# Use it or Lose it: A Bio-economic Model of Quota Utilization Rules in an ITQ Fishery

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## Introduction

- Movement to property rights-based management of natural resources:
  - Cap-And-Trade
  - Water quality trading programs
  - Fishery catch shares or Individual Transferable Quotas (ITQs)
- Social & economic goals embedded in ITQ design
  - Efficiency costs of social objectives (Kroetz et al. 2015)
  - Consolidation of fishing fleet (Willmann 2000, Carothers 2010)
- Quota under-utilization
  - Use-it-or-lose-it penalties in water trading, export permits
  - How to incentivize productive use of permits
- Fisheries as key contributor to export earnings, food security, & employment in developing countries (Smith et al. 2010)

### TOTAL ALLOWABLE CATCH (TAC)





## **Research Questions**

- How do configurations of property rights based management influence efficiency-equity trade-offs?
  - How do use-it or lose-it policies in constructed resource markets influence firm behavior under economic and ecological uncertainty?
  - What are economic efficiency and distributional outcomes generated by use-it or lose-it policies?







## Outline

- 1. Theoretical Framework & Model
- 2. Empirical Motivation & Context
- **3.** Preliminary Empirical Analysis
- 4. Summary & Next Steps

## **Theoretical Framework**

- Fishery Management & Harvest under Uncertainty
  - Reed (1979); Clark & Kirkwood (1986); Costello et al. (2001); Weitzman (2002);
    Sethi (2005); Kennedy & Barbier (2015)
  - Two-period decision model
  - Sources of Uncertainty:
    - Environmental, Market, Institutional

## Production Uncertainty & Quotas as options

- Anderson (1987), Appelbaum & Lim (1985), Pakes (1986), Newell (2005), Weninger & Just (2002), Singh & Weninger (2015)
- Firms bid for quota prior to production
- Production & market uncertainties
- Uncertainty: optimal for forward-looking agents to incur short term net losses to maintain the future **option value** of holding the quota and associated return



Photography: Stephanie Stefansk

## Model: Firm's Problem



## Model: Use it or Lose it

#### **Annual Profit Function:**

$$\Pi_{t} = \begin{cases} p(F_{1t}^{\alpha}X_{1t} + F_{2t}^{\alpha}X_{2t}) - c(F_{1t} + F_{2t}), F_{1t}^{\alpha}X_{1t} + F_{2t}^{\alpha}X_{2t} < q_{t} \\ pq_{t} - c(F_{1t} + F_{2t}), o/w \end{cases}$$

## **Annual Quota Transition Function:**

$$q_{t+1}(y_t) = \begin{cases} q_t, & y_t \ge 0.9\\ \sum_{m=1}^{M} F_{m,t}^{\alpha} X_{m,t}, & y_t < 0.9 \end{cases}$$

Long-Run Steady-State Quota:

$$\bar{q} = \mathbb{E}[\mathbf{F}_{1t}^{\alpha}\mathbf{X}_{1t} + \mathbf{F}_{2t}^{\alpha}\mathbf{X}_{2t}]$$

# **Expected Outcomes**

- Value function higher under stochastic case due to updating production decisions after 1<sup>st</sup> period observations
- Intra-seasonal and inter-seasonal dynamics
- Once in equilibrium quota holding,
  - Stochastically bad year: exert more effort in 2<sup>nd</sup> period to avoid penalty
  - Stochastically good year: exert less effort in 2<sup>nd</sup> period to avoid excess costs and penalty
- If quota > equilibrium quota, harvest patterns will depend on future expectations of market and environmental conditions

# Next Steps for Model

- How to measure the impact of Use It or Lose It on equity-efficiency outcomes?
  - Resource rent & economic efficiency
    - Permit price (Kroetz et al. 2015)
    - Distribution of landings (Gini coefficient) (Birkenbach et al. 2017)
  - Equity
    - Distribution of quota holdings across sectors
- Modeling approaches absent counterfactual
  - Structural model
    - Nested Fixed Point Algorithm (Rust 1987)
    - Conditional Choice Probability (Hotz & Miller 1993)

## Empirical Application: ITQ Program in Argentina

- ITQ program designed to achieve both social & economic objectives
- Implemented 2010 in four fisheries
- 25% of total fisheries export value
- Permanent and temporary transfers
  - Two year limit on leases
- Unidirectional trading restriction:
  - Coastal fleet can buy from but not sell to offshore processing fleet
- "Use-it-or-lose-it":
  - Vessels lose quota for insufficient use (under 90%)
  - 2013 Reallocation Fund:
    - *Give up* quota to avoid a penalty
    - Pay an administrative fee to receive quota
    - Exogenous Deadline: 11/2013, 9/2014, 6/2015-2016



	Species	Country	Export Value per ton (USD)
a for the second	Chilean Seabass	Argentina	19,565
	Argentine red shrimp	Argentina	6,320
2	Cod	United States	2,936
	Southern blue whiting	Argentina	2,850
	Hake (Fillets & Steaks)	United States	2,845
	Argentine Hake	Argentina	2,464
	Surimi	United States	2,363
	Pollock	United States	2,155
	Argentine Hoki	Argentina	2,116
and the second s	Hake, Whiting (Fresh & Frozen)	United States	1,623



## Fleet Composition: Fishing Vessels

Attribute	<b>Offshore Catcher/Freezer Processor</b> Fleet (Arrastreros)	Coastal Ice Trawler Fleet (Fresqueros)
Vessel type	Double-beam & factory trawler Freezer trawler processor Long-liner	Rada o ria (yellow fleet) Costeros (coastal) Fresqueros (ice trawler)
Length	25-80m	10-65m
Average Trip Length	60-70 days	4-15 days
Storage	Freezer hold	On ice storage
Processing	Onboard	Onshore
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## Data

- 20 years of legislative documents (1998-2018)
- Annual ITQ reports (2010-2016)
- Monthly landings & effort data, by boat and fishery (2006-2016)
- Monthly fuel and export price data
- Semi-structured surveys with fishery management authorities and participants





## Survey Sample

- Semi-structured survey
- Seven Industry representatives from fisheries chambers and councils, national government, and unions
- Managers from **11 firms** located in Buenos Aires & Patagonia ports.
  - Four freezer trawler operators
  - Seven ice trawler or coastal vessel operators
  - **Eight** hold quota for the hake fishery

# Survey Results

#### **POLICYMAKERS:**

- Firms give up quota due to lack of profitability or to avoid the "use-it-or-lose-it" penalty
- Use-it-or-lose-it penalty meant to incentivize productive use and prohibit permanent lease of quota to other vessels
- Disincentive to trade quota
- Quota could be valuable in future firms don't want to permanently lose access

#### FIRMS:

- Overall supportive of ITQs, BUT...
- Offshore vessels indirectly receive coastal vessel quota through Administrative Fund when ice trawlers give up quota to avoid penalty
- Give up quota to **avoid insufficient use penalties** or to target shrimp.
- N=11

• N=7

How do use-it-or-lose-it penalties in constructed resource markets influence firm behavior, specifically extraction timing and patterns, under economic and ecological uncertainty?

# Exploratory Empirical Analysis

#### Total Number of Hake ITQ Permanent Transfers, 2009-2016



#### Mean Percentage of Hake ITQ Utilization, 2010-2016



Graphs by Vessel fleet type

#### Hake ITQ Insufficient Use Penalties, 2010-2016







#### Ice Trawler Fleet: Annual and Monthly Quota Use, 2010-2015

10 11 12

10 11 12



Graphs by year

#### Freezer Trawler Fleet: Annual and Monthly Quota Use, 2010-2015

2012

2015

10 11 12

9 10 11 12

5 6 7 8 9

5

6 7 8



Graphs by year

# Summary

- Mixed evidence on determinants of decision to give up quota
- Dynamic decision
- Initially high level of quota trading in both fleets
  - Vessels generally hold equilibrium level of quota, but may target other species
- Uncertainty regarding future price and abundance of red shrimp
- Coastal and ice trawler vessels appear to be disproportionately hurt by this policy
- Under what conditions might this be at least a second-best policy in ITQ design?
  - Discourage discarding and high-grading
  - Encourage productive use of quota & innovation
  - Limit perpetual leasing
  - Ensure greater redistribution of quota among vessels

## **Next Steps**

- Implement dynamic structural model to model harvest & quota participation decisions of firms
- Estimate drivers of participation in fishery under uncertainty
- **Expect** to find different social and economic outcomes across different fisheries, fleet types, and coastal regions.



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