

How Are ITQ Prices Discovered?

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How Are ITQ Prices Discovered?

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Abstract

In the creation of new environmental markets, prices for newly created assets must be discovered by market participants. We study price formation in newly created catch share markets, focusing on how relative prices received by small and large quota holders evolve as markets mature. Using transaction-level data from New Zealand individual transferable quota fisheries, we document substantial and persistent price discounts for smaller sellers in permanent quota sales. In contrast, price differences in lease markets are smaller and less systematic over time. Event-time analyses show that seller-size-related price gaps remain pronounced in sales markets well beyond program inception, while lease markets exhibit weaker and less stable patterns. These findings highlight the role of contract structure in shaping price dispersion in decentralized resource markets.

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1 Introduction

In the creation of new environmental markets, prices for newly created assets must be discovered by market participants. In general, prices in environmental markets are tied to marginal extraction costs or marginal abatement costs across heterogeneous firms. Aside from political concerns surrounding the initial allocation of permits (Costello and Grainger, 2022), there are often concerns about how trading itself may have distributional impacts. In particular, if large firms have better information about underlying asset values or better access to trading opportunities, informational asymmetries could lead large firms to offer small firms relatively low prices during the early consolidation period. Although such outcomes need not be inefficient, they raise equity concerns that can slow the adoption and expansion of market-based environmental policy. Evidence from other quota-based systems suggests that consolidation and changes in fleet structure can be substantial following the introduction of transferable rights, with implications for the distribution of rents (Abe et al., 2024). One concrete example is the West Coast groundfish IFQ program in the United States, where regulators initially imposed a moratorium on permanent quota share transfers during the first years of implementation, while allowing quota use and leasing arrangements as part of transitional measures to stabilize the emerging catch share market (Pacific Fishery Management Council, 2017).

Individual Transferable Quota (ITQ) prices reflect marginal costs as well as fisheries conditions (Arnason, 1990). Indeed, quota prices capitalize expectations about future rents, biological conditions, and regulatory risk. Newell et al. (2005) show that quota lease and sale prices in New Zealand behave in a manner consistent with forward-looking valuation, including a close relationship between lease prices, sale prices, and interest rates. Newell et al. (2007) formalize and empirically assess asset pricing in created markets, emphasizing how expectations about future rents shape equilibrium prices. Relatedly, Grainger and Costello (2014) show that insecurity in property rights is capitalized into natural resource asset values, with more weakly enforced or uncertain rights trading at a discount. While

this literature treats prices as informative signals of expected rents, it largely abstracts from strategic interaction and information asymmetries between buyers and sellers. Our analysis complements this work by examining how transaction prices vary systematically with seller size in decentralized quota trades.

This paper contributes to several strands of literature in natural resource economics and industrial organization, while filling a gap at their intersection.

First, it builds on the literature studying the transition from common-pool resources to property rights in fisheries. A large body of work documents efficiency gains, changes in harvesting behavior, and distributional consequences following the introduction of individual transferable quotas (ITQs). This literature emphasizes heterogeneity in marginal extraction costs across firms and shows that quota markets can reallocate harvesting rights toward lower-cost producers. Grainger and Costello (2016) highlight that while aggregate efficiency may increase, the distribution of rents across firms can change substantially following the introduction of property rights. Related work using Norwegian fisheries data documents substantial heterogeneity in cost structure and capacity across firms, reinforcing the empirical relevance of scale differences in quota-based systems (Nøstbakken, 2006a). Our analysis takes this heterogeneity as given but focuses on how differences in information or trading conditions correlated with seller size are reflected in transaction prices.

Second, a smaller literature examines quota markets directly, including the determinants of quota prices and trading activity. While this work treats quota prices as informative signals of expected rents, it typically abstracts from strategic interaction or information asymmetries between trading parties. We complement this literature by studying how prices vary with the relative size of sellers, conditional on transaction characteristics and market conditions.

Third, this paper relates to research on price dispersion and price formation in markets with costly information and decentralized trade. Classic models show that equilibrium price dispersion can arise even for homogeneous goods when information is costly (Stigler, 1961;

Burdett and Judd, 1983). In over-the-counter settings where trade is bilateral and negotiated rather than centralized, price dispersion and buyer-specific pricing can arise endogenously (Duffie et al., 2005). Quota trades—particularly permanent transfers—share these institutional features: they are often bilateral, infrequent, and negotiated, rather than conducted on centralized exchanges.

Finally, the paper contributes to a broader literature on information frictions in markets for productive assets and on price discovery under asymmetric information. Market microstructure models emphasize how heterogeneity in information can shape transaction prices even absent explicit market power (Glosten and Milgrom, 1985). More broadly, uncertainty about future stock and price conditions is a central feature of fisheries management problems, even in stylized settings (Nøstbakken, 2006b). We provide empirical evidence consistent with systematic differences in transaction prices across sellers in the context of natural resource rights, where information about fleet-wide cost conditions and future rents is costly to acquire and unevenly distributed.

2 Theoretical Framework

We build on the structure in Grainger and Costello (2016) and Costello and Grainger (2022). The framework allows us to motivate price dispersion in tradable quota markets and to understand how seller size may be related to transaction prices. The framework is intentionally reduced-form and is not intended to provide a fully specified equilibrium model of quota trading or bargaining as in Rubinstein (1982). Rather, it serves to organize the empirical analysis and to generate testable implications regarding price differences across sellers, contract types, and time.

The framework below abstracts from several important features of real-world fisheries. In particular, we treat biological stock conditions and total allowable catch as fixed within a season and do not model stock dynamics or feedbacks from catch share systems to stock

rebuilding over time (see Costello et al. (2008) for effects of catch share programs). We also abstract from entry and exit, investment, and strategic interactions across seasons. These simplifications allow us to focus narrowly on price formation in secondary quota markets and on how seller characteristics relate to transaction prices, holding biological and regulatory conditions fixed. The framework is therefore intended as a partial-equilibrium description of quota trading behavior rather than a comprehensive model of fisheries management outcomes.

2.1 Baseline Environment

Consider a fishery with a fixed total allowable catch (TAC) allocated across firms through tradable quota. Let \bar{Q}_s , which is chosen by the regulator, denote the total quota for stock s in a given season. Firms differ in their marginal extraction costs, which follow the structure in Grainger and Costello (2016). Let firm i 's marginal extraction cost be parameterized by θ_i , where higher θ_i implies higher marginal cost at all output levels.

Let $\rho_{s,t}$ denote the ex-vessel price of fish for stock s in season t . We treat $\rho_{s,t}$ as exogenously determined in international fish markets and taken as given by firms. Let $C(q_i; \theta_i)$ denote firm i 's extraction cost, increasing and convex in output, with marginal cost $C_q(q_i; \theta_i)$ increasing in θ_i .

In a frictionless competitive equilibrium with perfectly functioning quota markets, firms choose harvest levels such that, for all active producers,

$$p_{s,t} = \rho_{s,t} - C_q(q_i; \theta_i), \tag{1}$$

where $p_{s,t}$ denotes the per-unit price of quota. Equation (1) highlights that quota prices reflect the residual value of harvest rights after accounting for extraction costs. In such an environment, quota trades reallocate harvest rights toward lower-cost firms until marginal rents are equalized across producers.

2.2 Quota Holdings and Seller Size

Each firm begins the season with an initial quota endowment $q_{i,s,t-1}$. We define seller size using a firm's quota holdings relative to the total quota in the fishery,

$$s_{i,s,t-1} \equiv \frac{q_{i,s,t-1}}{Q_{s,t-1}}.$$

This lagged quota share reflects a firm's scale and market presence prior to the transaction and is predetermined with respect to contemporaneous trading outcomes.

Seller size is relevant because quota prices depend on expectations about the distribution of extraction costs in the fleet and, equivalently, about the residual rents embodied in quota. Firms may differ in their information about these objects. In particular, larger firms—by virtue of operating at greater scale and participating more frequently in quota and harvest markets—may have more precise beliefs about fleet-wide extraction costs and aggregate quota demand.

2.3 Beliefs and Price Formation

Let $\theta_{s,t}^*$ denote a summary object capturing the distribution of marginal extraction costs relevant for determining quota rents in stock s and season t . We do not require that quota prices be pinned down by a single marginal firm; rather, $\theta_{s,t}^*$ should be interpreted as an index summarizing the cost conditions that determine equilibrium quota values through equation (1).

We assume that sellers differ in the precision of their beliefs about $\theta_{s,t}^*$ as a function of seller size. Formally, let seller i 's belief be

$$\tilde{\theta}_{i,s,t}^* = \theta_{s,t}^* + \varepsilon_{i,s,t},$$

where $\mathbb{E}[\varepsilon_{i,s,t}] = 0$ and

$$\text{Var}(\varepsilon_{i,s,t}) = \sigma^2(s_{i,s,t-1}), \quad \sigma'(s) < 0.$$

Smaller sellers therefore have noisier beliefs about the cost conditions that determine quota rents.

2.4 Bilateral Trades and Price Dispersion

Quota trades occur bilaterally between buyers and sellers. A seller's reservation value for a unit of quota is determined by expected forgone rents from retaining that unit, which depend on beliefs about $\rho_{s,t}$ and $C_q(\cdot)$ through equation (1). When seller beliefs are imprecise, transaction prices may deviate from the equilibrium quota value implied by common knowledge of cost conditions.

This framework predicts systematic price differences across sellers even in the absence of market power or explicit frictions. Conditional on buyer identity and aggregate market conditions, sellers with noisier beliefs may accept lower prices on average than sellers with more precise beliefs.

Prediction 1 (Seller Size). Conditional on buyer identity and aggregate conditions, transaction prices are increasing in seller size:

$$\frac{\partial p_{i,s,t}}{\partial s_{i,s,t-1}} > 0.$$

2.5 Leases and Permanent Quota Transfers

Quota transactions can be permanent transfers or annual leases. Annual leases convey the right to harvest quota within a single fishing season, while permanent quota transfers convey a durable claim to a stream of future harvest rights. Let $p_{i,s,t}^L$ and $p_{i,s,t}^S$ denote lease and permanent quota prices, respectively.

Lease prices primarily reflect contemporaneous rents,

$$p_{i,s,t}^L \approx \rho_{s,t} - C_q(q_i; \theta_i),$$

while permanent quota prices reflect expectations over a stream of future rents,

$$p_{i,s,t}^S \approx \mathbb{E}_t \left[\sum_{k=0}^{\infty} \beta^k (\rho_{s,t+k} - C_q(q_{i,s,t+k}; \theta_i)) \right] - \mathbb{E}_t \left[\sum_{k=0}^{\infty} \beta^k \tau_{s,t+k} \right],$$

where β is a discount factor and $\tau_{s,t}$ captures wedges associated with permanent ownership, such as regulatory risk, illiquidity, or transaction costs.

Because permanent quota prices embed expectations over future conditions, differences in belief precision across sellers may have larger effects on permanent transactions than on leases.

Prediction 2 (Contract Type). Price differentials between large and small sellers are larger for permanent quota sales than for leases.

2.6 Timing Within the Season

Quota values may over time and within a fishing season as uncertainty over stock conditions, realized catches, and market conditions resolves (Fell and Haynie, 2016). Let $t \in [0, 1]$ index time within the season. As the season progresses, information about realized costs and quota demand may improve, potentially reducing belief dispersion across sellers.

This suggests that price differences associated with seller size may vary systematically over the course of the season, although the direction and magnitude of such variation depend on how quickly information is revealed and incorporated into transactions.

Prediction 3 (Seasonal Timing). Price differentials between small and large sellers vary over the fishing season.

2.7 Empirical Implications

Taken together, the framework predicts that conditional on buyer identity, time effects, and transaction characteristics, quota prices are systematically related to seller size, with stronger and more persistent differences in permanent quota markets than in lease markets. These predictions guide the empirical analysis that follows.

3 Data

3.1 Fisheries and Institutional Background

The analysis focuses on three New Zealand fisheries managed under the Individual Transferable Quota (ITQ) system: FLA3 (Flatfish 3, 4, 5, and 6 combined), PAU4 (Pāua/Abalone 4), and CRA8 (Spiny Rock Lobster 8). These fisheries were selected for three reasons. First, they span different biological stocks, harvest technologies, and economic environments. Second, all three were allocated quota in the late 1980s and have well-established secondary markets for quota and quota leases prior to 2001. Third, detailed transaction-level administrative records are available consistently across these stocks.

New Zealand's ITQ system allocates perpetual quota shares that entitle holders to a proportion of the Total Allowable Commercial Catch (TACC), which is set annually by the regulator. Quota can be transferred permanently through sales of quota shares or temporarily through annual leases. Permanent transactions reflect long-run expectations about future profitability and stock conditions, while leases primarily govern short-run reallocation of harvesting rights within a fishing year (e.g., Newell et al., 2005; Grainger and Costello, 2014).

The data were provided by Fisheries New Zealand (Ministry for Primary Industries) under a confidential data-use agreement. The raw transaction records cannot be shared or redistributed. All results presented in the paper are derived from these administrative

records, and no individual firm or transaction can be identified from the reported statistics.

For each stock, we observe complete transaction histories for the stocks described, covering the period from initial quota allocation through 2001, including both priced and unpriced transactions. Each record corresponds to a quota transfer event and includes the transaction date; quota quantity (in tonnes); price per tonne, where applicable; transaction type (permanent quota sales or annual leases); buyer and seller identifiers; regulatory flags; and stock identifiers. Initial government allocations are flagged as administrative assignment rather than market exchange.

Figures 1 and 2 summarize the evolution of lease and permanent quota prices by stock. Prices exhibit substantial dispersion within and across years, consistent with earlier evidence on New Zealand quota markets (e.g., Grainger and Costello (2014)). In robustness checks, we restrict attention to transactions within stock–type–year price ranges to assess sensitivity to potential clerical errors or protest prices.

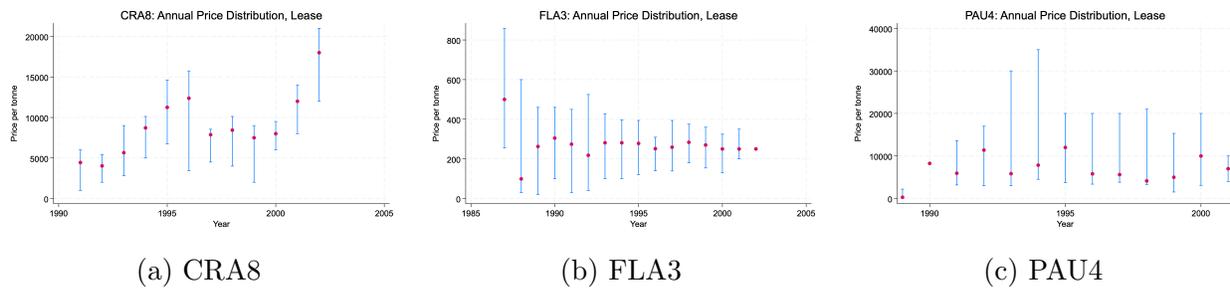


Figure 1: Annual quota lease prices by stock (median with 10th–90th percentiles)

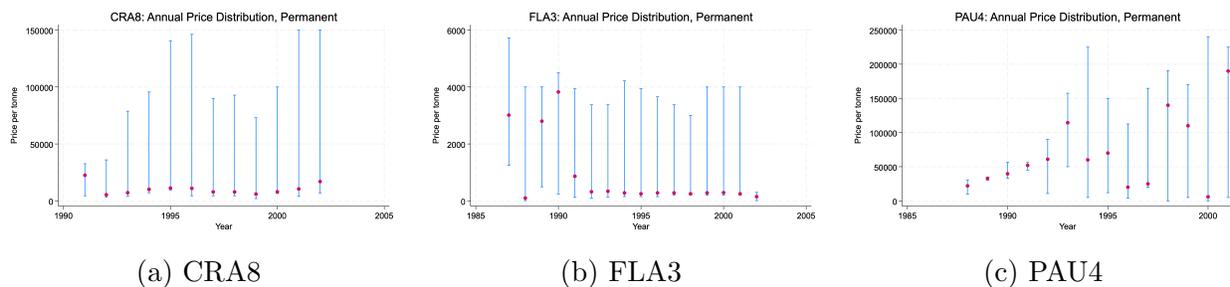


Figure 2: Permanent quota sale prices by stock (median with 10th–90th percentiles)

3.2 Construction of Quota Holdings and Seller Size

To measure firm size and market position, we reconstruct firm-level quota holdings dynamically over time using the full transaction histories. For each stock, we proceed as follows:

1. Identify initial quota allocations as the first appearance of quota holdings for each firm.
2. Track all subsequent purchases, sales, and leases, including transactions without prices.
3. Construct start-of-year quota holdings for each firm and fishing year by cumulatively updating holdings based on the complete transaction record.
4. Aggregate total quota holdings at the stock–year level to compute market totals.

This procedure yields firm-specific quota holdings (in tonnes) by stock and fishing year. Firms cannot be linked across stocks. Seller size is defined as a firm’s quota holdings relative to total quota in the stock.

In the baseline analysis, we measure seller size using the seller’s *lagged* quota share, defined as holdings in fishing year $t - 1$ when analyzing transactions in year t . Using lagged holdings ensures that measured size is predetermined with respect to contemporaneous trading outcomes and avoids mechanical correlation between current transactions and measured size.

As a robustness check motivated by the theoretical framework, we also consider an alternative definition of seller size based on *initial holdings*. Specifically, we define initial size using a firm’s average quota share during the first years following quota allocation and hold this classification fixed over time. This alternative measure captures long-run market position rather than contemporaneous trading activity.

3.3 Final Analysis Dataset

The final analysis dataset links transaction prices to seller characteristics at the time of trade. For each priced transaction, we observe the price per tonne; transaction quantity; transaction

type (lease versus permanent sale); buyer and seller identifiers; the seller’s lagged or initial quota share; stock; fishing year; and transaction date. Observations with clearly implausible prices are flagged using relative price rules based on stock–type–year medians and excluded in robustness checks.

The resulting dataset provides a comprehensive view of quota market activity in three major New Zealand fisheries, combining transaction-level prices with dynamically constructed measures of firm size and market position. This structure allows us to distinguish short-run lease markets from long-run ownership transfers and to study how prices vary systematically with seller characteristics across institutional contexts.

4 Empirical Approach

We examine how quota transaction prices vary with the size of the selling firm, focusing on pre-2001 quota trades in New Zealand fisheries. The empirical analysis is guided by the theoretical framework developed above, which emphasizes that quota prices reflect residual rents from harvesting and that seller size may be associated with systematic differences in information or trading conditions.

4.1 Baseline Specification

Our starting point is a transaction-level regression of log prices on seller size. For transaction i occurring in fishing year t , we estimate

$$\ln(p_{it}) = \beta \text{Share}_{s(i),t-1} + \gamma \ln(q_{it}) + X'_{it}\delta + \varepsilon_{it},$$

where p_{it} is the price per tonne paid in the transaction, $\text{Share}_{s(i),t-1}$ denotes the seller’s share of total quota in the relevant stock at the start of the previous fishing year, and $\ln(q_{it})$ is the logarithm of the quantity traded. The coefficient of interest, β , captures how prices vary with seller size, conditional on transaction size.

We estimate specifications separately for leases and permanent transfers, reflecting the distinct economic nature of short-term versus long-lived quota rights. Across specifications, we include $\ln(q_{it})$ in all regressions and progressively add fixed effects to assess robustness. The first specification includes no fixed effects. The second adds fishing-year fixed effects, absorbing aggregate shocks to quota values, stock conditions, and regulatory expectations. The third adds month-of-year fixed effects to capture within-season price variation. The fourth includes buyer fixed effects to absorb persistent buyer-specific pricing differences.

4.2 Initial Size Robustness

To assess whether the relationship between prices and seller size reflects long-run market position rather than short-run fluctuations in holdings, we re-estimate the baseline specifications using initial quota shares in place of lagged shares. Initial size is defined as a firm's average quota share during the first years following quota allocation and is held fixed over time. The resulting estimates are reported alongside the baseline results and allow us to distinguish persistent differences associated with long-run ownership from those linked to contemporaneous holdings.

4.3 Results

The results are shown in the Tables. Results are reported separately by stock for leases and permanent quota sales. We control for transaction quantity in every specification, and fixed effects are added progressively across columns.

Quota transaction prices vary systematically with seller size. Larger sellers tend to transact at different prices than smaller sellers, even after conditioning on transaction quantity and time effects. The estimates using initial quota shares closely track those obtained using lagged shares, indicating that the relationship between prices and seller size is not driven solely by short-run changes in holdings, though there are differences in significance (particularly for Paua) when using different measures of size.

The magnitude and precision of the estimated effects differ markedly across contract types. Price differences associated with seller size are larger and more precisely estimated for permanent quota transfers than for leases. In lease markets, the corresponding estimates are smaller and less stable across specifications.

4.4 Interpretation

Taken together, the baseline results document economically meaningful heterogeneity in quota prices across sellers and contract types. The stronger and more persistent price differentials observed in permanent quota markets suggest that long-run ownership transfers are more sensitive to seller characteristics than short-run leases.

While these patterns are consistent with the theoretical framework in which seller size proxies for differences in information or trading conditions, the empirical analysis does not uniquely identify the underlying mechanism. Alternative explanations—such as liquidity constraints, risk preferences, or search frictions—could also generate systematic price differences across sellers. The results therefore establish the presence of systematic price dispersion associated with seller size while remaining agnostic about the precise channel through which these differences arise.

5 Price Formation and the Small Seller Discount

The baseline regressions document systematic differences in quota transaction prices associated with seller size, with substantially larger and more persistent effects in permanent quota sales than in lease markets. While these estimates characterize average price differences, they do not indicate whether such differences are confined to the early years of the catch share system or persist as markets mature. To address this question, this section examines how seller-size-related price gaps evolve over market age using an event-time framework that tracks relative prices at comparable stages of program development.

5.1 Empirical Specification

Let p_{it} denote the price per unit of quota transacted in trade i at time t . We estimate variants of the following specification separately by stock and transaction type:

$$\ln p_{it} = \sum_{k \in \mathcal{K}} \beta_k (\mathbb{1}\{\text{Small}_i = 1\} \times \mathbb{1}\{\text{Age}_t = k\}) + \sum_{k \in \mathcal{K}} \alpha_k \mathbb{1}\{\text{Age}_t = k\} + \gamma \ln q_{it} + \delta_m + \mu_b + \varepsilon_{it}. \quad (2)$$

Here, $\ln q_{it}$ is the logarithm of the quantity traded and is included in all specifications. The terms δ_m and μ_b denote month-of-year and buyer fixed effects, respectively, which are included in preferred specifications. Standard errors are heteroskedasticity-robust.

The coefficients of interest are the interaction terms between a seller size indicator, Small_i , and a set of event-time indicators, $\text{Age}_t = k$, which measure the number of years since the introduction of the catch share program for a given stock. Event time is discretized into coarse bins,

$$\mathcal{K} = \{0, 1, 2-3, 4-5, 6-8, 9+\},$$

to allow for flexible but stable dynamics while avoiding reliance on sparsely populated cells.

5.2 Seller Size and Event Time

Seller size is defined using a stock-level baseline measure. For each stock, we compute a seller's average quota holdings over the first three years following program inception. Sellers in the bottom quintile of this baseline distribution are classified as *small sellers*. This classification is fixed over time and applied uniformly to both permanent and lease transactions, ensuring that seller size reflects underlying ownership rather than contemporaneous trading behavior.

Event time is defined relative to the first year in which the catch share program is observed for a given stock. This transformation replaces calendar-year fixed effects with market-age fixed effects, allowing prices to evolve flexibly with institutional maturity rather than with

time per se.

5.3 Identification

Identification of β_k relies on variation in prices across sellers of different baseline sizes within the same event-time bin, conditional on transaction characteristics and fixed effects. Because seller size is defined using pre-determined baseline holdings, it is not mechanically affected by contemporaneous trading outcomes. All specifications control for transaction quantity, and preferred specifications further include month fixed effects to capture within-season price variation and buyer fixed effects to absorb persistent buyer-specific pricing differences.

The event-time structure controls for common price movements associated with market maturation, so the interaction coefficients isolate differences in prices received by small and large sellers at comparable stages of program development. The estimates should therefore be interpreted as descriptive measures of relative pricing patterns over time, rather than as causal effects of seller size on prices.

5.4 Interpretation

The coefficients $\{\beta_k\}_{k \in \mathcal{K}}$ represent the *level difference* in log prices between small and large sellers within each event-time bin. Unlike specifications normalized to the program's inception year, this parameterization reports period-specific price gaps directly and does not anchor estimates to an initial baseline period.

Because the dependent variable is in logs, coefficients can be interpreted as approximate percentage differences. For example, a coefficient of -0.30 implies that small sellers receive prices roughly 30% lower than large sellers in a given event-time bin, while a coefficient of 0.30 implies a premium of approximately 35%.

Figures 3 and 4 plot the estimated coefficients β_k and their 95% confidence intervals for permanent quota sales and lease transactions, respectively. In both figures, all estimates

condition on transaction quantity, and the lease specification additionally controls for month-of-year fixed effects.

In permanent quota sales, the estimated price gaps are large in magnitude and persist across event-time bins, indicating that smaller sellers consistently receive lower prices than larger sellers even as the market matures. In contrast, lease markets exhibit substantially weaker and less systematic differences. While some coefficients differ from zero in intermediate periods, the overall pattern suggests that relative prices in lease markets are less strongly associated with seller size.

Taken together, these results indicate that seller-size-related price differentials are pronounced and persistent in permanent quota sales but are smaller and less stable in lease markets. This distinction highlights the role of contract duration in shaping price formation patterns in catch share systems.

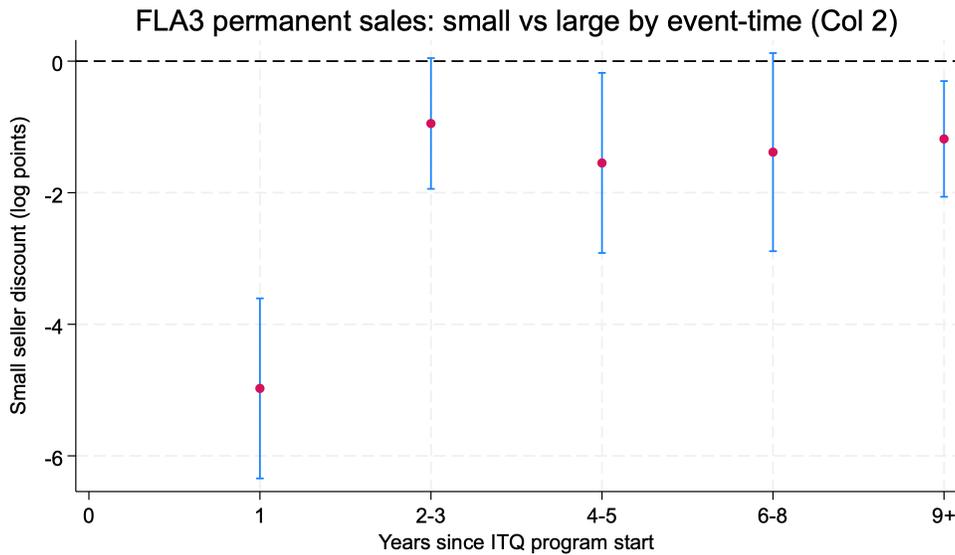


Figure 3: Small–large seller price gaps over time in permanent quota sales. Points show estimated log price differences between small and large sellers by event-time bin; bars denote 95% confidence intervals. Estimates control for transaction quantity but exclude month and buyer fixed effects.

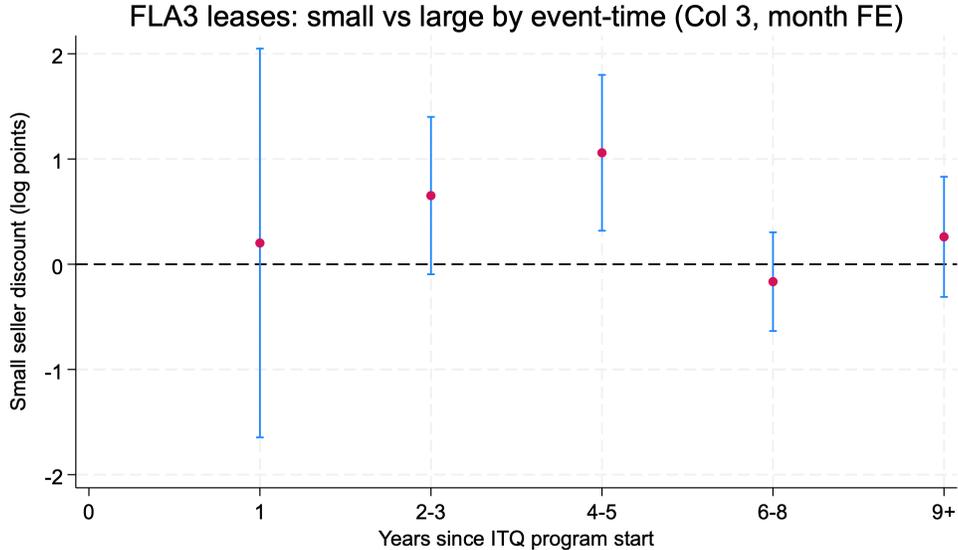


Figure 4: Small–large seller price gaps over time in lease transactions. Points show estimated log price differences between small and large sellers by event-time bin; bars denote 95% confidence intervals. Estimates control for transaction quantity and month fixed effects but exclude buyer fixed effects.

6 Conclusion

This paper studies price formation in newly created catch share markets, focusing on how quota transaction prices vary with seller size and contract type. Using transaction-level data from three New Zealand ITQ fisheries prior to 2001, we document systematic price differences associated with seller size, even after controlling for transaction quantity, time effects, and buyer fixed effects. These differences are large and persistent in permanent quota sales, while they are smaller and less stable in short-term lease markets. An event-time analysis further shows that seller-size-related price gaps in permanent sales persist well beyond the initial years of the program.

Our analysis is deliberately descriptive. While the patterns we document are consistent with a framework in which seller size proxies for differences in information, beliefs, or trading conditions in decentralized quota markets, the data do not allow us to isolate a unique mechanism. Alternative explanations—such as liquidity constraints, risk preferences, or search frictions—could also generate systematic price differences across sellers. Identify-

ing the precise channels underlying these price gaps remains an important topic for future research.

Despite this limitation, the results have clear implications for the design of catch share systems. The persistence of large price differentials in permanent quota sales suggests that early permanent transfers may lock in long-run ownership patterns that reflect transitory informational or market frictions rather than underlying efficiency. From this perspective, temporary restrictions or moratoria on permanent quota sales during the initial years of a catch share program may reduce the scope for irreversible reallocations occurring under immature market conditions. In contrast, the weaker and less systematic price differences observed in lease markets suggest that short-term trading may provide a lower-risk mechanism for reallocating harvesting rights while markets develop.

The findings also point to a potential role for institutional features that improve transparency and information aggregation in quota markets. Greater availability of transaction price information, standardized contracts, or centralized clearing mechanisms could reduce dispersion arising from decentralized bilateral trading and may improve price discovery, particularly in markets for permanent quota transfers.

Finally, this paper focuses on the early years of New Zealand's ITQ system. An important next step is to extend the analysis to more recent transactions and to other fisheries and jurisdictions. Examining whether seller-size-related price differences attenuate as markets mature, and whether institutional innovations alter price formation, will help clarify the extent to which the patterns documented here are transitional features of market creation or persistent characteristics of catch share systems. These extensions are a natural direction for future work and are especially relevant as catch share programs continue to expand globally.

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Tables

Table 1: FLA3 Permanent Sales: $\ln(\text{price})$ on lagged quota share and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
seller_share_lag	7.031*** (2.699)	6.336*** (2.432)	6.826*** (2.498)	0.496 (2.854)
ln_qty	-0.084*** (0.031)	-0.099*** (0.030)	-0.109*** (0.031)	-0.076** (0.033)
N	1254.000	1254.000	1254.000	1254.000
R-sq	0.012	0.146	0.163	0.627
$\ln(\text{qty})$	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Table 2: FLA3 Permanent Sales: $\ln(\text{price})$ on initial seller size and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
Initial seller size: mean seller_share in first 3 years	0.537 (3.260)	1.109 (2.702)	0.435 (2.800)	-7.327 (8.529)
ln_qty	0.066 (0.072)	-0.007 (0.059)	-0.044 (0.059)	-0.164 (0.104)
N	250.000	250.000	250.000	250.000
R-sq	0.003	0.309	0.444	0.842
$\ln(\text{qty})$	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: FLA3 Lease Market: $\ln(\text{price})$ on lagged quota share and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
seller_share_lag	-4.074*** (1.008)	-3.404*** (0.994)	-3.410*** (0.989)	-2.577* (1.517)
ln_qty	0.044** (0.020)	0.032 (0.020)	0.034* (0.020)	0.035 (0.025)
N	975.000	975.000	975.000	975.000
R-sq	0.023	0.095	0.113	0.592
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Table 4: FLA3 Lease Market: $\ln(\text{price})$ on initial seller size and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
Initial seller size: mean seller_share in first 3 years	4.189*** (1.251)	3.112** (1.352)	3.377** (1.412)	-2.079 (3.437)
ln_qty	0.046 (0.036)	0.056 (0.036)	0.046 (0.039)	-0.055 (0.068)
N	390.000	390.000	390.000	390.000
R-sq	0.048	0.159	0.196	0.751
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: CRA8 Permanent Sales: $\ln(\text{price})$ on lagged quota share and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
seller_share_lag	18.803*** (4.707)	8.573* (4.792)	8.177* (4.512)	-5.739 (3.703)
ln_qty	-0.020 (0.025)	-0.014 (0.024)	-0.025 (0.027)	-0.070*** (0.020)
N	2233.000	2233.000	2233.000	2233.000
R-sq	0.009	0.088	0.150	0.646
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Table 6: CRA8 Permanent Sales: $\ln(\text{price})$ on initial seller size and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
Initial seller size: mean seller_share in first 3 years	-0.639 (3.377)	4.419 (3.478)	5.905* (3.328)	-4.161 (4.062)
ln_qty	-0.056* (0.030)	-0.030 (0.030)	-0.051 (0.032)	-0.088*** (0.024)
N	1481.000	1481.000	1481.000	1481.000
R-sq	0.003	0.098	0.168	0.705
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: CRA8 Lease Market: $\ln(\text{price})$ on lagged quota share and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
seller_share_lag	-27.887*** (2.152)	-16.758*** (1.980)	-14.856*** (1.800)	-8.632*** (2.354)
ln_qty	0.109*** (0.016)	0.080*** (0.015)	0.016 (0.015)	0.027* (0.015)
N	1392.000	1392.000	1392.000	1392.000
R-sq	0.118	0.469	0.559	0.698
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Table 8: CRA8 Lease Market: $\ln(\text{price})$ on initial seller size and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
Initial seller size: mean seller_share in first 3 years	-25.419*** (2.385)	-19.648*** (2.115)	-16.613*** (1.816)	-10.019*** (3.690)
ln_qty	0.147*** (0.021)	0.095*** (0.018)	0.022 (0.018)	0.015 (0.020)
N	807.000	807.000	807.000	807.000
R-sq	0.153	0.517	0.608	0.762
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: PAU4 Permanent Sales: $\ln(\text{price})$ on lagged quota share and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
seller_share_lag	17.763*** (4.153)	16.779*** (5.267)	16.245*** (5.587)	-4.117 (6.156)
ln_qty	-0.268*** (0.069)	-0.262*** (0.070)	-0.126* (0.070)	-0.008 (0.081)
N	356.000	356.000	356.000	356.000
R-sq	0.053	0.145	0.309	0.768
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Table 10: PAU4 Permanent Sales: $\ln(\text{price})$ on initial seller size and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
Initial seller size: mean seller_share in first 3 years	9.770*** (3.513)	5.801 (4.551)	7.501 (5.672)	27.425 (46.474)
ln_qty	-0.185* (0.103)	-0.073 (0.083)	-0.033 (0.108)	-0.294 (0.349)
N	103.000	103.000	103.000	103.000
R-sq	0.071	0.560	0.593	0.679
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: PAU4 Lease Market: $\ln(\text{price})$ on lagged quota share and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
seller_share_lag	7.386*** (2.513)	3.273 (2.860)	4.249 (2.973)	-0.068 (3.536)
ln_qty	-0.180*** (0.061)	-0.114* (0.062)	-0.093 (0.059)	-0.088 (0.076)
N	277.000	277.000	277.000	277.000
R-sq	0.034	0.140	0.201	0.625
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Table 12: PAU4 Lease Market: $\ln(\text{price})$ on initial seller size and $\ln(\text{qty})$

	(1)	(2)	(3)	(4)
Initial seller size: mean seller_share in first 3 years	19.253*** (3.053)	17.676*** (1.773)	15.996*** (2.499)	31.760*** (5.484)
ln_qty	-0.324** (0.157)	-0.129 (0.158)	0.061 (0.117)	0.002 (0.154)
N	55.000	55.000	55.000	55.000
R-sq	0.392	0.802	0.891	0.985
ln(qty)	X	X	X	X
Year FE		X	X	X
Month FE			X	X
Buyer FE				X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In the creation of new environmental markets, prices for newly created assets must be discovered by market participants. We study price formation in newly created catch share markets, focusing on how relative prices received by small and large quota holders evolve as markets mature. Using transaction-level data from New Zealand individual transferable quota fisheries, we document substantial and persistent price discounts for smaller sellers in permanent quota sales. In contrast, price differences in lease markets are smaller and less systematic over time. Event-time analyses show that seller-size-related price gaps remain pronounced in sales markets well beyond program inception, while lease markets exhibit weaker and less stable patterns. These findings highlight the role of contract structure in shaping price dispersion in decentralized resource markets.

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