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Fishery Revenue Shocks and Permit Migration in Alaska Salmon Fisheries

By

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THESIS

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Abstract

Rights-based fishery management is designed to improve biological and economic outcomes by limiting access to fisheries and reducing incentives for overfishing. However, it can also create concerns for coastal communities if locally owned permits leave the community. Existing literature has focused mainly on permit transfers, where permits are sold from local to non-local owners. Less attention has been given to permit migration, where permit holders retain their permits but move away from their original communities. This research examines potential economic drivers of permit migration in Alaska salmon fisheries by analyzing how fishery revenue shocks are associated with the number of out-migrating permit holders. Using fishing-related data from the Commercial Fisheries Entry Commission and community-level socioeconomic data from the Alaska Local and Regional Information database from 2000 to 2015, this study constructs a community-year panel of permit migration, local and non-local fishery revenues, discrete revenue shocks, and economic controls. The empirical analysis uses a Poisson Pseudo Maximum Likelihood model to account for the count nature of the dependent variable and the large number of zero observations. The results show that increased local and non-local fishery revenues are associated with lower permit migration. However, contemporaneous positive and negative fishery revenue shocks do not have statistically significant effects. The main finding is that cumulative local negative shocks have a positive and statistically significant association with permit migration. One additional cumulative local negative shock is associated with an approximately 11.3% increase in the expected number of out-migrating permit holders. These results suggest that permit holders are more responsive to repeated negative shocks in local fisheries than to contemporaneous one-year shocks. In terms of the theoretical framework, the findings are more consistent with a survival narrative, in which accumulated negative local fishery conditions make remaining in the origin community less economically viable.

1 Introduction

The exploitation of ocean resources has raised concerns for centuries, and several fisheries worldwide have experienced the consequences of overfishing (Jackson et al. 2001; Hilborn et al. 2003). To prevent further unsustainable harvesting, rights-based fishery management was introduced as one approach to limit access to fisheries and reduce incentives for the “race for fish.” Although management designs vary across fisheries, rights-based systems are generally intended to reduce overcapitalization, improve economic efficiency, and support sustainable harvesting by assigning secure fishing rights (Hilborn, Parrish, and Little 2005). However, rights-based fishery management has also been criticized for its potential negative impacts on local economies (McCay 2004; Lowe and Carothers 2008) and on the sociocultural foundations of coastal communities (McCay 1995; Young et al. 2018). One central concern is that transferable fishing rights may lead to a decline in local permit ownership, reducing the economic and cultural connections between fisheries and the communities historically tied to them.

In Alaska, concerns about declining local permit ownership first appeared through permit transfers after the implementation of the Limited Entry Act. In a permit transfer, a permit owner in a local community sells or transfers the permit to a non-local owner. This phenomenon has received substantial academic attention, especially regarding its impacts on coastal communities and local fishing economies (Knapp 2011; Carothers, Lew, and Sepez 2010; Himes-Cornell and Hoelting 2015). However, local permit ownership can also decline through permit migration. In this case, permit holders retain their permits but move away from their original communities. Although permit migration has become an important mechanism of permit loss in Alaska communities, it has received much less attention than permit transfer. This gap motivates the present study.

Alaska salmon fisheries provide an important setting for examining permit migration. Alaska salmon fisheries experienced overfishing and economic instability before the adoption of limited-entry management (Gorelick 1973). The Limited Entry Act was implemented in 1974 to prevent further exploitation of fish stocks and to stabilize the fishery. Because local permit ownership can support local economic activity (Watson et al. 2021) and help fishers manage risk through diversified fishing

portfolios (Knapp, Suresh, and Reimer 2014; Cline, Schindler, and Hilborn 2017), the program was intended to support both biological sustainability and economic stability. However, the number of locally owned permits has declined through both transfers and migration. While the consequences of local permit loss have been discussed, the economic conditions associated with permit migration remain less well understood.

This research examines potential economic drivers of permit migration in Alaska salmon fisheries. The primary focus is to analyze how fishery income, the locality of income sources, and the accumulation of income shocks are associated with permit holders' migration decisions. This focus is motivated by the broader migration literature, which shows that income conditions can shape migration decisions. Changes in earnings, home income, and remittances may affect whether individuals or households move from one place to another (Ghimire and Kapri 2023; Grigoryan and Khachatryan 2022; Piracha and Amrita 2015). In addition, repeated exposure to shocks may affect migration differently from isolated one-year shocks (Di Falco et al. 2024). Applying these insights to Alaska salmon fisheries, this study asks whether fishery revenue shocks, and especially repeated local negative shocks, are associated with permit migration. To answer this question, this study uses fishing-related information from the Commercial Fisheries Entry Commission and community-level socioeconomic data from the Alaska Local and Regional Information database from 2000 to 2015. Using unique permit and fisher identifiers, permit migration is distinguished from permit transfer and aggregated to the community-year level. These migration counts are then combined with fishery and non-fishery information, including local and non-local fishery revenues and positive, negative, contemporaneous, and cumulative discrete fishery revenue shocks. The analysis using the Poisson Pseudo Maximum Likelihood model finds three main patterns.

First, higher local and non-local fishery revenues are associated with lower permit migration, suggesting that stronger fishery income can help retain permit holders in their communities. Second, contemporaneous fishery revenue shocks do not have statistically significant effects on permit migration, indicating that one-year shocks may not be sufficient to affect migration decisions systematically. Third, cumulative local negative shocks have a positive and statistically significant association with permit migration. This result implies that repeated adverse shocks in local fisheries

may weaken the economic basis for remaining in the origin community and increase the likelihood that permit holders migrate with their permits. The discussion interprets these findings through the conceptual framework and argues that the results are more consistent with a survival narrative than an investment narrative in the context of fishery revenue shocks. In particular, permit migration appears to respond more strongly to accumulated economic pressure in local fisheries than to temporary income fluctuations or positive fishery income shocks.

This research contributes to the existing literature in several ways. First, it adds to the literature on rights-based fishery management and the policy consequences of Individual Transferable Quotas (ITQs) by focusing on permit migration as a distinct outcome from permit transfer. Much of the discussion surrounding ITQs has examined whether rights-based systems improve economic efficiency, reduce overfishing, or lead to the consolidation and transfer of fishing rights. However, less attention has been given to cases in which permit holders retain their fishing rights but relocate away from their original communities. By examining permit migration separately from permit transfer, this study provides a more nuanced understanding of how fishing rights become spatially disconnected from local communities.

Second, this research contributes to understanding the potential drivers of permit migration in Alaska salmon fisheries. By analyzing what economic conditions are associated with local permit holders leaving their communities, the study highlights permit migration as an important but relatively unexamined phenomenon. This perspective is particularly relevant for evaluating the broader community-level implications of rights-based fishery management. Even when permits are not formally transferred out of a community, the migration of permit holders may still reshape the local distribution of fishing income and the cultural connection between fisheries and communities that have historically depended on them. Therefore, examining permit migration can help clarify one pathway through which fishery management systems may generate asymmetric local impacts.

Finally, this research contributes to the literature by distinguishing between contemporaneous and cumulative income shocks. Migration decisions may respond not only to current economic conditions but also to income patterns experienced over time. A temporary decline in local fishery

revenue may not have the same effect as repeated or persistent revenue shocks, and cumulative income changes may influence fishers' expectations about the long-term viability of remaining in a community. By separately analyzing contemporaneous and cumulative fishery revenue shocks, this study explores how short-term and longer-term economic pressures may affect permit migration differently.

2 Background and Literature Review

Overfishing is considered one of the earliest major human disturbances in coastal marine ecosystems, and marine exploitation had already reshaped coastal environments long before modern ecological studies documented these changes through archaeological, historical, and ecological evidence (Jackson et al. 2001). Hilborn et al. (2003) also emphasize that the consequences of overfishing became especially salient as harvesting pressure expanded in the twentieth century. Fishery collapses occurred both globally and within the United States, including herbivorous reef fishes in the Caribbean, the Newfoundland cod fishery, and sheephead, spiny lobsters, and abalone in southern California (Jackson et al. 2001; Hilborn et al. 2003). Growing concern about marine resource exploitation motivated the adoption of rights-based fishery management. Rights-based systems are applied through different mechanisms, but they generally aim to reduce the “race to fish” and increase the efficiency of fishing by shifting incentives away from speed and toward productivity (Hilborn, Parrish, and Little 2005). One commonly adopted mechanism is the individual transferable quota (ITQ), which can promote sustainable fishing outcomes by reducing the probability of overfishing (Oostdijk and Carpenter 2022). Alaska’s limited-entry permit system for salmon fisheries reflects this broader movement toward rights-based management.

Alaska’s salmon fisheries suffered from decades of excessive exploitation under weak or ineffective management, especially after the expansion of commercial fishing in the 1880s (Gorelick 1973). From the perspective of sustainable stock management, the Limited Entry Act was introduced to Alaska salmon fisheries in 1974. The program limits entry to commercial salmon fisheries, and permits are exclusive and transferable. Local fishery communities play a significant role in the Alaska economy,

and the sustainable management of fish stocks is closely connected to the economic sustainability of these communities. Watson et al. (2021) show the spillover benefits of local permit ownership by examining the impact of local fishing activities on local economic outcomes in Alaska. Knapp, Suresh, and Reimer (2014) and Cline, Schindler, and Hilborn (2017) emphasize the importance of local permit ownership through analyses of diversified fishing portfolios and risk management. Thus, the program was intended to support both sustainable fisheries and local economic stability.

However, limited-entry and rights-based systems have also raised social, cultural, and economic concerns. There is an ongoing debate about whether permit programs can simultaneously foster sustainable resource allocation and sustainable development in local communities. Family- and community-based fisheries can be especially vulnerable to rights-based fishery management when rules are applied uniformly across fishers and communities. Large-scale management may also contribute to the loss of knowledge and culture in traditional fishing communities and families by weakening local control over access rights (McCay 1995; Young et al. 2018). In addition to sociocultural concerns, the deterioration of local economies is a major criticism of rights-based management. Although ITQs and related systems may allocate fish stocks more efficiently, they may not allocate profits equitably. Fishing rights may become concentrated among a few individuals or firms, resulting in fewer opportunities for employment and fishery participation in local coastal communities (McCay 2004; Lowe and Carothers 2008). Local fishers themselves also hold mixed views: according to one survey (Carothers (2013)), some fishers expressed concerns about limitations imposed by the permit system, while others viewed the system as a positive change.

As expected, transfers of permits from local communities to non-local communities occurred in Alaska after the permit program was implemented. Knapp (2011) shows the decline in local ownership of permits for Kotzebue gillnet, Alaska Peninsula purse seine, Alaska Peninsula drift gillnet, and Bristol Bay drift gillnet fisheries. Halibut ITQs in small remote fishing communities and indigenous communities also had a higher likelihood of loss in local ownership based on data between 1995 and 1999 (Carothers, Lew, and Sepez 2010). Interviews with people involved in Bristol Bay fisheries show that the sale of permits from local to non-local fishers weakened economic and cultural connections to local communities (Apgar-Kurtz 2015). Selling one's permit can also weaken

ties to fishing communities, potentially contributing to emigration and population decline in coastal communities in Alaska (Himes-Cornell and Hoelting 2015).

However, over the past 20 to 30 years, permit migration has become increasingly important relative to permit transfer. According to Alaska Commercial Fisheries Entry Commission (2023), permit migration has accounted for 62% of the outflow of permits from local communities in Alaska, while permit transfer has accounted for only 4% since 1975. Figure 1 shows the cumulative net change in permits from 1975 to 2015. For about 20 years after the implementation of the Limited Entry Act, permit transfers accounted for most of the loss of ownership in local communities in Alaska. However, permit migration became more prevalent around 1995, and the trend grew over time.

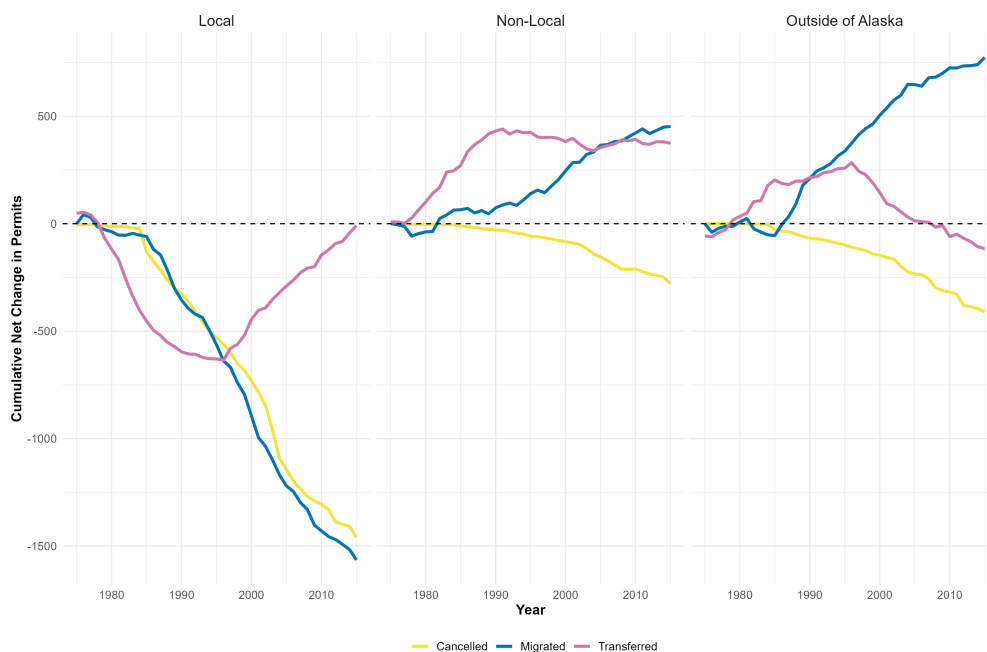


Figure 1: Cumulative net change in permits from 1975 to 2015. The definition of local and non-local communities is based on the salmon regulatory areas by the Alaska Department of Fish and Game. The data and definition were sourced from CFEC (2023).

Donkersloot et al. (2020) also show the decline in local permit ownership through permit migration in Bristol Bay from 1975 to 2017. During this period, Bristol Bay communities experienced about twice as many losses of locally owned permits through permit migration as through permit transfer. Despite the documentation of permit migration, its analysis and discussion remain limited, and its

economic drivers are not yet well understood. Most of the literature focuses on permit transfer and emigration rather than permit migration, where people move out of their local community while retaining their permits. Only a few studies, such as Gho (2020) and Meredith (2023), have attempted to explain permit migration directly. Understanding this phenomenon is important for evaluating the future of Alaska salmon fisheries and the community-level consequences of limited-entry permit programs, because permit migration may change the spatial distribution of fishing income and local participation even when permits are not formally transferred to new owners.

The migration literature has demonstrated the crucial role of income and repeated shocks in shaping migration patterns. First, remittances may accelerate migration. Grigoryan and Khachatryan (2022) find that remittances increase emigration intentions rather than reduce them. Using household-level data from Armenia and an empirical framework that accounts for the endogeneity of remittances, they show that individuals in remittance-receiving households are more likely to express intentions to migrate abroad. The authors interpret this result as evidence that remittances function primarily as a resource that helps potential migrants finance the migration process, while also signaling that migration has been successful for earlier migrants. Piracha and Amrita (2015) also argue that remittances can encourage further migration rather than simply helping households remain in their home country. Using household survey data from Moldova and a simultaneous-equations framework, they find a reciprocal relationship between remittance receipt and migration intentions among those left behind. On the one hand, remittances increase the likelihood that non-migrants will want to move abroad. On the other hand, individuals who already intend to migrate are also more likely to receive remittances, suggesting that transfers may help finance future migration.

While remittances may encourage emigration, higher home income may decrease migration. Ghimire and Kapri (2023) provide evidence that higher household income at home reduces migration. Using nationally representative household survey data from Nepal, they find that households with higher per capita income are less likely to send migrants and also tend to send fewer migrants overall. Their interpretation is that higher income at home raises the opportunity cost of migration, making households less dependent on labor migration as a strategy for improving welfare. From a

commuting and well-being perspective, the costs of distance may also discourage migration or long-distance work arrangements. Using micro-survey data in China, Han, Peng, and Xu (2022) find that longer commuting time reduces health, economic satisfaction, and overall well-being. Similar results are found in Canada, where longer commuting time is associated with lower life satisfaction, partly because it reduces leisure time (Hilbrecht, Smale, and Mock 2014). In addition, the accumulation of shocks may affect migration decisions differently from isolated shocks. According to Di Falco et al. (2024), it is not enough to consider only contemporaneous climate shocks when studying migration. Using panel household data from five sub-Saharan African countries merged with gridded rainfall data, they show that a single recent drought has only a modest effect on the probability that someone leaves the household, while repeated exposure to drought over several years has a larger and more persistent migration effect. In other words, migration may respond more strongly to the cumulative burden of shocks than to one isolated event.

3 Conceptual Model

The conceptual model is based on migration theory from Jia et al. (2023) and Kleemans (2015). Kleemans (2015) adds location choice and migration decisions to the dynamic savings model established in Deaton (1991). This research adapts the general idea to the context of permit migration in Alaska salmon fisheries and argues that changes in income can play an important role in migration decisions. The impact of income changes may differ depending on the locality of the income source and whether shocks are isolated or accumulated over time.

Consider an individual who maximizes utility over multiple periods while deciding whether to live. The individual starts in a current location with an endowment x . Based on income w and endowment x , the individual chooses consumption c . In each period, the individual evaluates the utility of staying s and migrating m . Let the set of location choices be M , where $M = (s, m)$. The cost of migration is expressed as a function $d(M)$, which is zero if the individual stays, i.e., $d(M = s) = 0$, and positive if the individual moves, i.e., $d(M = m) > 0$. The individual's endowment evolves dynamically as follows:

$$x' = (1 + r)(x - c - d(M) + w), \quad (1)$$

where r is the interest rate, showing that endowment wealth grows over time. Assuming that an individual is not able to borrow, the nonnegative condition $x \geq 0$ represents a liquidity constraint. These conditions give rise to the following Bellman equation:

$$V(x, s) = \max_{c, M} \left\{ U(c, M) + \beta \int V(x', M) dF(w) \right\} \quad (2)$$

Equation (2) shows that the individual maximizes current utility U , which depends on consumption and migration choice, together with expected future utility V . When evaluating the relative utility of staying or moving, the individual may consider factors such as distance to work, alternative job opportunities, amenities, housing options, relationships with neighbors, and health conditions in the area. The decision is made based on the conditions and information available in a given period. For example, the individual may have imperfect information about the job market, alternative opportunities, and amenities in both the current location and potential destinations.

Applying this framework to salmon fisheries in Alaska, permit holders are treated as decision-makers who evaluate whether migrating to another location would yield greater utility than remaining in their current location. Consider an individual who owns a fishing permit and makes location decisions repeatedly over time. In each period, the owner decides whether to migrate with the permit based on utility maximization. If the owner stays, they continue living in the same location and repeat the decision process in the next period. If the owner considers migration, they choose among possible destinations, which differ in both benefits and costs. The benefits associated with each location may include fishing-related factors, such as distance to fishing grounds and port infrastructure; non-fishing economic factors, such as non-fishery employment opportunities, amenities, or housing affordability; and non-economic factors, such as family or community ties. If permit owners choose the option that gives them the highest expected utility, permits may move toward places where net benefits are relatively high, provided that the costs of migration are not prohibitive.

3.1 Changes in Fishery Income

This research focuses on the economic aspects of permit migration because one key concern in rights-based fishery management is that permit systems may disrupt coastal communities economically. Fishery income shocks can affect permit migration through two possible narratives. On one side, negative income shocks may increase permit migration because fishing may no longer provide sufficient income to justify remaining in the origin community. This mechanism is related to the “survival rationale of migration” in Kleemans (2015). According to this view, negative shocks can increase emigration from one’s current residence as a form of post-risk coping behavior. Recall Equation (1), where the evolution of wealth depends partly on income w . Holding other factors constant, a negative income shock in the fishery can reduce the relative utility of living in the origin community. Fishers may then seek alternative income opportunities in a new location, increasing migration from the origin community. In the context of permit systems, the right to continue fishing through permit ownership may make it possible for fishers to move while retaining access to the fishery. In short, this explanation predicts that negative shocks in fishery income can increase permit migration.

On the other side, positive income shocks may also increase permit migration if they relax liquidity constraints and allow fishers to move to preferred locations. This mechanism is related to the “investment rationale of migration” described by Kleemans (2015). Migration is costly, and liquidity constraints may prevent individuals from moving even when they would prefer to do so. When fishers earn higher income, the increase in w in Equation (1) can ease the liquidity constraint and make migration more feasible. In this case, positive fishery income shocks may allow permit holders to move to locations with better amenities, stronger non-fishery opportunities, or other household benefits. Under this narrative, positive shocks may increase permit migration by making relocation financially possible. Therefore, both positive and negative shocks can theoretically increase permit migration, although they operate through different mechanisms.

Although changes in income can be an important driver of permit migration, the impact of income changes may be heterogeneous across different characteristics. This research focuses on two

potential sources of heterogeneity: the locality of fishery income and the accumulation of shocks. First, fishery income is not homogeneous. Many fishers engage in multiple fishing activities, and income may come from fisheries that are local or non-local to the community where they live. Therefore, it is important to distinguish between local and non-local fishery income when analyzing permit migration. Second, because fisheries are inherently uncertain, fishers may tolerate short-term income fluctuations. A one-year shock may not be sufficient to alter a migration decision if fishers expect conditions to recover. However, repeated shocks over time may affect accumulated wealth, expectations about future income, and the perceived viability of remaining in the origin community. Therefore, it is important to examine the heterogeneous impact of income changes based on both locality and accumulation.

3.2 Locality

The distance between residence and employment location can play an important role in migration decisions. This research argues that income changes in local and non-local fisheries may have different relationships with permit migration. Conceptually, local fishery income can be treated as income tied to the home community, while non-local fishery income can be compared to income earned outside the home community. This distinction is useful because the migration literature suggests that home income and remittance-like income may affect migration decisions differently. In economic migration theory, remittances can affect migration by relaxing liquidity constraints and changing household expectations. Taylor (1999) suggests that remittances can increase migration because they raise the expected value of migration to the household. In the new economics of labor migration, migration is a household-level response to imperfect markets in the place of origin. When households cannot borrow easily, insure themselves adequately, or finance productive activities from local income alone, they may seek non-local opportunities to access additional earnings. Remittances then function as both a source of liquidity and a form of insurance, reducing the risks associated with staying and producing at home. Under these conditions, the prospect of remittance income can make migration a rational household strategy, even when migration involves costs. Empirical studies also show that remittances can encourage migration (Grigoryan and Khachatryan 2022; Piracha and Amrita 2015), implying that income from outside one’s home community may increase

the feasibility or attractiveness of moving.

On the other hand, higher home income may make people less likely to migrate because it raises the opportunity cost of leaving. Djajic, Kirdar, and Vinogradova (2016) model migration as an intertemporal choice in which a worker compares lifetime welfare under two options: staying at home or migrating after accumulating enough savings to pay the migration cost. One effect of higher earnings at the origin is that staying becomes more attractive because the current location provides better income opportunities. In this case, migration involves giving up improved income at home, which increases the opportunity cost of moving. Empirically, higher income at home is associated with lower migration (Taylor 1999; Ghimire and Kapri 2023). This point is also supported by studies on commuting and well-being, which show that longer commuting time can reduce well-being (Han, Peng, and Xu 2022; Hilbrecht, Smale, and Mock 2014). These studies suggest that people may be discouraged from moving away from locations where work opportunities are close and income conditions are favorable.

Applying this logic to Alaska salmon fisheries, local fishery income is expected to reduce permit migration because it increases the economic value of remaining in the origin community. If a fisher's residence is close to the fishery that generates income, higher local revenue raises the opportunity cost of leaving. In contrast, the expected effect of non-local fishery income is theoretically ambiguous. On one hand, non-local fishery income may resemble remittance income because it provides income from outside the home community and may relax liquidity constraints, making migration more feasible. On the other hand, higher non-local fishery income may still increase total fishery earnings and allow permit holders to remain in their current community while continuing to participate in fisheries elsewhere. Therefore, separating local and non-local fishery income is important for examining whether the geographic source of fishery revenue shapes permit migration differently.

3.3 Accumulation of Shocks

Heterogeneity can also arise from differences in how fishers respond to contemporaneous and cumulative shocks. As Equation (1) expresses, one's endowment evolves over time depending on the

current endowment x , consumption c , the migration decision $d(M)$, and fishery income w . Consider an income shock in year t . Such a shock directly affects w_t and can therefore influence the current migration decision. However, the decision may also depend on accumulated wealth, x_t , which is not observed in the data. That is, while income shocks are observable, shocks to accumulated wealth are not directly observed. To illustrate this point, recall Equation (1) and rewrite it for x_t :

$$x_t = (1 + r)(x_{t-1} - c_{t-1} - d(M_{t-1}) + w_{t-1}), \quad (3)$$

and likewise, x_{t-1} is expressed as

$$x_{t-1} = (1 + r)(x_{t-2} - c_{t-2} - d(M_{t-2}) + w_{t-2}), \quad (4)$$

which repeats back to the initial endowment x_0 , which is also unobserved. This recursive structure shows that past income realizations enter the accumulation of wealth over time. Although x_t is not directly observed, income shocks in prior years, such as year $t-1$ and year $t-2$, directly affect x_{t-1} and x_{t-2} . This suggests that accumulated income shocks over time can serve as a proxy for changes in cumulative wealth. This distinction helps motivate why contemporaneous and cumulative shocks may affect migration decisions differently. If a fisher experiences an income shock in only one year, the shock may affect current income but may not substantially change cumulative wealth or expectations. In that case, the fisher may not adjust their migration decision. In contrast, repeated similar shocks over consecutive periods may have a more substantial effect on accumulated wealth and expectations about future fishery conditions. Because wealth can relax or tighten the liquidity constraint associated with migration, repeated shocks may lead to a different migration response than an isolated contemporaneous shock. Empirically, Di Falco et al. (2024) find that experiencing climate shocks over several years has a stronger effect on migration than experiencing a shock in a single year. Applying this logic to permit migration suggests the importance of examining whether cumulative shocks affect fishers' migration decisions differently from contemporaneous shocks.

4 Data

To estimate the relationship between fishery revenue shocks and permit migration in Alaska, this study combines data from two sources for 16 years, from 2000 to 2015. Fishing-related information is obtained from the CFEC, while community-level socioeconomic information is drawn from the Alaska Local and Regional Information (ALARI) database maintained by the Alaska Department of Labor and Workforce Development. These datasets are used to construct the key variables required for the analysis, including permit migration, fishery revenues, employment rates, non-fishery wages, and general migration rates.

Ideally, individual-level data would allow this study to examine permit holders' migration decisions directly. However, because individual-level information is not available for all variables used in the analysis, the dataset is constructed at the community-year level. The dependent variable is the number of permit holders who out-migrate from each community in each year. To construct this measure, this study uses the CFEC Permit Database, which records a unique permit ID number for each issued permit, a unique CFEC identification number for each fisher, and the fisher's residential address. By following each permit across years and locations, the analysis identifies cases in which a permit moves from one community to another. It then distinguishes permit migration from permit transfer using the CFEC fisher identifier. If the permit is associated with a different CFEC ID after the move, the movement is classified as a transfer. If the permit remains associated with the same CFEC ID but the recorded residential location changes, the movement is classified as permit migration. The number of migrating permit holders is then aggregated by origin community and year. These permit migration counts are merged with a community-year panel containing both fishery and non-fishery variables. The resulting dataset includes measures of local and non-local fishery revenues, employment rates, non-fishery wages, and general migration rates for each community in each year.

4.1 Definitions of Key Variables

This study first distinguishes between local and non-local fishery revenues. Using the CFEC community-fishery-year panel, a fishery is defined as local to a community if more than 0.5 percent of that fishery’s annual landings occurred in that community between 1995 and 1999. An indicator is then assigned equal to one for each community-fishery pair that meets this threshold, and zero otherwise. For salmon fisheries, this procedure identifies 52 community-fishery pairs. Based on this classification, fishery revenues are separated into local and non-local revenues at the community-fishery-year level and then aggregated to the community-year level.

This study next constructs positive and negative revenue shock variables separately for local and non-local fishery revenues. For each community-fishery-year observation, the fishery income growth rate is calculated and compared with the 10-year rolling average of the growth rate. A positive shock is defined as an income growth rate that is more than one standard deviation above the 10-year rolling average. Similarly, a negative shock is defined as an income growth rate that is more than one standard deviation below the 10-year rolling average. This procedure produces binary shock indicators at the community-fishery-year level for local positive shocks, local negative shocks, non-local positive shocks, and non-local negative shocks. These binary shock indicators are then aggregated to the community-year level. Therefore, the shock variables used in the analysis measure the number of revenue shocks experienced by a community in a given year, rather than simply whether any shock occurred. Finally, this study distinguishes between contemporaneous and cumulative shocks. Because the precise timing of permit migration within a year is not observed, shocks measured in year t are not used to explain permit migration in year t . Instead, to avoid using potentially future information, contemporaneous shocks in year t are defined as the number of shocks that occurred in year $t - 1$. Cumulative shocks in year t are defined as the total number of shocks that occurred from year $t - 5$ through year $t - 2$. This cumulative measure captures recent historical exposure to revenue shocks while excluding the contemporaneous shock period. The construction of cumulative shocks follows the approach of Di Falco et al. (2024).

4.2 Descriptive Statistics

Figure 2 shows changes in the share of permit ownership from 2000 to 2015. There are nine salmon fisheries in Alaska, and most of them are operated primarily by local permit owners, based on this paper’s definition of local communities. However, three salmon fisheries, S03M, S03T, and S04T, have a higher share of non-local residents and permit holders who live outside Alaska. S03T and S04T belong to the Bristol Bay salmon fishery, which is considered one of the most valuable fisheries not only within Alaska but also in the world. S03M also includes part of Bristol Bay, which may contribute to the smaller share of local permit ownership compared to the other categories. This pattern highlights the importance of salmon fisheries in coastal communities in Alaska.



Figure 2: Changes in the Share of Permit Owners for Each Fishery

Figure 3 presents the number of out-migrating fishers by borough from 2000 to 2015. The figure indicates that permit migration is not evenly distributed across boroughs. Instead, a relatively small number of boroughs account for a large share of the observed variation in out-migrating permit holders. In particular, boroughs closely connected to major salmon fisheries, such as the Dillingham Census Area, Bristol Bay Borough, Kodiak Island Borough, Lake and Peninsula Borough, and Kenai Peninsula Borough, tend to show consistently higher numbers of out-migrating fishers. The Municipality of Anchorage also records a relatively large number of out-migrating fishers, suggesting that some permit holders reside in Alaska's major population center while participating in fisheries located elsewhere. By contrast, several interior or less fishery-dependent boroughs, such as Denali Borough, North Slope Borough, Northwest Arctic Borough, and Yukon-Koyukuk Census Area, show very few out-migrating fishers during the sample period. This pattern suggests that much of the variation in the dependent variable comes from coastal boroughs where commercial fishing activity is more concentrated. The concentration of permit migration in these regions is consistent with the structure of Alaska salmon fisheries, where permits, fishing revenues, and residence decisions are geographically tied to coastal communities.

The summary statistics for the variables used in the empirical analysis are shown in Table 1. The dependent variable, the number of out-migrating fishers, has a mean of 0.811 and a standard deviation of 2.117, indicating that many community-year observations have no or only a small number of out-migrating fishers, while a smaller number of observations have substantially higher levels of out-migration. The maximum value of 24 further suggests that permit migration is concentrated in specific community-year observations rather than being evenly distributed across all communities and years. The revenue variables also show substantial variation. Non-local revenue has a mean of 27.701 and a standard deviation of 90.448, while local revenue has a mean of 47.239 and a standard deviation of 177.161. Since both variables are measured in units of \$10,000, these statistics indicate large differences in fishery revenue exposure across community-year observations. The maximum values are much larger than the means for both local and non-local revenue, suggesting that a small number of communities are exposed to very high fishery revenues. This variation is important for the empirical analysis because it allows the model to compare communities with different levels of dependence on local and non-local fisheries.



Figure 3: Number of Out-Migrating Fishers by Borough

The shock variables also indicate meaningful variation across communities and years. Positive and negative shocks occur for both local and non-local revenues, but non-local shocks are more common on average than local shocks. Similarly, cumulative non-local shocks have larger means than cumulative local shocks. This pattern suggests that communities are more frequently exposed to repeated shocks through fisheries that are not directly local to them, which may reflect the broader geographic connection between fishing permits, residence choices, and revenue opportunities. Together, these summary statistics show that the data contain both temporal variation in fishery revenue shocks and spatial variation across boroughs and communities.

Table 1: Summary statistics for variables used in the empirical analysis. The dependent variable is the number of outmigrating fishers.

	Mean	SD	Min	Max	N
Outmigrating Fishers	0.811	2.117	0	24	1969
Non-Local Revenue (\$10,000)	27.701	90.448	0.000	1372.961	1943
Local Revenue (\$10,000)	47.239	177.161	0.000	2334.869	1943
Non-Local Positive	0.212	0.509	0	4	1943
Non-Local Negative	0.186	0.485	0	5	1943
Local Positive	0.099	0.367	0	3	1943
Local Negative	0.085	0.345	0	4	1943
Cumulative Non-Local Positive	0.800	1.123	0	7	1969
Cumulative Non-Local Negative	0.785	1.112	0	7	1969
Cumulative Local Positive	0.364	0.984	0	8	1969
Cumulative Local Negative	0.344	0.948	0	7	1969
Wages (\$10,000)	7195.997	50314.637	1.859	633678.005	1960
Outmigration Rate	8.259	5.479	-5.263	50.000	1932
Employment Rate	62.920	11.528	10.638	92.424	1960
Fishery HHI	0.500	0.299	0.000	1.000	1943
Non-Fishery HHI	0.265	0.137	0.106	1.000	1810
Log Fishers	1.738	1.543	0.000	5.886	1949

5 Empirical Strategy

As Figure 4 indicates, the dependent variable contains a large number of zeros because many communities do not have any outmigrating permit holders in a given year. This feature of the

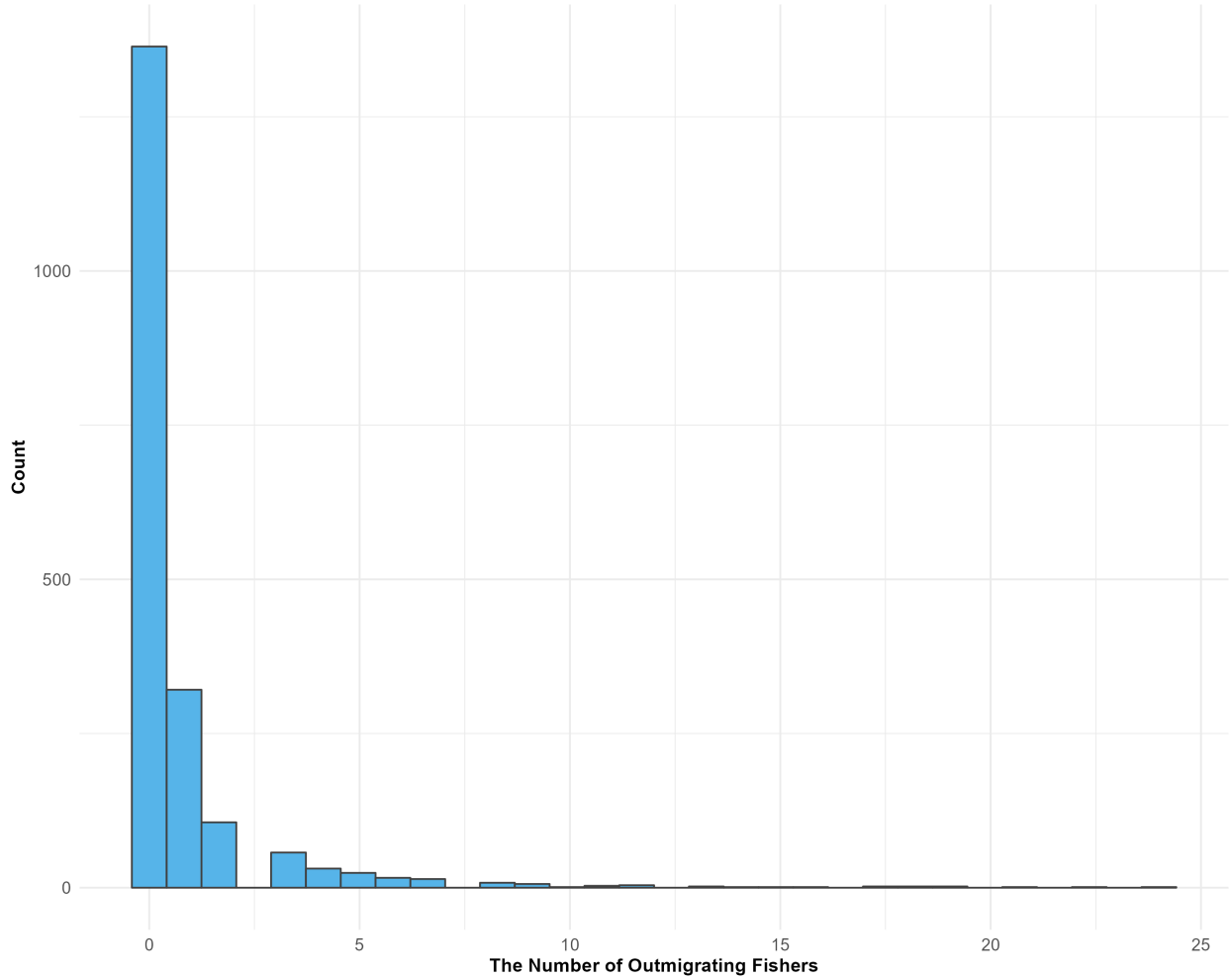


Figure 4: The Histogram of the Number of Migrated Permit Holders

outcome variable makes a log-linear model inappropriate, since the logarithm of zero is undefined, and dropping zero observations would remove meaningful information from the sample. In addition, even when the dependent variable is strictly positive, estimating a log-linearized model by OLS can lead to biased estimates in the presence of heteroskedasticity. This problem arises because the expected value of the logarithm of the dependent variable is not generally equal to the logarithm of its conditional expectation, and the bias can be especially important when the variance of the error term depends on the covariates. For these reasons, this study uses the Poisson Pseudo Maximum Likelihood (PPML) model (Silva and Tenreyro 2006). The PPML model allows the analysis to estimate the conditional mean of the number of outmigrating permit holders directly in levels while retaining observations with zero migration. Although it is commonly associated with count data,

its use does not require the dependent variable to follow a Poisson distribution. Rather, consistency requires the correct specification of the conditional mean.

The PPML model is thus suitable for this analysis, where the outcome is a nonnegative count variable and the variance is likely to vary across communities and years. The empirical model, therefore, estimates an exponential conditional mean model and uses the logarithm of the number of fishers living in a given community and year as the exposure variable. This exposure term adjusts for differences in the size of the fishing population across communities, so that the model estimates changes in permit migration relative to the number of fishers who could potentially migrate. Community and year fixed effects are included to account for unobserved heterogeneity. Community fixed effects account for time-invariant differences across communities, such as geographic location, historical dependence on fisheries, and persistent differences in local economic conditions. Year fixed effects account for shocks or trends common to all communities in a given year, such as statewide economic conditions, policy changes, or broader changes in fishery markets. Together, these fixed effects allow the estimation to focus on within-community changes over time while controlling for common year-specific fluctuations.

This study estimates three empirical specifications. The first model estimates the relationship between continuous fishery revenue and permit migration:

$$\begin{aligned} \text{Outmigrating Holders}_{ct} = \exp \big(& \text{Community FE} + \text{Time FE} + \beta_1 \text{Non-Local Fishing Rev}_{ct} \\ & + \beta_2 \text{Local Fishing Rev}_{ct} + \beta_3 \text{Wage}_{ct} \\ & + \beta_4 \text{Outmigration Rate}_{ct} + \beta_5 \text{Employment}_{ct} + \beta_6 \text{Fishery HHI}_{ct} \\ & + \beta_7 \text{Non-Fishery HHI}_{ct} + \ln(\# \text{ of Fishers Living}_{ct}) \big) \end{aligned}$$

The main targets of estimation are β_1 and β_2 . The other variables include the wages, out-migration rates, employment, Fishery Herfindahl-Hirschman Index (HHI), and Non-Fishery HHI. This specification examines whether changes in local and non-local fishery revenues are associated with permit migration. The coefficients on non-local fishery revenue and local fishery revenue allow the analysis to compare whether income earned from fisheries outside the community has a different relationship

with permit migration than income earned from fisheries local to the community. The coefficient on wage revenue controls for broader income opportunities outside the fishery sector.

The second empirical specification estimates the relationship between contemporaneous discrete income shocks and permit migration:

$$\begin{aligned} \text{Outmigrating Holders}_{ct} = \exp \big(& \text{Community FE} + \text{Time FE} + \beta_1 \text{Non-Local Positive}_{ct} \\ & + \beta_2 \text{Non-Local Negative}_{ct} + \beta_3 \text{Local Positive}_{ct} \\ & + \beta_4 \text{Local Negative}_{ct} + \beta_5 \text{Wage}_{ct} \\ & + \beta_6 \text{Outmigration Rate}_{ct} + \beta_7 \text{Employment}_{ct} + \beta_8 \text{Fishery HHI}_{ct} \\ & + \beta_9 \text{Non-Fishery HHI}_{ct} + \ln(\# \text{ of Fishers Living}_{ct}) \big) \end{aligned}$$

The main targets of estimation are β_1 through β_4 in the second model. This specification replaces continuous fishery revenue measures with discrete positive and negative shock variables. This allows the analysis to examine whether unusually high or unusually low fishery income growth is associated with permit migration differently as a discrete event, rather than as a continuous revenue measure. Separating positive and negative shocks is important because the effect of income changes on migration may be asymmetric, as the conceptual framework suggests.

The third specification adds cumulative discrete income shocks to the second model, and it is

the main focus of the research among the three specifications:

$$\begin{aligned}
\text{Outmigrating Holders}_{ct} = \exp \big(& \text{Community FE} + \text{Time FE} + \beta_1 \text{Non-Local Positive}_{ct} \\
& + \beta_2 \text{Non-Local Negative}_{ct} + \beta_3 \text{Local Positive}_{ct} \\
& + \beta_4 \text{Local Negative}_{ct} \\
& + \beta_5 \text{Cumulative Non-Local Positive}_{ct} \\
& + \beta_6 \text{Cumulative Non-Local Negative}_{ct} \\
& + \beta_7 \text{Cumulative Local Positive}_{ct} \\
& + \beta_8 \text{Cumulative Local Negative}_{ct} \\
& + \beta_9 \text{Wage}_{ct} + \beta_{10} \text{Outmigration Rate}_{ct} \\
& + \beta_{11} \text{Employment}_{ct} + \beta_{12} \text{Fishery HHI}_{ct} + \beta_{13} \text{Non-Fishery HHI}_{ct} \\
& + \ln(\# \text{ of Fishers Living}_{ct}) \big)
\end{aligned}$$

The main coefficients of interest in the third model are β_5 through β_8 . Specifically, β_5 and β_6 measure the effects of cumulative positive and negative shocks in non-local fishery revenues, while β_7 and β_8 measure the effects of cumulative positive and negative shocks in local fishery revenues. The contemporaneous shock variables capture the relationship between income shocks in the most recent observed period and permit migration, while the cumulative shock variables capture whether repeated exposure to shocks over prior years has an additional association with migration. This distinction follows the conceptual model, in which cumulative shocks may serve as a proxy for changes in accumulated wealth that are not directly observed.

Across all specifications, the coefficient can be interpreted as semi-elastically: a one-unit increase in the corresponding independent variable changes the expected number of out-migrating permit holders by $100 \times (\exp(\beta) - 1)$ percent, holding other variables constant.

6 Results

6.1 Primary Results

Table 2 presents the results from the three PPML specifications, where the reported coefficients can be converted to a semi-elasticity using the formula: $100 \times (\exp(\beta) - 1)$. Column (1) reports the specification using continuous fishery revenue measures. Column (2) replaces these continuous measures with contemporaneous positive and negative revenue shocks. Column (3), which is the main specification, adds cumulative shock measures to the contemporaneous shock variables.

In the first specification, both local and non-local fishery revenues show a negative and statistically significant relationship with permit migration: a \$10,000 increase in non-local fishery revenue is associated with approximately a 0.075% decrease in the expected number of outmigrating permit holders. Similarly, a \$10,000 increase in local fishery revenue is associated with approximately a 0.062% decrease in the expected number of outmigrating permit holders. Although the magnitude of each marginal effect is small, the negative signs suggest that higher fishery income is associated with lower permit migration. Conversely, declines in fishery revenue are associated with higher permit migration. This is consistent with the interpretation that fishery income can help retain permit holders in their communities by improving the economic value of remaining. The coefficient on wages from non-fishery sectors is positive and statistically significant across all three specifications. This suggests that stronger non-fishery labor market opportunities are positively associated with permit migration. Therefore, while higher fishery revenue appears to reduce permit migration, higher non-fishery wages may increase the attractiveness or feasibility of moving.

Column (2) examines whether contemporaneous discrete revenue shocks affect permit migration. None of the contemporaneous fishery shock coefficients is statistically significant. Because these estimates are not statistically significant, they should not be interpreted as clear evidence that contemporaneous shocks systematically increase or decrease permit migration. Column (3) adds cumulative shocks and provides the main result of the analysis. Among the cumulative shock variables, cumulative local negative shocks have a positive and statistically significant effect on permit migration. The coefficient of 0.107 implies that one additional cumulative local negative shock

Table 2: Primary Results

	(1)	(2)	(3)
	First Model	Second Model	Third Model
Non-Local Revenue (\$10,000)	-0.000747*** (0.000218)		
Local Revenue (\$10,000)	-0.000624*** (0.000209)		
Non-Local Positive		-0.00115 (0.0429)	0.0242 (0.0439)
Non-Local Negative		-0.0326 (0.0529)	-0.0415 (0.0630)
Local Positive		-0.0257 (0.0356)	-0.0407 (0.0346)
Local Negative		-0.0182 (0.0798)	0.0112 (0.0763)
Cumulative Non-Local Positive			0.0174 (0.0362)
Cumulative Non-Local Negative			-0.00916 (0.0378)
Cumulative Local Positive			0.00621 (0.0412)
Cumulative Local Negative			0.107*** (0.0188)
Wages	6.61e-10*** (1.21e-10)	3.55e-10*** (8.73e-11)	4.58e-10*** (1.51e-10)
Outmigration Rate	0.00637 (0.0124)	0.00485 (0.0112)	0.00490 (0.0118)
Employment Rate	0.0168 (0.0103)	0.0127 (0.0110)	0.0146 (0.0111)
Fishery HHI	-1.167*** (0.395)	-1.107*** (0.409)	-1.105** (0.451)
Non-Fishery HHI	-1.394** (0.627)	-1.121* (0.581)	-1.239** (0.570)
_cons	-4.036*** (0.651)	-3.772*** (0.692)	-4.179*** (0.600)
Observations	1385	1385	1385
Standard errors in parentheses			
The dependent variable is the number of outmigrating fishers.			
* p < 0.10, ** p < 0.05, *** p < 0.01			

increases the expected number of outmigrating permit holders by approximately 11.3%, holding other variables constant. This is the largest and most statistically robust fishery shock effect in the main specification. Overall, the main results show three patterns. First, higher fishery revenues are associated with lower permit migration. Second, contemporaneous positive and negative shocks do not have statistically significant effects. Third, cumulative local negative shocks have a large and significant positive association with permit migration.

6.2 Robustness Checks

As a robustness check, Figures 5 and 6 divide the shock variables into minor, medium, and large shocks. This exercise examines whether the main shock coefficients mask heterogeneous effects across different shock magnitudes. In the main specification, each shock variable combines shocks of different sizes into a single measure. The robustness check separates these shocks into three categories. Minor positive and negative shocks are defined as income growth that is between 1 and 1.5 standard deviations away from the rolling average. Medium shocks are defined as income growth between 1.5 and 2 standard deviations away. Large shocks are defined as income growth at least 2 standard deviations away. The cumulative shock variables are constructed in the same way, using the number of shocks over the four-year cumulative window.

Figure 5 presents the robustness check for contemporaneous shocks. Consistent with the results in column (2) of Table 2, the estimated effects of contemporaneous shocks are generally imprecise. Most confidence intervals include zero, indicating that the data do not provide strong evidence that contemporaneous shocks have a systematic effect on permit migration. The signs and magnitudes vary across shock size, direction, and locality, suggesting that one-year shocks may not translate into a stable migration response.

Figure 6 presents the robustness check for the specification that includes cumulative shocks. The results again show substantial heterogeneity across shock size and locality. The most important pattern is that the significant cumulative effect in the main results appears to be driven by large cumulative local negative shocks. Based on the plotted coefficient, a large cumulative local negative

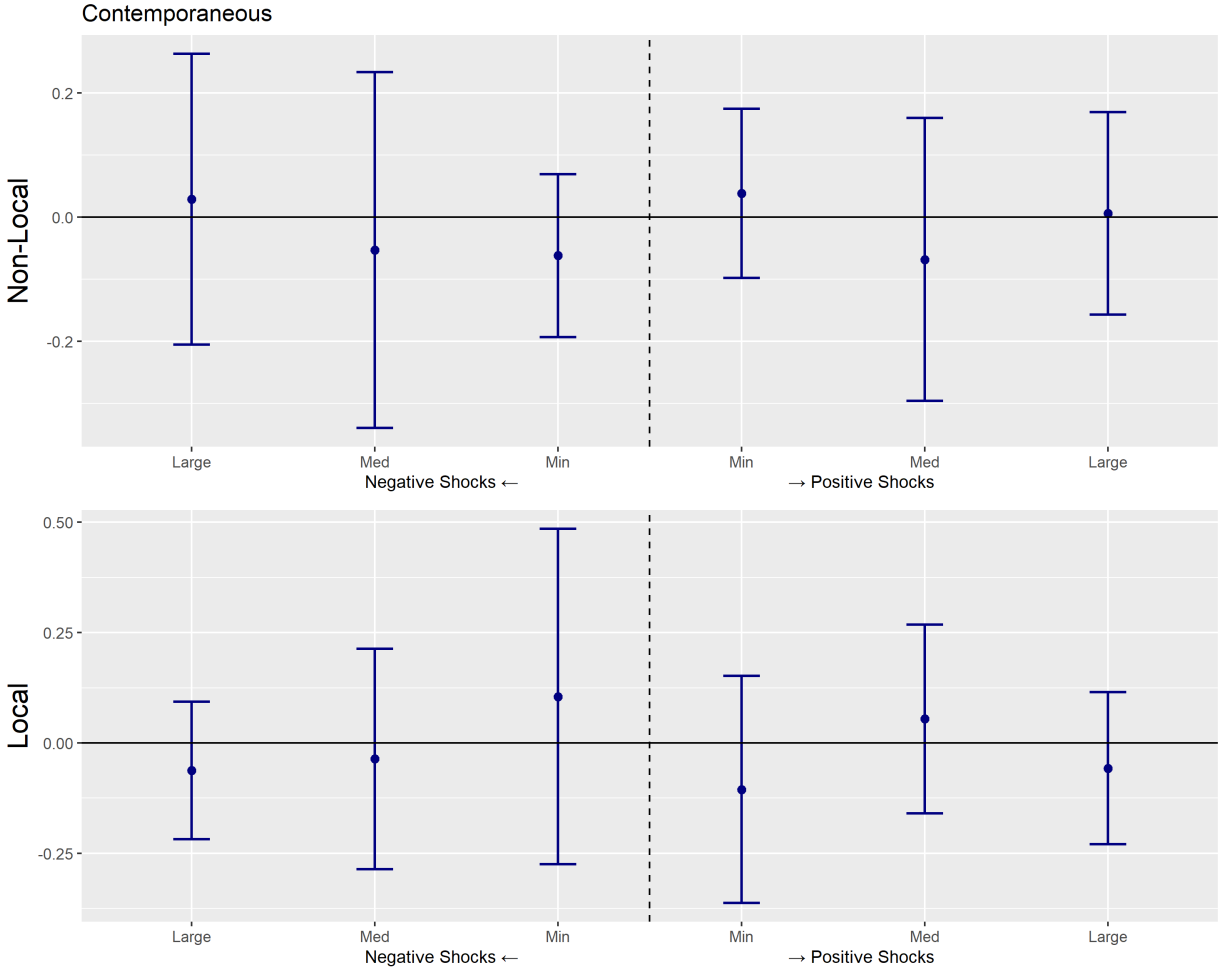


Figure 5: Robustness Checks for the Second Model

shock is associated with an increase in permit migration of approximately 11–12%. This is consistent with the main result in Table 2, where cumulative local negative shocks increase expected permit migration by approximately 11.3%.

The robustness checks provide additional support for the main interpretation. The average cumulative local negative shock effect in Table 2 does not appear to be driven equally by all negative local shocks. Instead, the effect is concentrated among larger cumulative local negative shocks. This suggests that small or moderate local revenue shocks may not be sufficient to induce permit migration, while repeated large negative shocks may create enough economic pressure to affect fishers' decisions to migrate. At the same time, the robustness checks also reveal that the relationship

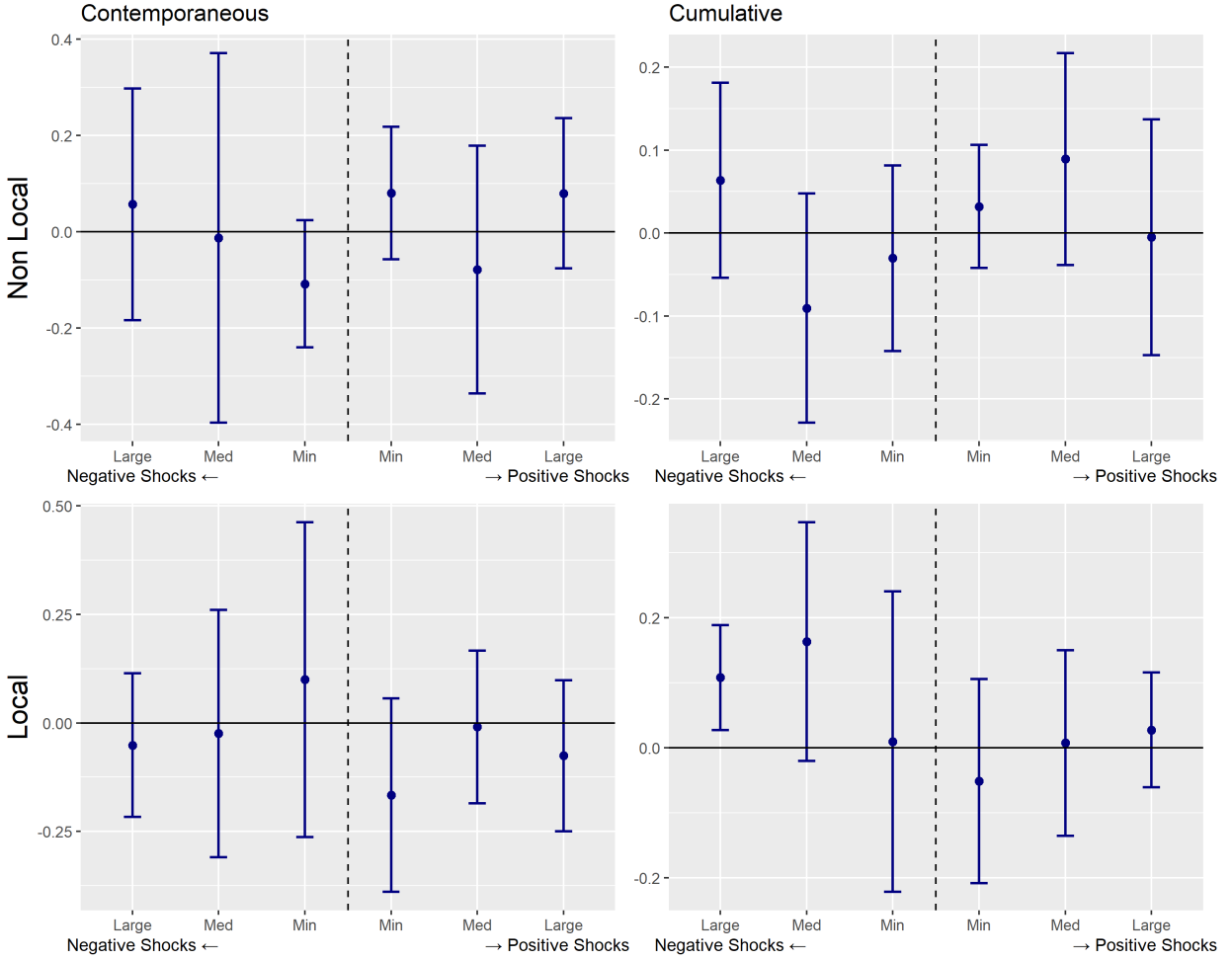


Figure 6: Robustness Checks for the Third Model

between revenue shocks and permit migration is not uniform across all types of shocks. Some binned shock coefficients change signs across categories, and most are not statistically significant. This helps explain why the contemporaneous shock coefficients in the primary results are unstable and insignificant. It also suggests that the average shock variables in the main specification may combine heterogeneous responses across shock size. Therefore, the robustness checks strengthen the main conclusion while also showing an important limitation: the migration response to shocks depends not only on whether the shock is positive or negative, but also on its magnitude, locality, and accumulation over time.

7 Discussion

The results suggest that permit migration is more responsive to repeated negative shocks in local fisheries than to contemporaneous shocks alone. This pattern is consistent with the conceptual framework developed earlier. In the model, fishers' migration decisions depend not only on current income but also on accumulated wealth and expectations about future conditions. A single negative income shock may reduce current income, but fishers may be able to absorb it through savings, short-term adjustment, or the expectation that fishery conditions will recover in the following year. In contrast, repeated negative shocks in local fisheries may have a more persistent effect. They may reduce accumulated wealth over time, weaken the expected return to remaining in the origin community, and make the economic basis of staying less stable. Therefore, the significant effect of cumulative local negative shocks suggests that permit migration is not driven only by short-term income fluctuations, but also by the accumulation of adverse local fishery conditions.

This interpretation is more consistent with a “survival narrative” than an “investment narrative” in the context of the conceptual framework. If the investment narrative were dominant, positive income shocks would be expected to increase migration by relaxing liquidity constraints and allowing fishers to finance relocation. However, the main results do not show statistically significant effects of positive fishery revenue shocks. Instead, the strongest result is that cumulative local negative shocks increase permit migration. This suggests that fishers may migrate with their permits not because positive fishery shocks provide them with additional resources to invest in migration, but because repeated negative shocks make remaining in the origin community less economically viable. In this sense, permit migration appears to be a response to accumulated economic pressure in local fisheries.

The distinction between local and non-local shocks is also important. Cumulative non-local shocks do not have statistically significant effects, while cumulative local negative shocks do. This suggests that shocks to fisheries connected to the home community may matter more for permit migration than shocks to fisheries located farther away. Local negative shocks may directly weaken the economic basis for remaining in the origin community because they affect income opportunities

tied to the place where fishers live. By contrast, non-local shocks may affect fishery income without necessarily changing the value of residing in the origin community. Therefore, the geographic source of fishery income appears to shape the migration response. The results suggest that permit migration is especially sensitive to repeated deterioration in fishery conditions that are local to the community.

At the same time, the investment narrative may still help explain the positive relationship between non-fishery wages and permit migration. Across all specifications, non-fishery wages have a positive and statistically significant association with permit migration, which may indicate that stronger non-fishery labor market opportunities provide fishers with alternative income sources, relax liquidity constraints, or reduce the cost of relocation. In this sense, fishers may be more likely to migrate when opportunities outside of the fishery sector improve, even though positive fishery revenue shocks themselves do not show the same effect. This contrast suggests that fishery income and non-fishery income may play different roles in migration decisions. Fishery revenue may retain fishers in their communities, while non-fishery wages may increase the attractiveness or feasibility of moving.

The contrast between the first and second models is also informative. While continuous fishery revenue measures are statistically significant in the first model, the discrete contemporaneous shock variables in the second model are not. Although both specifications examine recent economic conditions, they may be capturing different aspects of fishery income. The first model uses the continuous level of fishery revenue, while the second model identifies whether income growth crosses a shock threshold in a given year. The difference in results may suggest that permit owners respond more clearly to the overall level of fishery income than to whether income growth is unusually high or low in a single year. It may also indicate that one-year shocks are not sufficient to alter migration decisions if fishers view them as temporary fluctuations. This interpretation is consistent with the conceptual framework, in which a short-term shock to income may affect current income but may not substantially change accumulated wealth and liquidity constraints.

Thus, the instability of the signs across the contemporaneous shock coefficients should be interpreted with caution. The results do not provide strong evidence that contemporaneous shocks, by

themselves, systematically increase or decrease permit migration. Instead, the weak and insignificant contemporaneous shock estimates suggest that fishers may not respond immediately to isolated shocks. Because fisheries are naturally volatile, fishers may tolerate some short-term variation in revenue before changing their location decisions. Migration is also costly and may require planning, household adjustment, and changes in employment or fishing strategies. For these reasons, the effect of shocks may become more visible only when adverse conditions accumulate over time.

This study has several limitations. First, the analysis is conducted at the community-year level rather than at the individual level. Therefore, the results should be interpreted as community-level relationships rather than direct evidence of individual fishers' behavior. Although the conceptual framework describes individual decision-making, the empirical analysis cannot observe each permit holder's wealth, household situation, expectations, or specific reasons for migration. This limitation is especially relevant for interpreting contemporaneous shocks, because individual responses may be blurred when outcomes are aggregated to the community-year level. Future research would benefit from analyzing permit migration using individual-level data with an individual choice model. Second, the analysis does not observe the exact timing of migration within a year. Because of this limitation, shocks are lagged to avoid using information that may occur after the migration decision. While this approach is necessary for consistency, it also means that the empirical definition of contemporaneous shocks is based on the most recent fully observed year rather than the exact moment of decision-making. As a result, the estimates may not fully capture short-term responses that occur within the same year.

Third, the revenue shock variables capture changes in fishery income but do not identify the precise source of those changes. Revenue shocks may reflect biological conditions, permit policy regulations, market prices, regulatory changes, and/or changes in fishing effort. Therefore, the results should be interpreted as the effect of revenue shocks rather than as the effect of any single underlying mechanism. In addition, the analysis cannot fully distinguish whether permit migration is driven by declining local fishery opportunities, improved opportunities elsewhere, household-level constraints, or other unobserved factors. Finally, the robustness checks suggest that the effect of shocks may differ by magnitude. This implies that the main shock variables may combine

heterogeneous responses across minor, medium, and large shocks. While the primary results show that cumulative local negative shocks are associated with higher permit migration, the robustness checks suggest that this effect may be concentrated among larger negative shocks. Future research could explore this heterogeneity more directly, especially with individual-level data and an individual choice model that allows for a more detailed analysis of permit holders' characteristics, household conditions, and migration timing.

8 Conclusion

This research examines potential economic drivers of permit migration in Alaska salmon fisheries by focusing on the role of fishery revenue shocks. While existing discussions of rights-based fishery management have often focused on permit transfers, permit migration has become an increasingly important mechanism through which local communities lose permit ownership. This study contributes to understanding this phenomenon by distinguishing permit migration from permit transfer and by examining whether local and non-local fishery income, contemporaneous shocks, and cumulative shocks are associated with permit migration differently. Using fishing-related information from the CFEC and community-level socioeconomic information from ALARI from 2000 to 2015, this research constructs a community-year panel of permit migration, fishery revenues, revenue shocks, and local economic conditions. The empirical analysis uses a PPML model because the dependent variable is a nonnegative count variable with many zero observations. The model also includes community and year fixed effects, allowing the analysis to focus on within-community changes over time while controlling for common year-specific shocks.

The results show that higher local and non-local fishery revenues are associated with lower permit migration. This suggests that stronger fishery income can help retain permit holders in their communities. However, when fishery income changes are measured as contemporaneous positive and negative shocks, the estimated effects are not statistically significant. This indicates that isolated one-year shocks may not be enough to systematically affect permit migration. Instead, the main result is that cumulative local negative shocks have a positive and statistically significant

association with permit migration. One additional cumulative local negative shock is associated with an approximately 11.3% increase in the expected number of outmigrating permit holders. This finding implies that permit migration is responsive to repeated adverse conditions in local fisheries, which is consistent with the survival narrative from the lens of the conceptual framework. If the investment narrative were dominant, positive income shocks would be expected to increase migration by relaxing liquidity constraints.

However, the results do not show statistically significant effects of positive fishery revenue shocks. Instead, repeated local negative shocks appear to increase permit migration, suggesting that fishers may migrate with their permits when remaining in the origin community becomes less economically viable over time. As the conceptual model also suggests, the locality of shocks is important. Cumulative non-local shocks do not have statistically significant effects, while cumulative local negative shocks do. This may indicate that adverse shocks to fisheries tied to the home community matter more for permit migration than shocks to fisheries located farther away. Local negative shocks may directly reduce the value of remaining in the origin community, while non-local shocks may affect income without necessarily weakening the economic basis of living in the community. Therefore, the geographic source of fishery income appears to shape migration decisions.

Because the analysis is conducted at the community-year level, the results should be interpreted with caution. The estimates represent community-level relationships rather than direct evidence of individual migration decisions. The dataset also does not record the exact timing of permit migration within a year, requiring the use of lagged shocks for contemporaneous analysis. In addition, revenue shocks may reflect multiple underlying causes related to fishing activities, biological conditions, market prices, and policy. Future research would benefit from individual-level data that make it possible to examine permit holders' wealth, household characteristics, permit portfolios, and precise migration timing. Such data would allow future studies to estimate individual choice models and further clarify the mechanisms behind permit migration. Overall, this research shows that permit migration is not simply a response to short-term fishery income fluctuations. Rather, it is closely associated with the accumulation of negative local fishery conditions. This finding has important implications for understanding the community-level consequences of rights-based fishery

management. Even when permits are not transferred to new owners, the migration of permit holders can still change the spatial distribution of fishing income, local participation, and the long-term relationship between fisheries and coastal communities.

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