Fish or Flight:

The Impact of Transferable Access Rights on Rural Alaskan Salmon Harvesters

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Version: November 2017

Abstract

This paper 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 an important source of potential liquidity. 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 for the construction of control groups from applicants given non-transferable permits and younger siblings of original permitholders. 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. Other impacts depend on the type of permit and the gender of the initial permitholder. Higher value drift net permits were primarily allocated to men whereas set net permits are a smaller asset that were traditionally fished by women and children. Drift net permit sales were leveraged into an immediate increase in the probability of outmigration but no long run improvements in descendant outcomes. Contrary to the intentions of the permit system, set net permit sales diminish the assets and formal employment of the original permitholder, and 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.

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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). Conversely, 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. 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). 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 and accelerate outmigration. 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. From a policy perspective, it is imperative to understand the distributional tradeoffs of limiting access 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. Household surveys were conducted in nine communities across the Bristol Bay region of Alaska and linked 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. To account for the endogeneity of permit sale, I exploit the eligibility

window at the initial allocation of salmon permits. The first generation of permitholders are compared to two control groups: members of the same village who were granted non-transferable permits and younger siblings who were ineligible for permits.

Employing this instrumental variables approach, I find that the sale of permits 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 20%. 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[2] 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 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 or secure formal employment. When lower barriers to entry in the set net fishery are considered, permit transfer makes descendants much more likely to seek alternate employment outside the community. The sale of a drift net permit does 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. 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.

This study primarily contributes to two existing strands of literature. The first is the large literature on the impact of fisheries rationalization in general and in the resource-dependent communities of Alaska in particular. Many communities in

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

Western Alaska rely on income from fishing to sustain livelihoods while local ownership in these fisheries is declining (Knapp, 2011). Carothers et al. (2010) found that 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 and a desire to diversify outside of commercial fishing (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 the labor mobility impact of reforming land rights. 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). In the presence of imperfect credit markets (Boucher et al., 2005) or cultural inheritance norms (Fernando, 2015) the probability of land tenure promoting outmigration becomes negligible. Because transferable access rights are rarely allocated in developing countries, there have been no corresponding analyses of the impact of reforming marine resource rights. These studies 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 so transferable access rights are more likely to facilitate outmigration by financing the high cost of relocation from rural to urban locations.

The results of this research will help the management regime understand local harvesters' economic decision to either participate in Alaskan fisheries or to move out

of the community into alternate employment in other locations. In addition, they will illuminate the potential economic and social impact of alternative policies designed to ensure that the fisheries generate sustainable rents for rural participants and curtail rural outmigration, such as providing credit for idiosyncratic shocks, permit subsidies, and improved access to education and training. While the focus of this work is on the residents of small rural Alaskan communities, the model developed is applicable to a range of fisheries and will generate insight into the social impact of property rights more broadly.

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 liquidity constrained individual with a transferable access right. 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.

2 Background

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.

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 instruments 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 Appendix A). 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[3]. Absentee ownership is discouraged by a provision requiring the permitholder to be present when landings are delivered to the post-harvest sector.

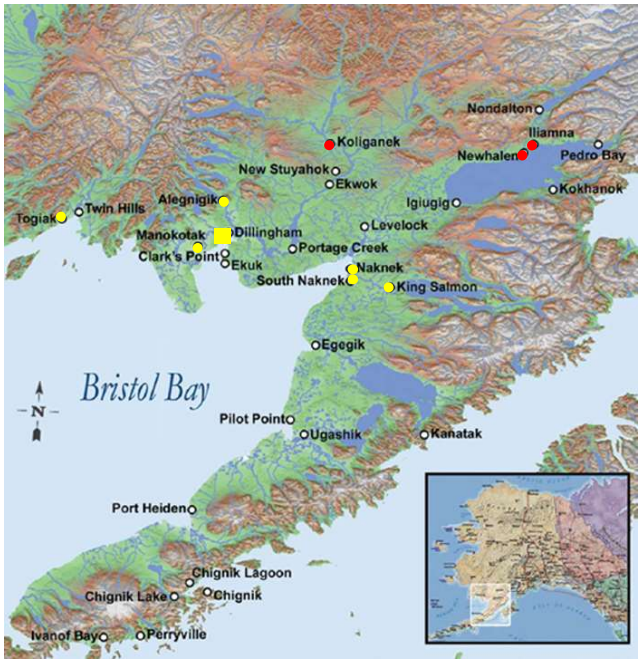
A unique community protection measure within Alaskan commercial fisheries is the Western Alaska Community Development Quota (CDQ) Program. The explicit goal of this program is to alleviate poverty and vulnerability in rural, economically depressed, and predominantly Alaska Native communities. Beginning 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[4]. Each CDQ group received a portion of the total allowable catch and as 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). Future work will analyze whether these

[3] 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.

[4] The boundaries were drawn 25 nautical miles from the coast.

interventions have been able to effectively curtail rural permit sales and increase the efficiency of local harvesting operations.

Figure 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

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 presents summary statistics within the communities surveyed. 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.

Table 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.

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.

3 Theoretical Model

3.1 Incorporating the Commercial Fishery into a Model of Rural to Urban Migration

This research will build 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, our extension of the model to incorporate resource-dependent communities reliant upon fisheries for income will have 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. (2015) 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 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 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:

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

In accordance with Galor and Zeira (1993), individuals who migrate to the urban sector will earn positive α which is greater than the investment β necessary to work in this sector. In the context of rural Alaska, this investment is likely to represent the

necessary social network, human capital, and financial assets required to adapt to urban life. Income in the urban sector becomes:

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

In the traditional sector, returns are nonrival and independent of aggregate effort, but depend on individual investment in sector-specific capital k_t (this represents vessels and gear), and exogenous variation in resource abundance θ_t. Traditional sector participants must also possess an access right A_t which can be inherited or purchased for price p. 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 depends largely on the transferability of access rights:

$$y_{t+1}^{r} = k_t\theta_t - k_t + b_t \qquad \text{if} \qquad A_t{=}1 \tag{3}$$

$$y_{t+1}^{r} = b_t \qquad \text{if} \qquad A_t{=}0$$

Sale of the access right will result in a one period infusion of p that can be consumed in the current period or used to invest in β. The assumption that $\alpha \geq p \geq \beta$ means that individuals have an incentive and ability to migrate. The tension results from the fact that p can also become part of a bequest and that sale of the asset may result in permanent inability of descendants to enter the fishery.

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 is not obvious because it depends on individuals' preferences 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 if the negative impact on rural wages is sufficiently high or if the revenue is used to overcome moving costs. Conversely, permit sale could make outmigration less likely if the revenue is

spent on 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 business opportunities outside of fishing, then their children are more likely to leave the rural community. Finally, the impact of permit sale could be zero for individuals whose preferences make rural utility sufficiently high or urban utility sufficiently low.

4 Survey Data and Fieldwork

From February to June of 2016 household surveys were conducted in the nine communities presented in Table 1. The following section describes how villages and individuals were selected and incentivized to participate in the study and describes the resulting dataset.

4.1 Sampling

4.1.1 Village Selection

The local CDQ group, Bristol Bay Economic Development Corporation (BBEDC) was a helpful partner in preliminary qualitative research. 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 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.

4.1.2 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 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 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. Younger sibling is defined as being born by an imposed age eligibility instrument wherein being less than 18 in 1975 made individuals significantly less likely to be allocated a permit (See Figure 2).

Figure 2: Number of Set and Drift Permits Allocated by 1975 Age and Gender

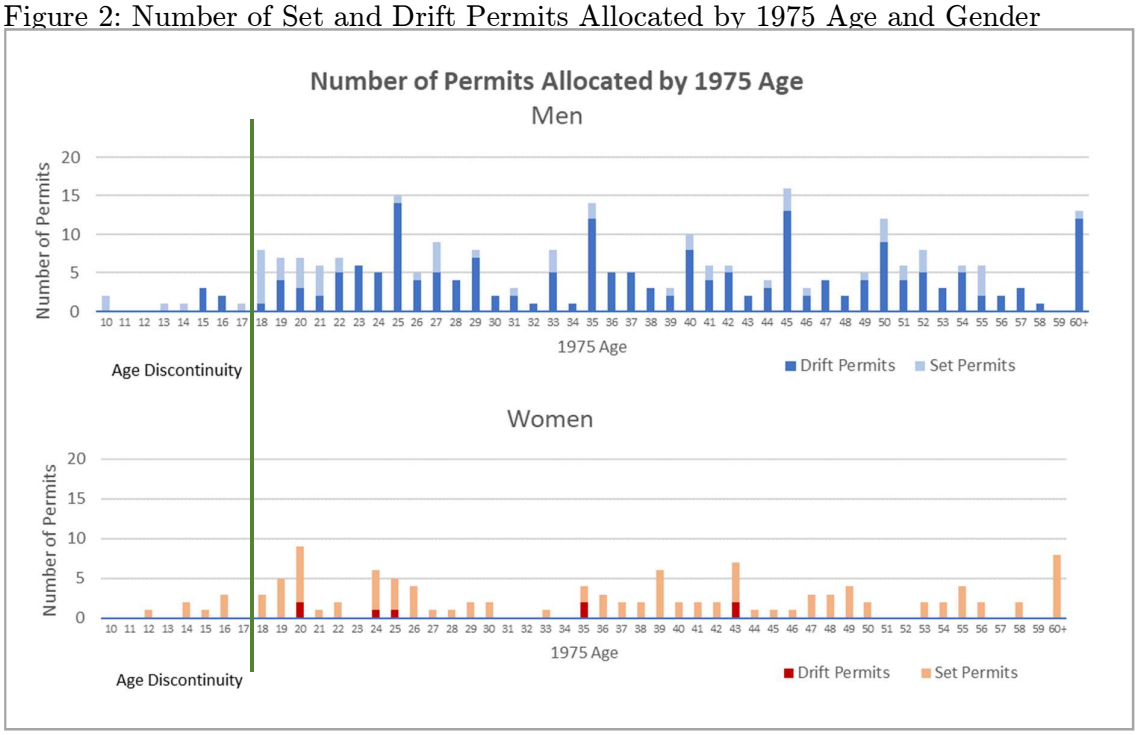


Figure 2 demonstrates that 1975 age and gender largely determined the allocation of permits. The requirement that participants prove fishery participation between 1969 and 1972 meant that only a small number of individuals younger than 18 were allocated a permit. The exogeneity of this regulation allows 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.

Table 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 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 62% of 1975 permits matched*
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)*	
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 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.

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.

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, an instrumental variables estimator that uses village fixed effects to compare the owners of transferable and non-transferable permits, and an alternate instrumental variables estimator 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.

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, and within the sample only include individuals whose family had a record of fishery participation. 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 IV estimates will be a lower bound. The endogeneity of permit sale is addressed by using two different instrumental variables. The first relies on the presence of NT permits and instruments for permit sale 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. The second instrument 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:

$$Outcome_{ihv} = \theta PermitSale_i + X_i + Village_v + Household_h + u_{ihv} \quad (5.1)$$

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. $Village_v$ is a time-invariant village fixed effect and $Household_h$ is a household fixed effect to control for unobserved differences in household characteristics. In the above specification, θ is the primary coefficient of interest, however there is likely to be co-determination of dependent variables and permit sale, rendering θ biased even if the sample is reduced to only permitholders of the same type.

To overcome the endogeneity issues with equation (5.1), I implement an instrumental variables approach and exploit the control groups of non-transferable permit holders and younger siblings. Instrumenting for permit sale using the possibility of permit transfer transforms equation (5.1) into:

$$Outcome_{ihv} = \theta Transferable_i + X_i + PermitType_i + Village_v + u_{ihv} \quad (5.2)$$

The inclusion of $Permit_i$ reduces the sample to permitholders who all received the same type of permit and makes the comparison group NT permitholders. Replacement of permit sale with a dummy variable equal to one if permits are transferable, means that θ is now a lower-bound estimate of the intent to treat and an unbiased predictor of the impact of permit transferability. First stage regressions suggest that permit transferability increases the probability of permit sale by 40%.

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:

$$Outcome_{ihv} = \theta 1975Age \geq 18_i + X_i + Household_h + u_{ihv} \quad (5.3)$$

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 corresponding permit sale. Because households are all 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 sibling pairs are no more than 15 years apart.

First stage regressions in Table 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 the instrument 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 of rural Alaska allow estimates to maintain robustness even with this modification.

While 40% of younger siblings also own permits (see Table 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 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%

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.

6.1 Outmigration

As discussed in the theoretical model in Section 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 4 shows the estimates of key coefficients from equations (5.1) - (5.3) with a dummy variable equal to one for first generation permanent outmigration as the dependent variable. Specification tests showed that the data was best fit by a logit model. Columns (2) and (3) indicate that regardless of whether permitholders are compared to those holding NT permits or younger siblings there is a strong impact of permit sale on the probability of outmigration for those who sell drift permits. Conversely, columns (5) and (6) indicate that the impact of selling a set 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 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 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. 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 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***
Control Group	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	0.606 (0.476)			0.146 (0.506)		
Permit Passed to Descendant	-0.070 (0.488)			-0.240 (0.494)		
Permit Transferable *(Instrument)*		1.173* (0.787)			0.614 (0.527)	
18+ Male in 1975 *(Instrument)*			0.972** (0.442)			
18+ Female in 1975 *(Instrument)*						1.664 (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 R^2	306 0.212	332 0.204	259 0.204	273 0.278	310 0.192	172 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 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 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 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).

Table 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*
Control Group	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	0.002			0.390**		
	(0.149)			(0.184)		
Permit Passed to Descendant	-0.108			-0.041		
	(0.157)			(0.218)		
Permit Transferable *(Instrument)*		0.744***			0.319**	
		(0.207)			(0.135)	
18+ Male in 1975 *(Instrument)*			0.348**			
			(0.149)			
18+ Female in 1975 *(Instrument)*						0.361**
						(0.148)
Married	-0.654***	-0.683***	-0.363	-0.154	-0.242	-0.299
	(0.339)	(0.122)	(0.266)	(0.184)	(0.186)	(0.194)
Years of Education	0.012	0.016	0.090***	0039	0.013	0.094***
	(0.018)	(0.011)	(0.032)	(0.024)	(0.017)	(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%

Columns (2) and (3) of Table 5 indicate that drift permit sales cause a net outflow of descendants. 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. In the case of set permits, columns (5) and (6) show

that the eventual impact of set permit sale is an increase in descendant outmigration. These initial results suggest that women who were allocated set 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.

6.2 Employment and Fishery Participation

As discussed in the theoretical model in Section 3, the impact of transferable permits on fishery participation and employment outside the fishery should be relatively unambiguous. Permitholders who liquidate their access right should be much more likely to participate in formal employment in the urban sector since once the possibility of harvest within the rural traditional sector is restricted. Table 4 shows the estimates of key coefficients from equations (5.1) - (5.3) with a dummy variable equal to one for first generation permanent formal employment as the dependent variable. Specification tests showed that the data was best fit by a logit model. 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. 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. Columns (5) and (6) indicate that set permit sales make the first generation of permitholders significantly less likely to be involved in formal employment. This could be due to poverty trap dynamic or debt constraint wherein permits are sold under duress and the resulting proceeds are used to pay off debts (an anecdote reported frequently in our surveys) or invested in

rural amenities that do not increase labor market participation but instead render it unnecessary.

Table 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*
Control Group	Unsold Permits	NT Permits	Younger Siblings	Unsold Permits	NT Permits	Younger Siblings
Permit Sold	0.189			-0.189		
	(0.439)			(0.475)		
Permit Passed to Descendant	-0.171			-0.307		
	(0.4592)			(0.483)		
Permit Transferable *(Instrument)*		0.666			-0.500	
		(1.099)			(0.534)	
18+ Male in 1975 *(Instrument)*			0.419			
			(0.449)			
18+ Female in 1975 *(Instrument)*						-1.517**
						(0.292)
Married	-0.365	-0.276	0.520	0.776*	0.940**	0.690
	(0.542)	(0.496)	(0.491)	(0.469)	(0.417)	(0.863)
Years of Education	0.120**	0.123**	0.567***	0.305***	0.292***	0.898**
	(0.053)	(0.058)	(0.161)	(0.082)	(0.070)	(0.356)
Number of Children	-0.022	-0.021	-0.034	-0.122	-0.085	-0.006
	(0.089)	(0.048)	(0.138)	(0.095)	(0.076)	(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%

Even if permit sale does not increase the probability of first generation formal employment, reduced rural incomes may still drive descendants to seek employment outside the fishery. Table 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.

Table 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				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variable	**Poisson** ***Men***	**Poisson** ***Men***	**Poisson** ***Men***	**Poisson** ***Men***	**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*
(Permit Sale Instrument)	(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				
	(6)	**(7)**	**(8)**	**(9)**	**(10)**
Variable	**Poisson** ***Women***	**Poisson** ***Women***	**Poisson** ***Women***	**Poisson** ***Women***	**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*
(Permit Sale Instrument)	(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 probability of drift gillnet fishing and a 30% reduction in the probability of set gillnet fishing. This impact is small relative to the predictions of our model which did not account for the possibility that descendants could be employed as crew. The increase in descendant outmigration corresponds to a reduction in subsistence fishing. While some respondents who had relocated outside of the village

indicated that they return to the village to fish every summer this is much less likely without the potential for employment in a family commercial fishing enterprise.

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 differential impact could come through two channels. Women selling permits could 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. 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.

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 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 increase in durable assets (Columns 2 & 3) while set permit sales correspond to a 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 be formally employed, but it appears that they may be substituting away from rural assets towards investment in less tangible productive assets that make their descendants more employable outside the village.

Table 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			0.067		
	(0.320)			(0.358)		
Permit Passed to Descendant	-0.290			0.279		
	(0.292)			(0.547)		
Permit Transferable *(Instrument)*		0.382*			-0.721***	
		(0.214)			(0.233)	
18+ Male in 1975 *(Instrument)*			0.502***			
			(0.162)			
18+ Female in 1975 *(Instrument)*						-0.492*
						(0.292)
Married	-0.306	-0.324	0.553**	1.093***	1.088***	0.404*
	(0.339)	(0.305)	(0.218)	(0.302)	(0.234)	(0.258)
Years of Education	0.002	0.017	-0.032	0.111***	0.104***	0.164*
	(0.033)	(0.058)	(0.032)	(0.039)	(0.033)	(0.091)
Number of Children	-0.010	-0.015	-0.002	0.091**	0.066*	0.043
	(0.068)	(0.061)	(0.053)	(0.045)	(0.038)	(0.077)
Fixed Effects	Village	Village	Family	Village	Village	Family
Observations	306	332	259	273	310	172
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%

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.

7 Discussion and Conclusion

This paper uses the collection of 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 exogenous instruments: 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 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.

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 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. Future research using this dataset will highlight the drivers of permit sale and examine 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. 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 separate 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. 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.

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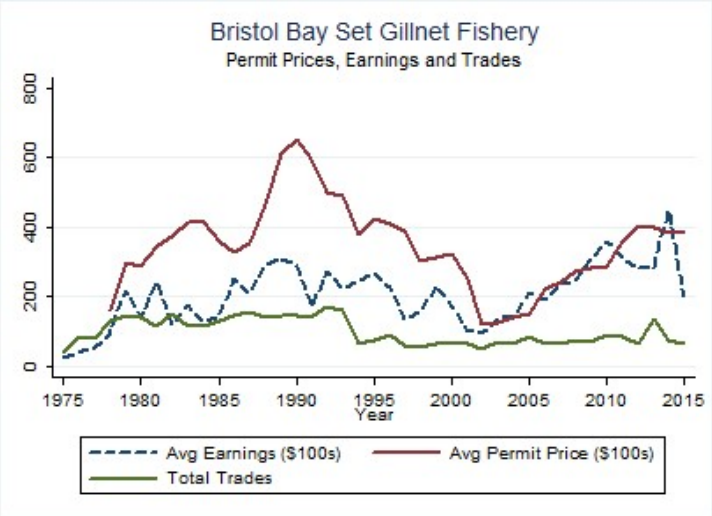
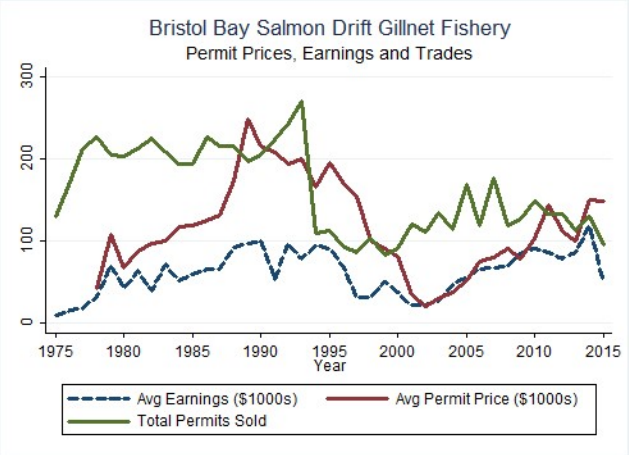
Appendix A: Additional Figures

Figure A1: Bristol Bay set net permit prices, average earnings and the volume of trades



Data Source: CFEC database, 2015

Figure A2: Bristol Bay drift net permit prices, average earnings and the volume of trades



Source: CFEC database, 2015