Alaskan fishing communities, especially Kodiak, but many of the largest harvesting operations were based out of the Seattle Metropolitan Area (SMA). While the crab fishery did not implement an owner-on-board provision, the crab rationalization program did implement individual ownership consolidation caps. There was particular concern about consolidation in the processing sector, as the derby fishery supported many communities near the fishing ground during the race to fish. Thus, harvesters were required to land 90% of the crab quota at eligible crab processors holding processing quota shares. In addition, these quota were regionalized so that landings and processing would occur in both the northern and southern portions of the Bering Sea in accordance with historic geographic patterns (see U.S. Department of Commerce, 2004, chapter 2 for more details). A characteristic of this program was the ability for quota owners to form cooperatives and receive a collective quota pound allocations each year which could then be divided among themselves to achieve organizational efficiency.

The catch share program for Central Gulf of Alaska rockfish fishery was designed to attenuate a derby and provide employment stability at the shoreside processors, predominantly in the city of Kodiak. As the derby reduced the length of the rockfish season, there was a corresponding fall in local processing operations, ex-vessel prices and community fish tax revenues. This program is largely based around catcher vessels which are required to form a cooperative around a processor, but there is also a limited entry component. In addition, participating catcher-processors were allowed to form their own cooperatives or opt out. However, they were not allowed to purchase catcher vessel quota in order to help retain an active catcher vessel fleet.

The American Fisheries Act was instituted to rationalize the incentives in the pollock fishery and to facilitate a transfer of the pollock quota between inshore and offshore sectors (Felthoven, 2002). The goals for their catch share programs were to institutionalize the cooperative arrangements that were already established to varying degrees and to facilitate coordination among member companies. The AFA was also driven in part to facilitate a reallocation between inshore and offshore sectors. The AFA catcher-processor and mothership sectors, are catcher-processors that make long trips; the AFA shoreside cooperatives are structured around processors, and vessels move among them to ensure a market for their product. Given the corporate ownership structure headquartered in the SMA, there are minimal community protection measures included in the AFA.

Amendment 80 to the Bering Sea fisheries management plan established a sector allocation to a group of vessels that already had a sub-component of catcher-processors who had been operating as a defacto-cooperative and had been struggling with bycatch for some time (see Abbott et al., 2015 for details). Again, given that this fleet of catcher-processors has a corporate ownership structure headquartered in the SMA, there are minimal community protection measures included in A80.

Perhaps the most significant community protection measure across all these programs is the Western Alaska Community Development Quota (CDQ) Program. The explicit goal of this program is to alleviate poverty and vulnerability in rural, economically depressed, and predominantly Alaska native communities. The basis of CDQ allocation is more closely tied to geographical proximity than to historical involvement in the fishery, as these groups received quota share in some groundfish and crab fisheries in which they have no history of participation. Beginning in 1992 with Bering Sea pollock, the six regional CDQ groups received a portion of the TAC and the framework for CDQ program allocation was established. With the Magnuson-Stevens Act reauthorization of 1996, the CDQ program was officially established and as subsequent fisheries rationalized, CDQ groups were allocated quota for BSAI groundfish, halibut, crab, and PSC. It is these explicit allocations of the TAC that are included in the respective CDQ entries in Table 3.1; CDQ groups may also purchase non-CDQ quota share. Each individual CDQ group has sovereignty over how they choose to harvest, lease, or invest their quota shares with their various harvesting partners. Current reporting requirements on business endeavors by CDQ groups do not facilitate an in-depth analysis of their activities, but these groups undoubtedly play an important role in the distribution of fishery benefits; we can track some of these effects through quota ownership data and annual reports that disclose their ownership share in fishing partner vessels.

This paper evaluates the extent to which these programs, and their associated community protection measures, have influenced the distribution of earnings from Alaska's catch share fisheries. We first explore whether catch share programs have resulted in a pattern of initial or ongoing consolidation within their respective fisheries. As a design intent of some programs, consolidation is anticipated, but it is unclear for how long a period it has continued, and whether it resulted in systematic shifts in geography or community scale. Therefore, a second focus of our examination is whether the catch share programs have, individually or collectively, resulted in an exodus of fishery ownership stake from Alaska. Third, we examine whether changes in ownership have led to systematic movement of catch shares into larger or smaller communities.

Table 3.1: *Characteristics of Alaska Catch Share Fisheries*

Fishery Description	**Avg. AK Owner % 2008-13**	**Avg. Value 2007-13 ($M)** *(Std Dev)*	**Avg. Landings 2007-13 (Metric Tons)**	**2012 No. of Quota Owners** (Landing Vessels)	**Management Style, Quota Share (QS) Allocation Method, (Year Implemented)**	**Years of Data**	**Individual vs. Cooperative Data**
AFA Catcher Vessels, Catcher Processors, and Motherships BSAI Pelagic Trawl Pollock	0	344.06 *(62.11)*	954,546	8 (103)	Cooperative (1998)	1999-2014	All quota share holdings and landings data are at the cooperative (shoreside) or sector level
BSAI Crab Catcher vessels and catcher processors targeting various species of crab with pot gear in the Bering Sea	27.08	226.12 *(46.09)*	34,565	526 (81)	Cooperative IFQ and IPQ (2005)	2005-2014	Landings at cooperative level but individual quota share transfers are known
Halibut IFQ Longline Catcher Vessels targeting halibut in GOA and BSAI	58.90	192.27 *(52.98)*	17,073	2,637 (1,013)	IFQ (1995)	1995-2013	Landings and quota share data are at the individual level
Amendment 80 BSAI Trawl Catcher Processors not targeting pollock. Mainly targeting flatfish and Pacific Cod or rockfish and Atka mackerel.	0	161.32 *(17.23)*	365,632	20 (19)	Cooperative (2008) also a limited access sector	2008-2014	Quota share data are at the individual level but landings are at the vessel/cooperative level
Sablefish Fixed gear catcher vessels and catcher processors predominantly targeting sablefish	39.89	132.39 *(21.51)*	12,948	841 (354)	IFQ (1995)	1995-2013	Landings and quota share data are at the individual level
Groundfish CDQ Catcher Vessels and Catcher Processors fishing groundfish quota owned by CDQ groups in Western Alaska	100	65.04 *(12.82)*	159,828	6 (52)	CDQ (1992)	2004-2014	Landings and quota share data are available for each CDQ group
Crab CDQ Catcher Vessels fishing crab quota owned by CDQ groups in Western Alaska	100	24.62 *(4.49)*	3,713	6 (29)	CDQ (1998)	1998-2014	Landings and quota share data are available for each CDQ group
Central GOA Rockfish Trawl Catcher Vessels and Catcher Processors in the Gulf of Alaska targeting Pacific ocean perch, northern rockfish, and pelagic shelf rockfish.	19.90	13.22 *(6.33)*	19,976	52 (45)	Cooperative (2007 Pilot) (2012)	2007, 2012, 2016	Quota shares of individuals are known in 2007, 2012 and 2016. Transfers and landings are known at the cooperative level.
Halibut CDQ Catcher Vessels fishing halibut quota owned by CDQ groups in Western Alaska	100	8.27 *(2.38)*	822	6 (238)	CDQ (1995)	1995-2014	Landings and quota share data are available for each CDQ group

3.4 Data and Methods

Constructing an aggregate picture of how different regions and population scales depend on quota, and how the distribution of that quota may be changing over time, necessitates generating a variable that is comparable across the various catch share programs. We chose to use ex-vessel revenue. However, in some fisheries the actual revenue was not observed at the level of the individual quota share holder, and each of the quota fisheries has different structures with regards to cooperatives, CDQ groups, and data reporting. These complications necessitated some decisions on how to construct the revenue data in each fishery; details on our quota share revenue data in those fisheries are outlined below.

For the AFA fleet, the annual data on quota share holdings and landings are at the level of the cooperative for the shoreside sector; data for motherships and catcher processor vessels are at the sector level. Actual revenue data was assigned to quota holding cooperatives and sectors using landings and observed ex-vessel revenue. Any movement in quota revenue over time comes through changes in the observed prices, inter-cooperative transfers of quota, and differences in the sector-level allocations of quota. Since almost all cooperatives and sectors are based out of the SMA, there is very little change in the spatial distribution of revenue.

Within the A80 and BSAI crab fleets, quota share is held by entities (individuals or corporations), but vessel landing records are attributed to the cooperative to which these entities belong. To assign pounds to these entities, quota share data were converted to estimated pounds using the ratio of total cooperative quota holdings and annual TAC. Revenues earned by each entity were then imputed by multiplying these estimated individual pounds by the average annual ex-vessel prices reported by NMFS according to region and species.

In both the halibut and sablefish IFQ fisheries, individuals or corporations hold quota share and landings are reported according to the NMFS ID of the landing permit holder. This means that absentee quota holders (27.7% of the dataset in 2013) do not appear in the landings database and actual revenue cannot be tied back to holdings of quota share. To standardize our estimates of revenue accruing to permit holders regardless of whether they were landing the fish themselves, we used the TAC and total quota share holdings to estimate pounds and multiplied by average annual ex-vessel prices in each management area as reported by NMFS.

CDQ groups are also allocated quota that counts towards the total TAC in the groundfish, crab, sablefish and halibut fisheries. Despite this, the data on CDQ quota ownership does not report their allocated pounds or quota share in a manner that is translatable to the IFQ fisheries; instead, annual CDQ quota share is reported as a percentage of the total TAC by each species and is not in a data format that is compatible with analysis. In addition, the reporting of CDQ groundfish revenue and allocation occurs at the level of individual species and not in the framework of the commercial fleets with whom they share quota. Thus, we used the actual ex-vessel revenue from CDQ-owned quota that is reported to NMFS in lieu of estimating revenue from quota shares as was done in the BSAI crab, catch share halibut/sablefish, and A80 fisheries.

The total ex-vessel revenue from halibut, crab, and a variety of groundfish species (including sablefish and some rockfish) was aggregated at the annual level and was attributed to the community in the CDQ region that had the largest number of CDQ employees (where this was evident from CDQ annual reports) or had the largest population. Although CDQ groups do not always report a corporate address that is within their region, it was assumed that the majority of the benefits from quota share ownership are accruing within their regions in accordance with their mandate. Our assumption that all ex-vessel revenue from CDQ landings is returned to the CDQ region as quota royalties would lead us to over-estimate the benefits that accrue to western Alaska, just as we ignore the share of quota revenue that returns to crew and hired captains in all other catch share fisheries. Assuming that the division of profits among quota holders, vessel owners, and crew is similar across fisheries, our analysis should not be biased by this issue. The complex nature of the agreements between

CDQ groups and their harvesting partners makes a more precise estimation of their quota revenue impossible with currently available data.

The Central Gulf of Alaska Rockfish program was established in pilot form in 2007 and implemented in full in 2012. Within this fishery the quota shares of individuals and corporations are only known at three snapshots in time (2007, 2012, and 2016). In the interim periods, data on quota transfers is only observed at the level of the cooperative. Landings and ex-vessel revenue are also observed at the level of the cooperative. To estimate the distribution of quota benefits accruing to individuals, we chose not to aggregate the data at the cooperative level and instead relied on the three data points that exist. We then estimated revenue from quota shares using the total TAC and average ex-vessel prices as described above.

3.5 Results

To evaluate changes in the distribution of fishery benefits following the implementation of catch share programs, we examine four aspects of the data. First, we look at trends in fishery revenue and the revenue concentration in specific catch share fisheries over time. Next, we explore the trends in regional distribution of ownership revenue. We then examine how regional ownership trends may be affected by CDQ groups' quota acquisition. Finally, we consider whether there are shifts in the scales of the communities that are receiving fishery ownership revenue.

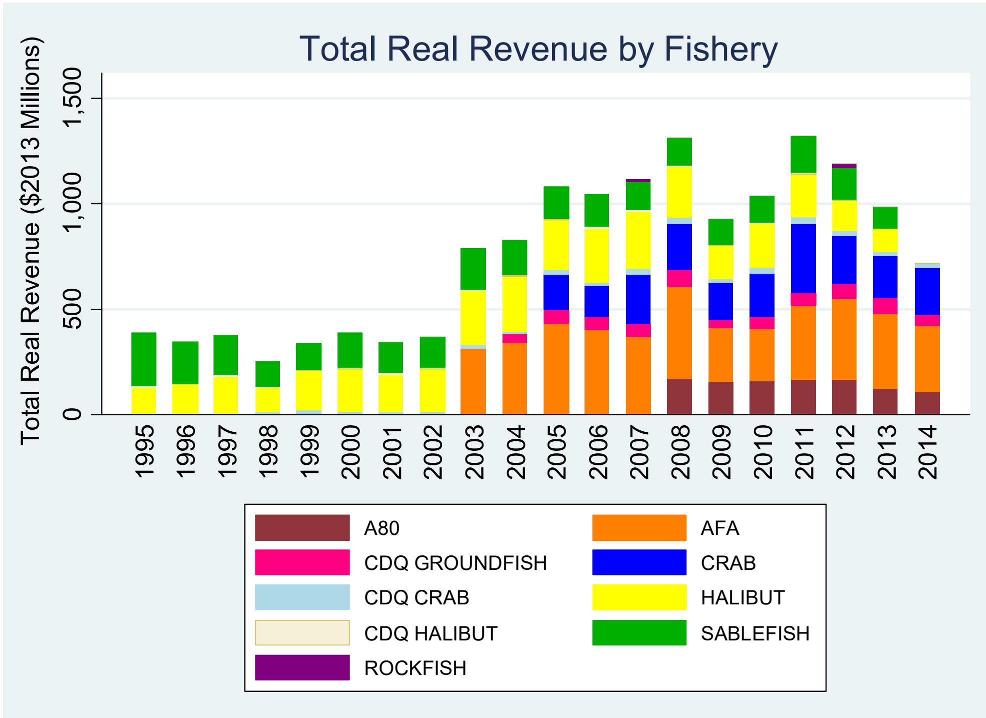

Figure 3.1: Total Real Ex-Vessel Revenue by Fishery (in 2013 $Millions)

Figure 3.1 illustrates both the timeline of quota program introduction and the relative size of each program with respect to total real revenue; it also reflects some constraints on our available data. As shown in Table 3.1, AFA pollock is by far the largest and most volatile catch share fishery, with a large downturn in 2009-10 attributable to low abundance of the prime-age year classes of pollock. The BSAI crab fishery has been trending upwards in relative value since its 2005 rationalization. Halibut is also a relatively large fishery producing a valuable product, although the TAC available to directed halibut fishing has fallen by 64% between 2005 and 2015. The A80 groundfish trawl fleet has been relatively stable since cooperative-based rationalization in 2008. Sablefish is roughly equivalent in size to A80, but with a higher degree of volatility. The Central GOA Rockfish program has individual quota revenue data in 2007 and 2012 and is comparable in size to the CDQ crab earnings. Importantly, although CDQ revenue appears miniscule in this figure (with only CDQ groundfish being visible in most years) the revenue streams from these fisheries play significant roles in the relatively small regional economies of western Alaska. Despite the pollock-driven dip in total revenue in 2009-10, revenue within each fishery has been stable or trending upwards with the notable exceptions of halibut and AFA. A common goal of rationalization is to stabilize fishery revenue; within aggregate total revenue, biological forces oftentimes dominate any stabilizing market forces in our short time series.

One of the goals of the halibut, sablefish, and crab rationalization programs is to transition to capacity levels more in line with resource abundance, but with a stable ownership and geographic distribution of fishery benefits that reflect National Standard 8's sustained participation provision. To capture potential changes in the concentration of ownership within each fishery, we calculate several Herfindahl-Hirschman Indexes (HHI) (Herfindahl 1955; Hirschman 1964). The HHI is a standard measure of concentration that takes on a value between 0 and 10,000 and is equal to the sum of squared market shares across entities in an industry. As such, it is very sensitive to movement away from complete concentration, and relatively insensitive to changes in diverse industries. Kasperski and Holland (2013) used HHIs to examine how the diversity of fisheries in which a vessel participates relates to its year-over-year variation in profits, finding that it is riskier to be less diversified across fisheries. Below, we calculate the HHI of each fishery above, to show how the concentration of ownership has changed over time.

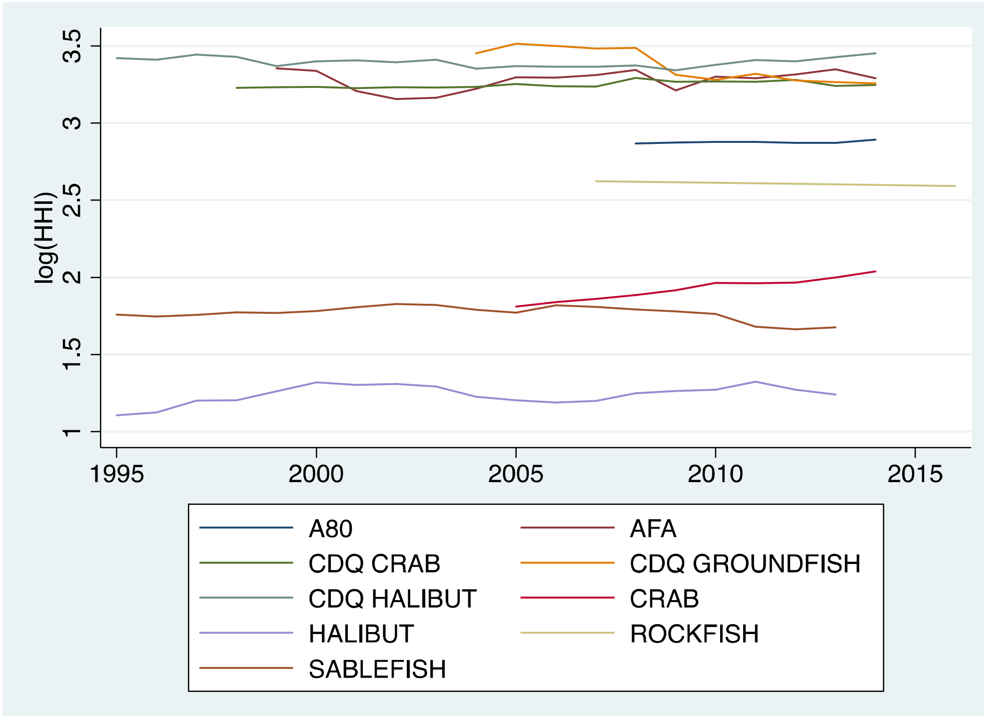

Figure 3.2: HHI of individual owners (nmfsids) within each fishery in each year. logHHI ranges from 0 (fully diffuse) to 4 (one owner is associated with all revenue in the fishery)

Figure 3.2 indicates considerable stability in the distribution of ownership within each fishery. The programs with logHHIs above 3.0 are either those where allocation is to a small number of cooperatives, or CDQ allocations where there are only six regional corporations that receive shares. Figure 3.2 collapses the CDQ allocations into their primary fisheries and calculates the HHI, counting the CDQ groups as owners of their allocations within the fishery. Again, most programs are stable except for crab and halibut, which show some increase in concentration over time. However, this consolidation is driven by CDQ groups purchasing non-CDQ quota share: dropping CDQ owned quota share reveals a virtually unchanged concentration of non-CDQ owned crab shares. Halibut has experienced a decrease in the number of entities holding quota share, from 4,534 in 1995 to 2,522 in 2014 (Fissel et al. 2015 p. 250), leading to a slightly more concentrated fishery, but much of the increase in Figure 3.2 is attributable to a few CDQ groups who are consolidating halibut quota shares. This CDQ activity is explored in more detail in section 3.5.2.

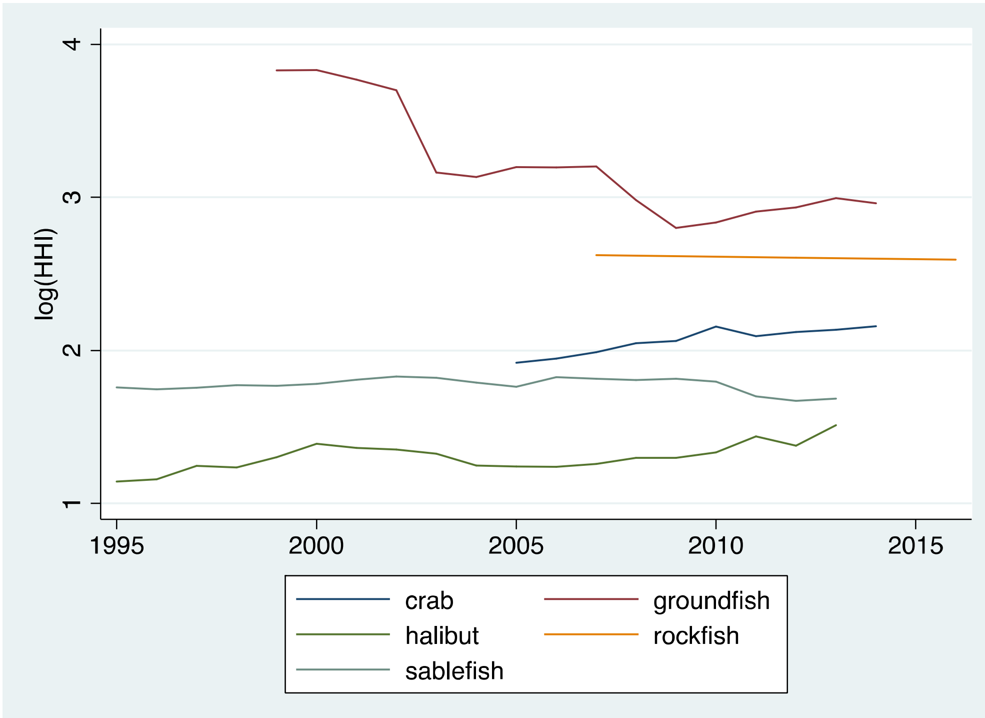

Figure 3.3: HHI of individual owners (nmfsids) within each fishery in each year, including the CDQ allocation within each species group for the fishery and counting the CDQ groups as individual owners.

3.5.1 Geographical Trends

Many of the social protection measures built into Alaska's catch share programs sought to promote local ownership within the newly rationalized fisheries. Looking at the distribution of earnings across regions allows us to evaluate whether these measures have been effective or if there has instead been a trend of quota ownership accumulating outside of Alaska. To analyze geographic movement of quota revenue, we use annual data on individual quota holders' city of residence, or on the fishing cooperative's headquarters when quota is not held by individuals. We assign quota revenue to regions that we identified as having significant representation in the North Pacific fisheries. In western Alaska, we use CDQ program region boundaries to define the regions: we pool St. Paul with the Aleutians/Pribilofs, and Yukon Delta with

Coastal Villages. We also include Kodiak, Anchorage/Matsu, Cook Inlet/Prince William Sound, and Southeast as distinct regions, along with Other Alaska. Outside of Alaska, we distinguish the Seattle Metropolitan Area (King, Snohomish and Pierce counties), Other Washington, Oregon, California, and Other States.

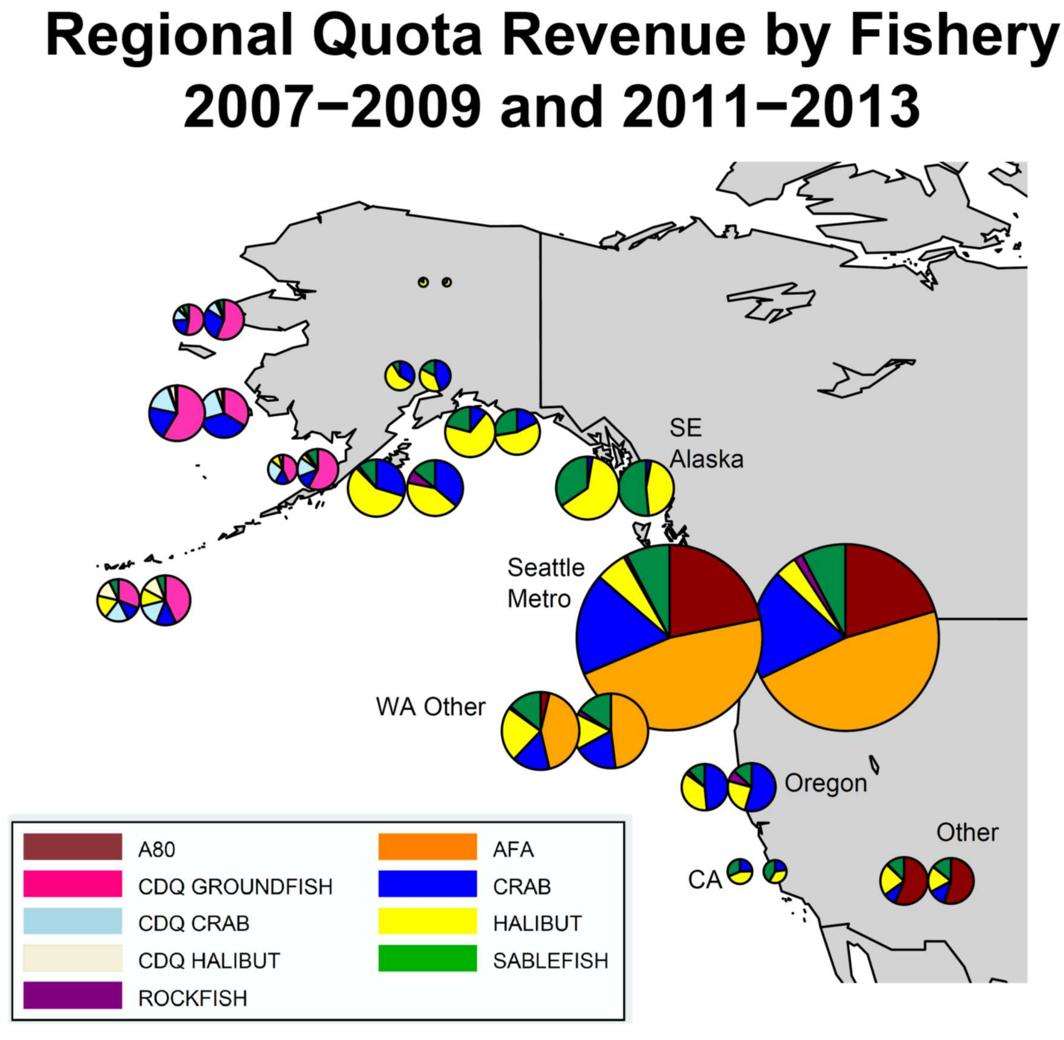

Figure 3.4: Regional distribution of real ($2013) quota revenue by fishery in 2007-2009 (left pie in each region) and 2011-2013 (right pie in each region). Pie area is proportional to share of total fishery revenue.

Figure 3.4 shows the distribution of real revenue from quota fisheries by residence of the quota owner. Within each region, the left pie chart shows the average revenue contribution from each fishery in 2007 through 2009, and the right pie reflects average revenues from 2011 through 2013; the area of the pies is proportional to the region's share of total Alaska catch share program revenue during each period. The Seattle Metropolitan Area is dominant in all years due to their ownership stake in the industrial AFA and A80 fleets. Some regions, such as Other Alaska and California, have such a small share of revenue that they are difficult to see. Between the two time periods, real revenue in most regions was stable or growing. The Coastal Villages Region Fund (CVRF) CDQ region is one exception, due to falling pollock royalties. The declining halibut TAC has also shrunk the share of Southeast and Cook Inlet/Prince William Sound, and the reduced TAC has not been compensated for with increased crab revenues as in Anchorage/MatSu and Kodiak because these regions have been much more likely to transition into the unrationalized state salmon fishery (See Figure 3.5).

The regions that increased their share the most were Bristol Bay/Peninsula, Aleutians/Pribilofs, and Norton Sound. For these CDQ regions, this is attributable to an increase in estimated CDQ groundfish revenue (and crab revenue for Norton Sound) and a smooth transition from halibut to sablefish. Across most regions, quota owners have been substituting falling halibut revenue with increased dependence on sablefish (and possibly other non-quota fisheries). Oregon and Kodiak are the only regions where the new GOA rockfish program is playing a significant role in increasing total revenues. In general, Alaska is relatively more dependent on the quota programs, such as crab and halibut, that were designed to facilitate consolidation and increase efficiency whereas the cooperative-based programs of A80 and AFA are primarily based out of Washington. Overall, the distribution of quota revenue is much more stable both within fisheries and across regions than when we examined ex-vessel revenue accruing by vessel owner city across a longer time series (Anderson, Meredith and Felthoven, 2018).

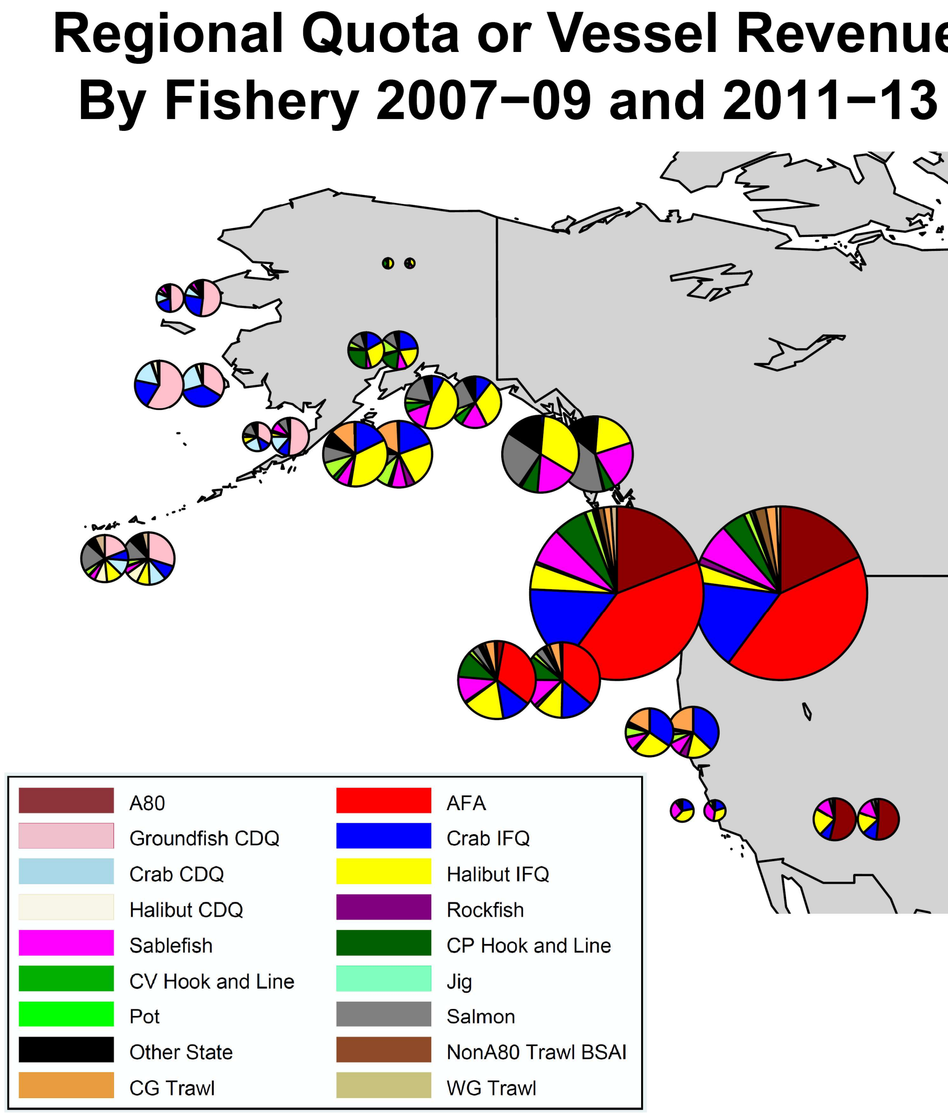

Figure 3.5: Regional distribution of real ($2013) revenue by fishery in 2007-2009 (left pie in each region) and 2011-2013 (right pie in each region). Revenue is attributed to the region of the quota holder if the fishery is rationalized and to the vessel owner if not. Pie area is proportional to share of total fishery revenue.

To estimate how regions' fishery portfolios change when non-rationalized fisheries are included, we combine data on ex-vessel revenue for non-quota fisheries with the estimated quota revenue.[7] Figure 3.5 shows how the map changes when we include all Alaskan fisheries in each region's portfolio. Ex-vessel revenue was attributed to the

[7] Revenue data for non-quota fisheries is drawn from fish landings tickets maintained by AKFIN. We used AKFIN's assignment of individual landings to harvesters within each fleet.

quota holders' city of residence for rationalized fisheries and to the vessel owner's city for non-rationalized fisheries. The largest change is that Seattle Metropolitan Area's share of the total revenue falling over time with decreases in halibut, CP hook and line and Non-A80 BSAI trawl. Southeast Alaska and Cook Inlet have been able to stabilize their revenues due to salmon harvest. The trend within the CDQ regions is similar to the trend in quota revenue alone, with most regions successfully leveraging their allocation into diversification across fisheries. Kodiak is another rural region that has shifted harvest composition, turning to rockfish and Central Gulf trawl to offset falling halibut revenue.

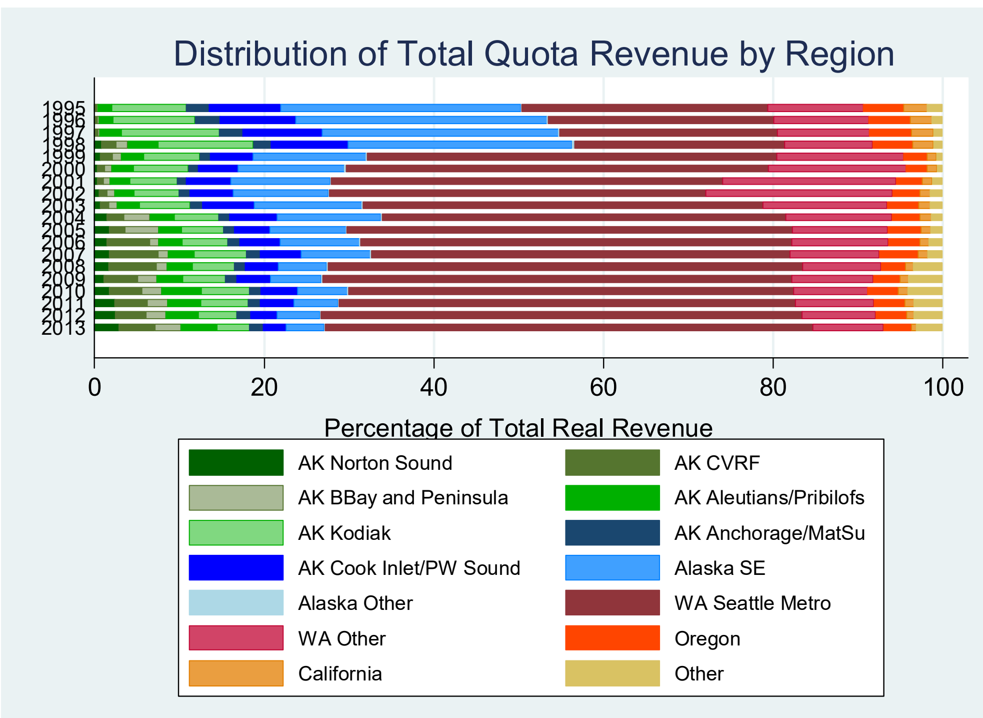

Figure 3.6: Regional distribution of total quota revenue from 1995-2013

When we examine the aggregate quota revenue across all catch share fisheries, as in Figure 3.6, we can clearly see the effects of the introduction of the new programs, especially the contribution of Seattle after AFA (1999) and A80 (2008). Trends after 2008 are relatively stable, when all rationalized fisheries are included in our data, with some rural Alaskan regions such as Norton Sound, Bristol Bay, and the Aleutians gaining share at the expense of Other Washington, Cook Inlet, and Southeast. This swing can largely be attributed to the decline in the halibut fishery and successful expansion in the BSAI crab fishery by some CDQ groups. The share of owners from outside the West Coast (Other) has doubled over our time period but this is an artifact of the late introduction of the highly industrialized fisheries into the dataset, not wealthy Alaskan quota owners retiring in the sunshine (as evidenced by the falling share of California).

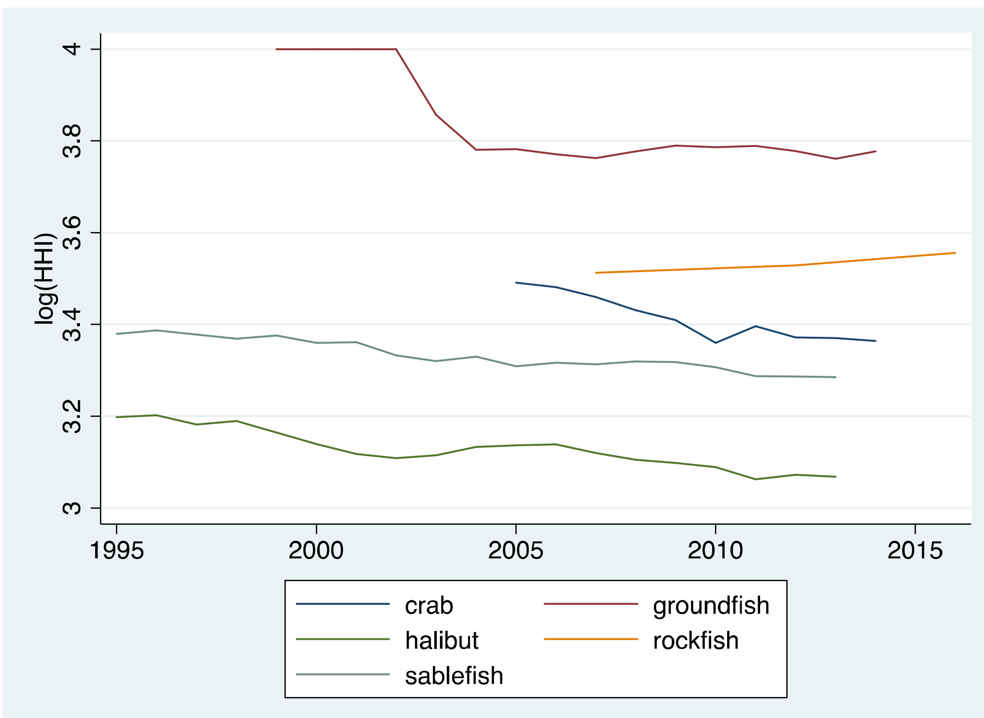

Figure 3.7: *HHI of each fishery across regions 1995-2016*

Figure 3.7 calculates the HHIs of five catch share fisheries across the 14 regions listed in Figure 3.6, depicting whether or not the revenue associated with quota share ownership in each fishery is becoming more or less concentrated within a particular region. The logHHI approaching 4.0 for groundfish reflects that it is highly concentrated within a single region, due to the prevalence of pollock and A80 ownership in the Seattle Metropolitan Area. Other fisheries are concentrated relative to the HHI scale but becoming less so as quota ownership is moving into historically underrepresented regions. For example, in the halibut fishery the disproportionate decline in the regional TAC in Southeast—previously representing over 30% of the market share—is causing its market share to fall relative to the type of quota held by owners in other regions. Sablefish exhibits a similar decline in concentration, similarly attributable to a decrease in TACs in the late 90s that affected owners in Southeast Alaska, Oregon and Washington; again, these are not due to quota movement out of these regions.

The steep decline in regional concentration of crab quota ownership is again attributable to CDQ groups actively purchasing non-CDQ quota share, and thus moving more of the ownership in this fishery into CDQ regions in greater proportion than their historical involvement in the fishery, as reflected in initial allocations. Trends in rockfish are difficult to account for, as data are only available from 2007, 2012 and 2016, and 2007 is an outlier because the rockfish program was a pilot program in which not all harvesters were participating, and thus not fully comparable.

Changes in concentration within a region could arise through a change in the number of quota holders or a change in the holdings of large quota share entities. In Figure 3.8 we examine the trend in the number of quota holders per region over time. Although the numbers are largely stable, there is an overarching theme of declining participation in the Alaskan regions within the top panel which is driven by marginal halibut operators exiting as the fishery abundance declines. Halibut is the only fishery that displays a clear downward trend in the number of owners. Nearly all Alaskan regions have lost a small number of owners, except CVRF which has had large losses and Norton Sound which has had small gains. Outside of Alaska, the number of quota holders is increasing as the AFA and Amendment 80 vessels are introduced into the dataset, but after 2008 the numbers are stable indicating that there is no ongoing change in the number of quota holders. This stability suggests that the decreasing regional concentration in halibut and crab is not driven by an increase in the number of participants and is instead the result of entities such as large regional CDQ groups buying non-CDQ quota share.

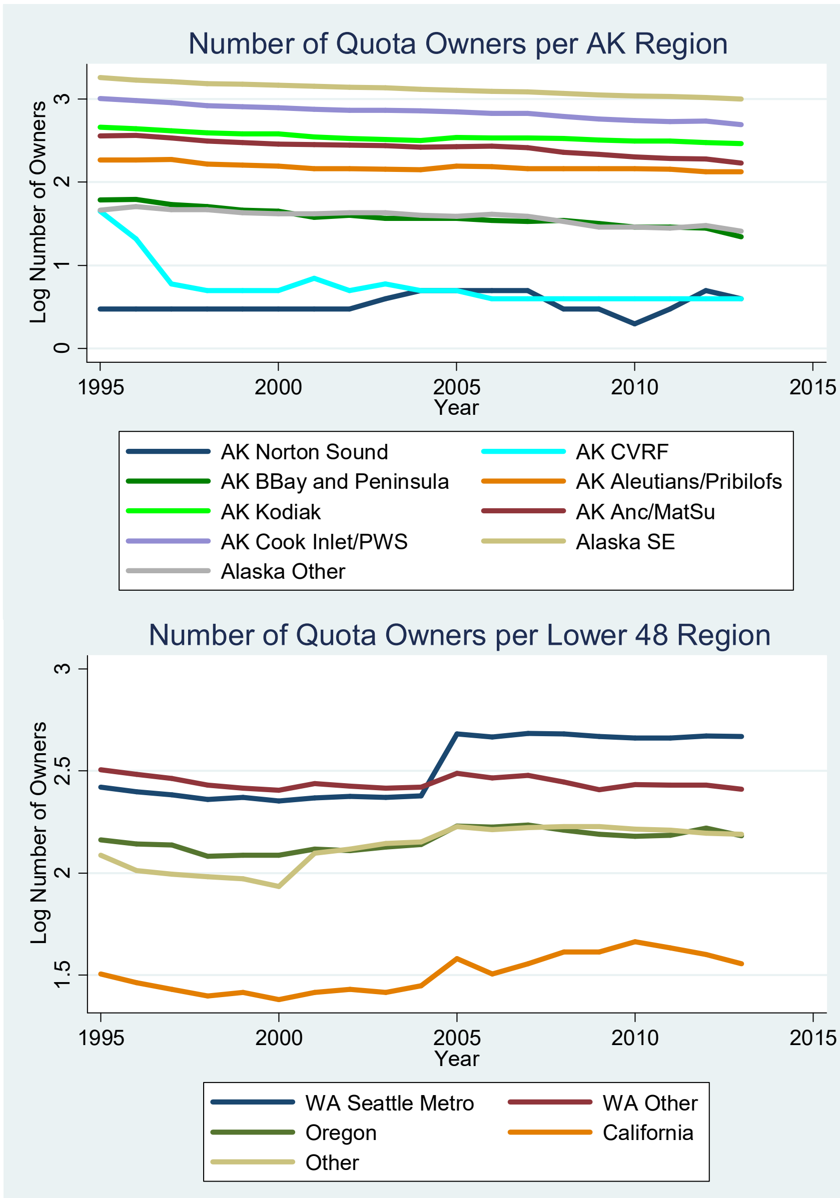

Figure 3.8: Log (base 10) of total number of quota holders in each region from 1995-2013

3.5.2 CDQ Groups Sustaining Western Alaska Ownership

As described above, the CDQ program is the major policy mechanism for sustaining participation in western Alaska. While NOAA does not have a formal database detailing CDQ ownership of the corporations that operate in the AFA and Amendment 80 fleets, we know from public testimony, personal communications, and publicly disclosed shareholder reports that CDQ groups have been active in buying both vessels and ownership shares in the companies that are active in those fleets.

For the smaller vessel fleets, we can ascribe much of the increase in the prominence of Western Alaska regions to CDQ group activity. Figures 3.9 and 3.10 highlight the CDQ groups' quota ownership, distinguishing between the CDQ groups' designated allocation of quota, and commercial quota share that they have purchased as a group, for crab and halibut, respectively.[8] If that quota share is instead held in an individual's name then it appears in the figures as an increase in individual-held quota share in western Alaska.

[8] Some CDQ groups provide programs such as brokerage and loans to help their residents purchase shares, but NOAA does not have data on this activity.

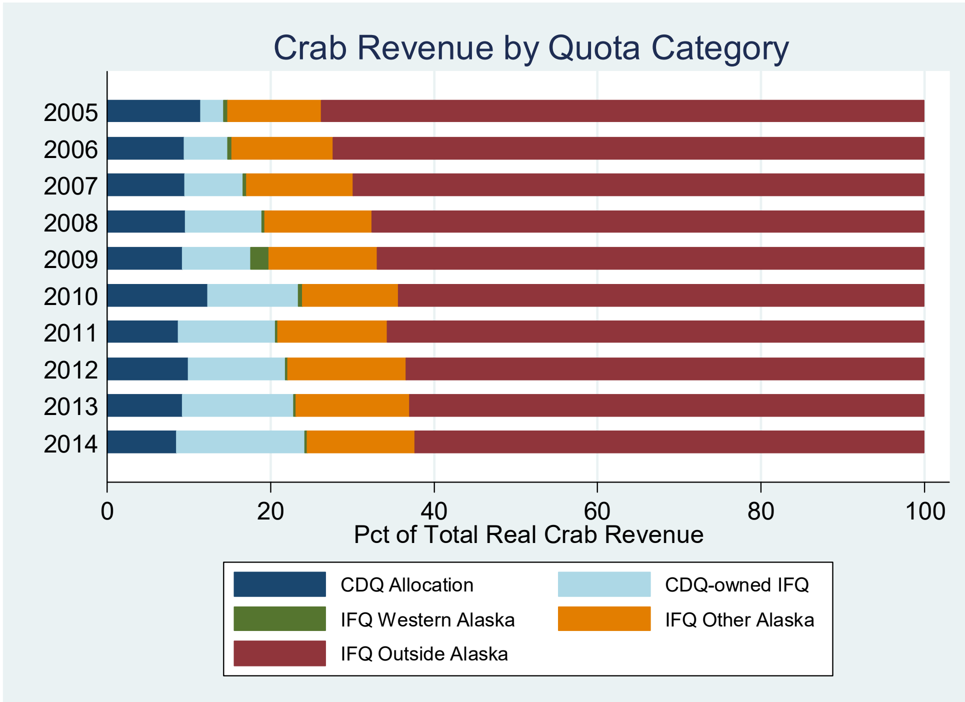

Figure 3.9: Percentage Distribution of Total Crab (IFQ and CDQ) Revenue by quota-holding entity.

Within the crab fishery, revenue from the CDQ allocation has been shrinking slightly, but the CDQ groups have been actively purchasing quota away from out-of-state entities. These purchases probably reflect an investment strategy rather than an employment diversification strategy for their own residents since the CDQ crab quota has been increasingly less likely to be fished by vessels from their region. The crab fishery is infrastructure-intensive, and it is not an easy fishery to enter, so it is unlikely that CDQ region residents would have the capital to fish this newly acquired quota (Szymkowiak and Himes-Cornell, 2018); CDQ crab is harvested overwhelmingly by Seattle and Anchorage-based vessels since 2010, though the CVRF region was significantly represented from 2003-2009. When we examine the activities of individual CDQ groups, it is evident that all six CDQ groups are nevertheless acquiring crab quota, but that the largest purchases in terms of estimated revenue volume have been by CVRF. Interestingly, CVRF is also located in the region whose revenue share has been hardest hit by falling CDQ pollock revenue, so this could be a diversification tactic to offset unsuccessful pollock harvest partnerships or unprofitable pollock years.

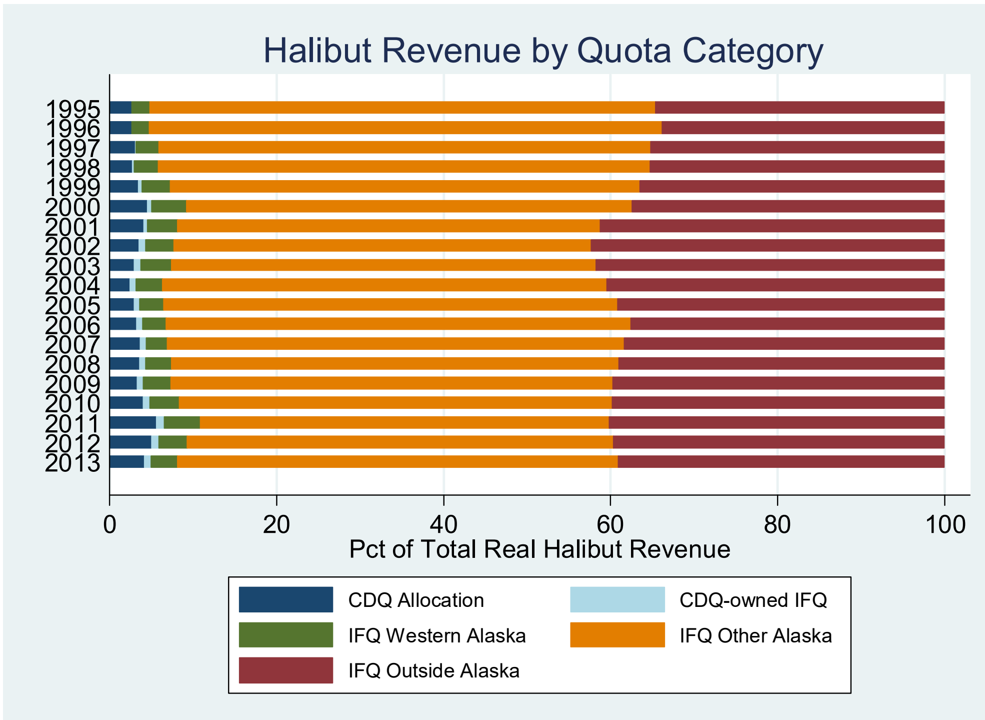

Figure 3.10: Percentage Distribution of Total Halibut (IFQ and CDQ) Revenue by quota-holding entity.

Figure 3.10 demonstrates that the strategy of CDQ groups with regards to halibut has been slightly different from crab. While their allocation has been increasing in value (probably due to biological changes in the spatial distribution of biomass driving prices up) they have not been buying additional quota to hold themselves, but the ownership within their region has increased. This suggests that CDQ groups are purchasing halibut IFQ shares for use by their residents who are much more likely to have the capital to be able to participate themselves in this fishery (Szymkowiak and Himes-Cornell, 2018).

3.5.3 Community Scale Trends

While there has not been a systematic transfer of ownership among regions, quota may nevertheless be moving out of small communities into larger towns within the same region. Limiting our investigation to the regional level could obscure movement out of the smallest (and perhaps most vulnerable) communities. To combat such oversights, we use data from the Alaska Department of Labor to determine the population of each vessel owner city and assigned them to one of six bins for analysis. For comparability within the literature, we used the bins Carothers et al. (2010) identified for small remote fishing communities.

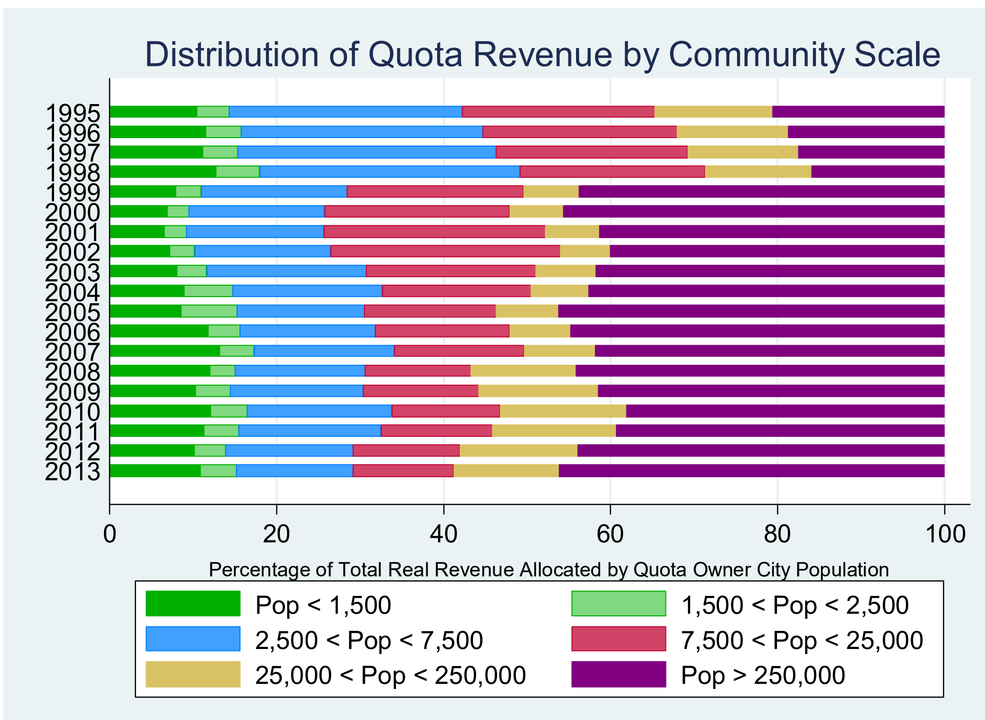

Figure 3.11: Distribution of Total Quota Revenue by community scale.

We explore whether quota revenue appears to be flowing out of small communities toward larger communities, which tend to have better access to capital and markets. Figure 3.11 demonstrates that the distribution across community scales has been largely stable since the most recent catch share program was added in 2008. Much of the variation exhibited in the largest communities (Anchorage and Seattle) is attributable to the pollock stock downturn and the increasing share of ownership held by CDQ entities. In recent years the largest revenue shifts have been away from medium size communities, which are the most likely to be experiencing falling halibut revenue. Overall, we see a trend of the large industrial cooperative fleets stabilizing revenues for large communities and CDQ groups diversifying in order to stabilize the share of the Alaskan communities with less than 2,500 residents, but the lack of similar social protection measures for the communities between 2,500 and 25,000 residents may be leaving them vulnerable to changes in the biological availability of a single species.

A related question is whether these aggregate trends are being experienced within individual communities at each size. Figure 3.12 shows the temporal distribution of the HHI across quota owners within individual fishing dependent communities of a particular size. To emphasize trends in communities that have significant fishery representation, a community is included if it had at least two quota owners in any year.

Figure 3.12: Violin density plots of the log HHI of ownership shares within individual communities at each scale; communities are represented in every year if they had two or more owners in one year

At every scale, most individual communities are highly concentrated: the median value (open circle) is above 3.5 in every year at all community scales. However, given the number of communities, movements in the density, median and lower tail are informative. Again, the picture at all community scales is one of stability: there is not a systematic shift of communities toward higher concentration, reflecting a loss of owners within those communities. Rather, the smallest communities are relatively stable, reflecting in many cases the support of the CDQ groups. The largest communities are also relatively stable, as they are home to members of the industrial fishing cooperatives. The middle-size communities, while they do not demonstrate any trends, experience considerably more volatility, perhaps because they, as a group, lack the stabilizing influence of the CDQ programs or industry-based cooperatives.

3.6 Discussion

With twenty years of experience with various catch share programs, and a range of program-specific protection measures to limit their effects on communities, the North Pacific fisheries provide an important case study on the medium-term distributional effects of catch share programs. The aggregate picture across fisheries, regions and community scales is one of stability. Individual fisheries are not consolidating into the hands of a few owners; some fisheries, such as crab and halibut, are becoming more diverse as the CDQ groups purchase IFQ shares; and the next generation of owners begins to buy into small ownership shares in the fisheries. The geographic distribution of ownership is also stable relative to the initial allocations, and there is no consistent trend toward ownership based in larger or smaller communities.

Several factors contribute to this stability. First, the largest fisheries implemented catch share programs in part to institutionalize the status quo; they were not anticipating dramatic changes in ownership. Constituted of companies headquartered in Seattle, the cooperatives which predated their fisheries' rationalization provided stability prior to catch shares and continue to do so while facing new challenges in the fishery, such as bycatch management, and product and market development.

If the cooperatives in the groundfish fisheries provide stability for the large non-Alaska communities invested in North Pacific fisheries, the small communities of Western Alaska are stabilized by the Community Development Quota program. The CDQ groups' allocations of catch share for the industrial fisheries—in which Western Alaska does not have a historic stake—represents an important source of capital for their regions. In many cases, this capital is reinvested in activities that stabilize the communities, including fisheries in which those communities do actively fish or process. CDQ groups' increasing ownership of crab IFQ, and to a lesser extent halibut IFQ, are important examples of this activity; purchase of vessels and ownership shares in companies involved in the AFA and A80 fisheries illustrate mechanisms through which small communities in western Alaska can diversify and expand into additional North Pacific fisheries through commercial markets, once adequate capital is available. However, the CDQ groups also represent extremely well capitalized buyers who have the potential to dominate the market for IFQ, with values for quota that may be supplemented by broader community objectives, and thus drive up prices and create barriers to new individual entrants.

One exception to the observed stability we note above may be the medium-sized communities that are too small to have highly diversified economies and too large or in the wrong region to have the support of a CDQ group. This describes several communities around the Gulf of Alaska, and especially Kodiak. Kodiak is often presented as a community experiencing the ill effects of catch share programs (e.g., Carothers, 2008), and it does illustrate what can happen in the absence of social protection mechanisms. Historically, Kodiak depended on halibut, crab, and Gulf of Alaska groundfish trawling. The former two programs included reduction in overcapacity in their design intent, and while quota ownership remains, there is less activity in these fisheries. Kodiak has been further affected by a reduction in processing as landings have declined. Based on these experiences, the opposition of Kodiak harvesters to implementing a catch share program for groundfish in the Gulf of Alaska is understandable; but evidence also suggests that such programs can be sustainable with sufficient social protection measures of the type that have been implemented in other programs in Alaska.

There are some important caveats to this analysis. First, this investigation is not intended to be a policy impact analysis, so we do not construct a counterfactual set of outcomes in the absence of catch shares to identify the changes in level or distribution of benefits that can be attributed to the catch share programs. Second, our data do not include the distribution of benefits before the implementation of catch share programs, and thus we cannot contrast pre-catch share distributions with post-catch share distributions with comparable data. It is possible that dramatic consolidation or redistribution occurred through the initial allocation process, and we would not observe that in our data. Third, our data are only able to link ownership to communities through the registered owner. In cases where this owner is a corporation, there may be many individual owners distributed throughout the country or the world. We know, for instance, that some CDQ groups own shares in groundfish companies, but it is not possible to associate an appropriate share of that company's revenue with the CDQ region with available information. Fourth, the reporting by the CDQ groups allows us to associate benefits of a fishery with its region, but limited reporting requirements do not allow us to explore how those benefits are distributed among residents of the region.

Finally, while we have focused on geographical distribution in this report, it is important to note that NOAA's mandate under the Magnuson-Stevens Act is to provide benefits for the nation; the Council should not have preferences for residents of Alaska, Washington or elsewhere in the United States. However, allocation issues are both politically important at the Council level, and important in ensuring compliance with National Standard 8. Therefore, understanding the changes that the communities invested in the North Pacific fisheries have undergone as catch share programs have matured, as well as the efficacy of the social protection measures implemented alongside them, is critical to crafting effective fishery policy going forward.

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Appendix A: Additional Figures and Details of Theoretical Model

Appendix A.1: Additional Figures for Chapter 1

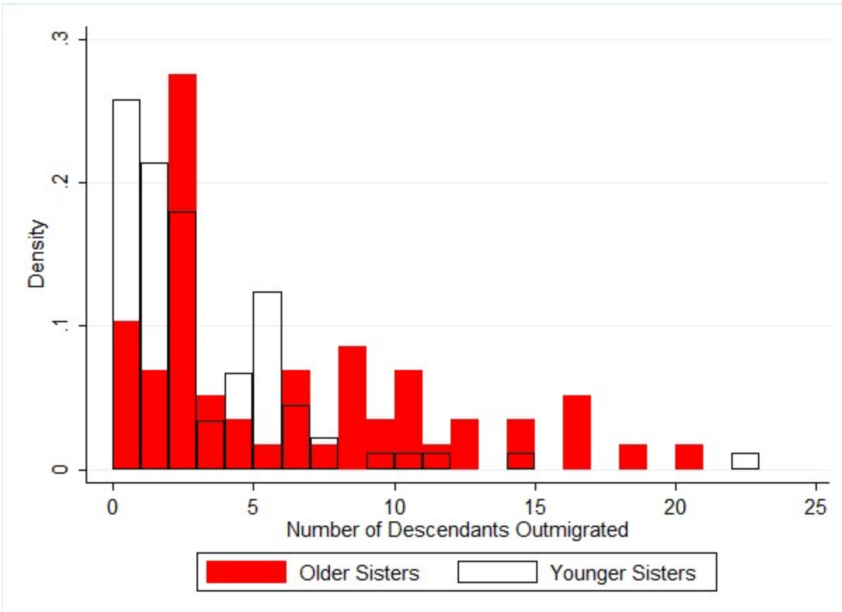

Figure A.1.1: Descendants Permanently Outmigrated by Female Age Eligibility Threshold

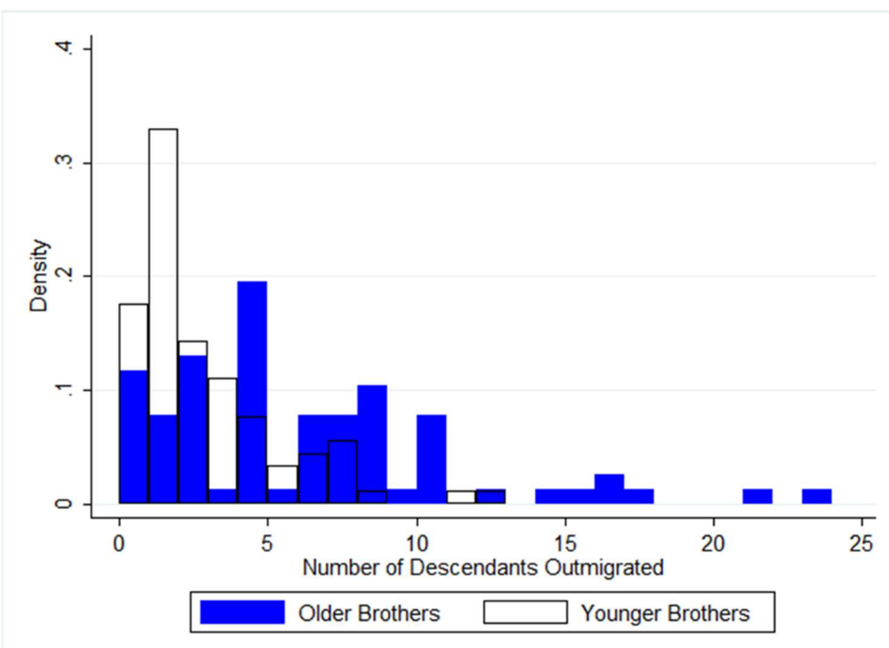

Figure A.1.2: Descendants Permanently Outmigrated by Male Age Eligibility Threshold

Appendix A.2: Details of Chapter 1 Theoretical Model

This appendix expands the setup of the theoretical model, shows how the steady-outcomes for tradeable permits were derived, and supports the main theoretical results: transferability of permits decreases the number of harvesters engaged in the rural sector and increases the bequest to descendants.

A.2.1 Harvest and Resource Dynamics

The harvest production function is given by a standard Gordon-Schaefer harvest function (Gordon, 1954; Schaefer, 1957),

$$h_t = qX_tk_t \tag{A1}$$

where h_t is individual harvest, q describes harvest efficiency which is assumed to be standardized across individuals, and k_t is the amount of harvesting capital that individuals choose to accumulate in order to exert effort. Following Noack et al. (2017), the dynamics of the resource stock X_t are described in continuous time τ to account for the difference of time scales between human generations and fish stock reproduction. Natural reproduction of the resource is given by a logistic growth function with intrinsic growth rate ρ and carrying capacity κ and once aggregate harvesting effort, assumed to be proportional to aggregate capital, $K_t(\tau) = \int_0^1 k_t(j,\tau)dj$, is subtracted off, net growth of the resource evolves according to:

$$\frac{dX_t(\tau)}{d\tau} = \rho X_t(\tau)\left(1 - \frac{X_t(\tau)}{\kappa}\right) - qX_t(\tau)K_t(\tau). \tag{A2}$$

With the assumption that the harvesting technology is linear, the rural income becomes (3). Harvesters in the fishing sector seek to maximize income by choosing a level of capital investment. If the marginal returns to capital exceed the marginal costs and $qX_t > 1$, then harvesters will always choose to invest $k_t = b_t$ when they possess a permit since the gains to investing in capital facilitate greater consumption and greater bequest in the second time period. We assume that this harvesting capital depreciates entirely after one period so that intergenerational harvesting capital dynamics are driven by wealth dynamics and occupational choices. This assumption is not unrealistic in the context of Alaska salmon where boat maintenance is difficult and capital quickly becomes obsolete.

A.2.2 Proof of Proposition 1

In an open access rural sector where harvesters invest their entire bequest into harvesting capital, Noack et al. (2017) show that individual bequest is determined largely by the resource stock according to:

$$b_{t+1}^r = \delta q b_t \int_0^1 X_t(\tau) d\tau \qquad \text{(A3)}$$

In steady state, we assume that all individuals bequeath the same amount, receive the same share of harvest, and experience a constant resource stock. This means that

$$b_*^r = \delta q b_*^r X_* \quad \text{and} \quad X_* = \frac{1}{\delta q} \qquad \text{(A4)}$$

and from the dynamics of the resource stock given in (A2), the steady state condition for the stock becomes:

$$\rho \left(1 - \frac{X_*}{\kappa}\right) = qK_t(\tau) = qn_* b_*^r \qquad \text{(A5)}$$

where $n_* \in [0,1]$ denotes the mass of resource harvesters in steady state. Total capital expenditure in this sector is determined by the optimal steady-state bequest and the number of harvesters. Rearranging yields the steady-state bequest of resource harvesters in open access:

$$b_*^r = \frac{\rho}{qn_*} \frac{\delta q \kappa - 1}{\delta q \kappa} \qquad \text{(A6)}$$

The steady-state bequest for harvesters will fall as the number of steady state harvesters increases, meaning that descendants under a management system that restricts access are unambiguously better off than under open access. In addition, (A6) demonstrates that intergenerational wealth is increasing in parental altruism δ, resource productivity ρ, and the extent of the resource κ, but harvesting efficiency q has an ambiguous impact.

The introduction of limited access regulations means that resource users are limited to investing in harvesting capital such that the maximum investment is the first-best capital stock derived in Noack et al. (2017) divided by the steady-state number of harvesters. This is equivalent to assuming policy makers have the goal of obtaining maximum sustainable yield and achieve this through capital restrictions which is similar to the way Alaska salmon is managed via vessel length restrictions, net length limits, and various other gear restrictions.

The upper limit on harvesting capital becomes

$$\bar{k} = \frac{\rho}{2qn_*}\frac{q\kappa-1}{q\kappa} \qquad \text{(A7)}$$

and the effort restriction will be binding if we assume that resource harvesters have enough inheritance to afford more than the allowable capital, $\bar{k} \leq b_*^r$, and are essentially wealthy enough to overuse the resource such that the management shift affects their behavior. In steady-state, Noack et al. (2017) show that resource users under limited access with non-transferable permits will move to the urban sector until income and bequest across both sectors is equalized. Setting $b_*^r = b_*^u$ they obtain the steady-state mass of resource harvesters that makes income in both sectors identical from

$$\frac{\delta}{1-\delta}(\alpha - \beta) = \frac{\delta}{1-\delta}\frac{\rho\kappa}{4n_*}\left(\frac{q\kappa-1}{q\kappa}\right)^2 \qquad \text{(A8)}$$

and rearranging yields n_{NT}^* as given in (6). When permits are transferable and we assume that there is an exogenous and constant permit price φ that can become part of urban or rural bequest, the equalization of incomes across sectors yields

$$\frac{\delta}{1-\delta}(\alpha + \varphi - \beta) = \frac{\delta}{1-\delta}\frac{\rho\kappa}{4n_*}\left(\frac{q\kappa-1}{q\kappa}\right)^2 + \delta\varphi \qquad \text{(A9)}$$

and rearranging yields n_T^* as given in (7).

A.2.3 Proof of Proposition 2

Given the preferences described in the utility function (1), offspring inherit a constant fraction of income, δ, such that $b_{t+1} = \delta y_{t+1}$ and in the urban sector individual wealth dynamics are given by

$$b_{t+1}^{u} = \delta(\alpha - \beta + b_{t}^{u}) \tag{A3}$$

and in steady state when $b_{*}^{u} \equiv b_{t+1}^{u} = b_{t}^{u}$, the bequest given to offspring whose parents choose the urban sector is

$$b_{*}^{u} = \frac{\delta}{1-\delta}(\alpha - \beta). \tag{A4}$$

Since we assume that individuals choosing the urban sector must liquidate their asset right, the introduction of tradeable permits leads to a one-time transfer of φ which leads to (9).