The value of secure property rights: global evidence from fisheries*

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Abstract

Property rights are often touted as a solution to common pool resource problems. But in practice the strength and security of these property rights varies significantly; this variation is expected to affect asset value. In fisheries, the property rights underlying individual transferable quotas (ITQs) very substantially both within and across countries, though the implications of the security of these rights has not been carefully studied. We compile a unique dataset covering ITQ sales and lease prices for fisheries in several countries, and examine the relationship between property rights strength and the value of fishery assets. We find that stronger property rights are associated with substantially higher asset values and lower implied discount rates. This result confirms basic economic intuition, and informs current policy debate on the design of property rights institutions for natural resources.

1 Introduction

Property rights and institutions are believed to have a profound impact on investment and economic growth, but it is difficult to disentangle the effects of institutions on economic variables. Some researchers have studied the effects of property rights institutions on economic growth (e.g. Acemoglu and Johnson, 2005), while others have focused on the effect of institutions on land investment or agricultural productivity (e.g. Alston, Libecap and Schneider, 1996; Banerjee, Gertler and Ghatak, 2002). This paper contributes to this broader literature by examining the effect of stronger property rights on the value of common pool resources.

To overcome the problems pervasive in common pool resources (e.g. Gordon, 1954), rights-based management approaches are increasingly employed globally. Strong evidence of increased economic and ecological performance from rights-based approaches has emerged (Grafton et al., 2000; Costello et al., 2008), and policy and academic debate has shifted away from 'whether' these approaches are effective toward questions of design. Many design elements are likely to affect the security of a property right. For example, so-called "sunset clauses" after which rights are revoked and redistributed will affect stewardship and value (Costello and Kaffine, 2008) and assignment of rights to only a portion of the resource stock may erode conservation incentives and therefore asset value. Despite their ubiquity and importance for design, the extent to which these limitations on

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property rights security affect behavior and economic value has not been carefully studied. The purpose of this paper is to empirically examine the effect of property rights security on asset values.

In fisheries, where the common pool feature has lead to widespread collapse (e.g. Worm et al., 2006) there is a significant trend toward property-based approaches. Individual Transferable Quotas (ITQs) are the most prevalent form in the industrialized world, where the holder of ITQ can use, sell, or lease the right to a share of the total allowable catch. ITQs have been hailed by economists as a means to secure the rents in fisheries. But in practice, the design of ITQ systems varies significantly across fisheries; these design idiosyncracies affect property rights security in complex ways.

Fisheries in developed countries have largely transitioned from open access to limited entry, where the number of vessels is restricted, and often an overall quota is set for all licensed fishermen. Under such management, resource rents are dissipated in the race to fish and overcapitalization (Homans and Wilen, 1997). Because of the problems associated with limited entry management, some fisheries have moved to catch shares or other rights-based management. In this paper, we focus our analysis exclusively on ITQ fisheries.

Under ITQ management, a share of the total allowable catch (TAC) is allocated to individuals (or firms or cooperatives), who then hold the right to harvest their share each year. In general, the holder of an ITQ can exercise that right and harvest their share of the TAC, lease their share to another individual, or sell their share. This has been shown to help achieve allocative and technical efficiency (Grafton, Squires and Fox, 2000), which adds significant value in a fishery. In addition to eliminating the "race to fish," ITQ management has been shown to reverse the collapse of fisheries (Costello, Gaines and Lynham, 2008).

Since the introduction of the first ITQs in the mid-1980s in Iceland and New Zealand, ITQ fisheries have been established in many countries. The general structure of ITQ management has been adopted widely, but ITQs as property rights are viewed very differently by governments around the world. In New Zealand, ITQs are viewed as perpetual rights to fish. A quota is a legal asset, and fishermen can use them as collateral in establishing credit with banks. On the other hand, in Canada and the United States ITQ ownership is considered a revocable privelege, and the future of ITQ property rights (at least in the long run) is uncertain.

Economic theory suggests that the strength of property rights should affect the value of a quota share, but the current lease value should be unaffected by uncertainty about the security of the quota in the future. That is, the lease rate should be equal to the current year's (expected) rents, whereas the sale price of a quota equals the sum of expected future discounted rents. Therefore, controlling for the average lease rate and the market interest rate, the more secure the property right is, the more value the market should place on the quota as an asset. We exploit differences in property rights across countries to determine the market implications of secure ownership of these assets and therefore the value of fisheries. We then exploit variation in the exclusivity of the property right within New Zealand to determine the impact of more secure property rights on the dividend price ratio, a measure of the implied discount rate in asset markets.

2 Background

2.1 Property Rights and the Value of Quota Shares

ITQs allow the capture of resource rents by eliminating the race to fish and allowing the price mechanism to flow harvest rights toward the most efficient fishermen. Viewed as an asset, however, there is considerable variation in the strength of property rights across countries.

Every country imposes idiosyncratic limitations on trades, duration, and use of ITQ shares, including (but not limited to) caps on ownership shares, restrictions on ownership by foreign fleets, vessel capacity or gear restrictions, and sunset provisions. Rather than modeling structurally the independent and combined effects of these restrictions,[1] we will take a reduced form approach and leverage the fact that the ITQ asset price should capitalize this array of limitations and restrictions. By calculating the dividend price ratio in each fishery through time, we are able to tease out the economic significance of property rights security.

2.2 ITQs as Property Rights

Experience with ITQ management varies widely, beginning with New Zealand as an early adopter in 1986. Species have been subsequently added over the past two decades, and there are currently 98 species (or species groups) under quota management in New Zealand, with 690 separate management areas.

North America has taken a more cautious approach toward ITQ adoption. Canada's Pacific Sablefish and Halibut ITQs were introduced in 1990, and the United States implemented its first ITQ program in the mid-Atlantic surf clam and ocean quahog fishery in the same year. Since the introduction of the first ITQs, several stocks have been added in the United States and Canada; the fisheries included in the analysis are listed in Table 1. While the general principle behind ITQs is the same in these countries, the governments have very different legal definitions of the quota share held by individuals; these imply palpable differences in property rights security. [2]

2.2.1 United States

In the United States, the resources in a marine fishery are deemed "common property," which is held in trust by the government for the community at large. Such resources cannot be transferred to individuals. The Magnuson-Stevens Act[3] holds that quota shares "shall be considered a permit;" "may be revoked, limited, or modified at any time;" "shall not confer any right of compensation to the holder...if it is revoked, limited, or modified;" "shall not create, or be construed to create, any right, title, or interest in or to any fish before the fish is harvested by the holder;" and "shall be considered a grant of permission to the holder of the quota share to engage in activities permitted by such...quota share."

As a result of this insecure property right, there is uncertainty about the future of the program, and holders of quota shares are generally unable to use their holdings as collateral at banks.[4] As anecdotal evidence, when asked why this is the case, a fisherman in the Red Snapper fishery in the Gulf of Mexico stated that "we don't really own anything. In the legal language, it's a privilege. There's always a danger that the government can change its fishery policy down the road, and then

[1] Arnason defines what he calls a "Q-Value", which is a measure of the quality (or strength) of property rights in fisheries. The Q-Value is a weighted index of assigned values for exclusivity, security, durability, and transferability, but in the current empirical setting the practical use of this index has limitations. Use of the Q-Value requires assigning values to each stick in the bundle for an individual country, and creating a weighted index of these scores to come up with an overall score for the property rights strength.

[2] Watts and LaFrance (1994) and Libecap (1981) look at grazing permits; Rucker, Thurman and Sumner (1995) examine agricultural quota transfers; and Johnson, Gisser, and Werner (1981) focus on water rights transfers in the Western United States.

[3] 16 U.S.C. 1801, 1996.

[4] This is not due to legal constraints, but rather the bank's willingness to accept a quota share as collateral. A recent exception in the United States is the ability of Alaskan fishermen to leverage against IFQ holdings with some Seattle-based banks.

the quota would be worthless."[5] Another expressed his concern that the ITQ management would disappear after the five-year review.

2.2.2 Canada

Under Canadian law, ITQ shares are also considered a revocable privilege, and a resistance to ITQs has led to other catch share systems (Enterprise Allocations) in the Atlantic Provinces. Although fish are considered "Property of the Crown" in Canada, in 2008 the Supreme Court ruled that fishing quota are "property" for the purposes of the federal Banking and Insolvency Act (Saulnier v. Royal Bank of Canada[6]). ITQs are in place in several fisheries in British Columbia (see Table 1), but restrictions on trading were cited as a constraint on potential efficiency gains in the halibut fishery. They argue that "substantial long-run gains in efficiency can be jeopardized by preexisting regulations and the bundling of the property right to the capital stock"(Grafton, Squires, and Fox, pg. 679).

2.2.3 New Zealand

In New Zealand, explicit property rights are established in the creation of ITQs. The right to a share of the catch is held in perpetuity, and when a program is discontinued, or where the allocation is changed by the regulator, fishers are entitled to financial compensation. Indeed, in the initial allocation of quota under the Quota Management System (QMS), allocations were in terms of tonnes, and the TAC was fixed. When fishery managers subsequently decided to lower the TAC, quota were bought back in an expensive scheme.[7] This buyback will be discussed further and leveraged in the empirical strategy in Section 5.

3 Theoretical Background

Economic theory allows us to examine the value of secure property rights by using information inherent in the relationship between lease and sales prices of quota shares.[8] In a competitive market the lease price of an ITQ should be equal to the expected economic rents from the current year. The lease price is given by $p_{it} = E\left[r_{it} - c_{it}\right]$, where r_{it} represents the revenues and c_{it} represents the economic costs in fishery i and year t; the expectation operator, $E\left[\cdot\right]$ simply reflects the fact that revenue and cost need not be known with certainty for this simple analysis to apply. Similarly, the sales price of an ITQ should be equal to the sum of expected discounted rent streams. If rights are secure and held in perpetuity, the current sales price is $\pi_{i0} = \sum_{\tau=0}^{\infty} \frac{E[r_{i,\tau} - c_{i,\tau}]}{(1+\delta)^{\tau}}$.

If the fishery is operating in steady state, expected costs and revenues are constant over time. Then the ratio of the lease price to sales price of an ITQ can be written compactly as $\frac{p_{i0}}{\pi_{i0}} = \frac{\delta}{1+\delta}$. This ratio is commonly used in finance to test future expectations about earnings, to compare measures of asset value across geographically distinct markets, and to test for bubbles in asset markets (see, e.g., Campbell and Shiller, 1988 and Cochrane, 1991). In that literature, it is referred to as the *dividend price ratio*, to which we will conform here. Under the simple model above, the dividend price ratio should be a function of only the discount rate, δ. However, this simple result implies an infinitely secure property right.

[5] Personal communication with Keith "Buddy" Guindon, April 6, 2009.

[6] 2008 SCC 58.

[7] For a detailed overview of the history of the Quota Management System, see Rees, 2005.

[8] A famous application of this type of reasoning is in Fogel and Engerman (1974), who examine slave price trends leading up to the end of the Civil War.

Suppose instead that participants in the market for quota share in fishery i place some non-zero annual probability, θ, on the government discontinuing the catch share system (or shutting down the fishery). In that case, the lease value remains unchanged, but the sales value (at time 0) is now given by

$$\pi_{i0}^{uncertain} = p_{i0} + \sum_{\tau=1}^{\infty}(1-\theta)^{\tau}\frac{E\left[r_{i,\tau} - c_{i,\tau}\right]}{(1+\delta)^{\tau}}. \tag{1}$$

If the fishery is in steady state, it is straightforward to show that the dividend price ratio is given by:

$$\tilde{R} = \frac{1+\delta-(1-\theta)}{1+\delta}, \tag{2}$$

All else equal, less security about ownership in an ITQ program leads to a predictable effect on the dividend price ratio, $\tilde{R}$. Perhaps of more practical significance, we can solve Equation 2 for the annual revocation probability, θ:

$$\theta = \tilde{R}(1+\delta) - \delta \tag{3}$$

For example, suppose the dividend price ratio is $\tilde{R} = 0.15$ (a typical value from the ensuing empirical analysis), and that the relevant discount rate is $\delta = 0.05$. These values imply an implied annual revocation probability of about 11%. Instead, if $\tilde{R} = 0.10$, the annual revocation probability is about 6%. We can use this formula in Equation 3 to tease apart the implied strength of property rights in two different fisheries with the same δ. The difference between annual revocation probabilities in fisheries i and j are given by:

$$\theta_i - \theta_j = (1+\delta)(\tilde{R}_i - \tilde{R}_j) \tag{4}$$

which provides a convenient means to compare property rights strength across fisheries.

In cases where ownership of an ITQ is considered a privilege and is not guaranteed in perpetuity, the sales price would be lower, while the lease price would remain unchanged. Similarly, if exclusivity of the right to a share of the TAC is attenuated by fishery-specific characteristics, $\tilde{R}$ would be high. All else equal, $\tilde{R}$ should be lower where property rights are secure.

The goal of this paper is to test the hypothesis that strong property rights lead to a lower dividend price ratio in the context of renewable resources. Using sales and lease prices from countries with varying strengths of property rights, we first test for differences in the dividend price ratio across countries. We then focus on differences in dividend price ratios within countries, examining how fishermen implicitly perceive the future value of quota holdings. Because ITQ programs are generally subject to federal laws that define catch shares, it is difficult to obtain within-country heterogeneity in property rights security. For within-country evidence, we exploit variation in the exclusivity of the property right across fisheries resulting from enforcement of the property right (illegal harvesting) and biological characteristics (migratory species). Furthermore, we exploit a policy shock to look for evidence that discounting behavior changed in quota markets following a high-profile buyback.

4 Data Description

We have compiled a unique panel dataset spanning hundreds of ITQ fisheries in three countries. The primary variables of interest involve ITQ share sales and lease prices. Because data on individual transactions are generally not available, we use annual average prices for sales and leases of quota shares in three countries: Canada, the United States, and New Zealand. Variables that can affect the price of quota shares include the TAC, ex-vessel prices, the market interest rate, and biological characteristics of the species. A detailed description of the data sources is available from the authors.

Data from New Zealand are the most comprehensive and come from FishServe, the New Zealand Seafood Industry Council, and the Ministry of Fisheries. For each species under quota management and for each management area, we have average annual prices for sales and leases, average greenweight tonnage prices,[9] the total allowable commercial catch, and biological data from the Ministry of Fisheries and FishBase. Consistent with previous studies, a small number of observations are omitted from the analysis because they likely contain significant errors (e.g. because sales prices are unreliable in thin markets). However, including these observations does not qualitatively change our results.

Canadian quota prices are from management reports, Department of Fisheries and Oceans consulting reports from Nelson Bros., and Individual Fishing Quota reports from Munro & Associates. Canadian quota included in the analysis are British Columbian halibut, sablefish coastwide hake, gulf hake, arrowtooth flounder, and "uncut" groundfish quota.

Finally, United States data come from the National Marine Fisheries Service (NMFS) and regional management councils. Fisheries under ITQ management included in the analysis are the Alaskan Halibut and Sablefish, the Gulf of Mexico Red Snapper, and the Virginia Striped Bass fishery.[10] Table 2 lists North American ITQ fisheries in the analysis.

As an introduction to the data, consider a simple graph of the median $\tilde{R}$ across time for New Zealand, Canada, and the United States (Figure 1). While this simple graph fails to control for other factors (e.g. the interest rate, fishery characteristics, etc.), it suggests there might be a systematic difference across countries. The median $\tilde{R}$ in New Zealand always falls below that of the US, and typically falls below that of Canada. Furthermore Canada's median $\tilde{R}$ is typically below that of the United States. This graphical evidence is consistent with our theory that property rights are most secure in New Zealand, somewhat less secure in Canada, and substantially less secure in the United States. The spike in 2007 for the United States includes only the first year of ITQs in the Red Snapper fishery. In 2008, both the Red Snapper and Virginia Striped Bass are included. These ratios tend to be significantly larger than US halibut and sablefish, which are included in earlier years in the figure.[11] In New Zealand, there is a downward trend from the first year of the Quota Management System (QMS) until present. The median ratio in the first year of the program was about 15%, whereas that rate in 2008 was near 8%. As is clear from Equation 2, the interest rate appears to play a key role in determining this ratio.

To motivate our approach, consider similar fisheries in the United States and New Zealand. The Snapper fishery (SNA) in New Zealand was first put under quota management in 1986, and the median $\tilde{R}$ for that species group for the first three years of the program (a period of extremely high interest rates) was about 17%, and over the entire series the median $\tilde{R}$ is about 8.8%. On the other hand, the Red Snapper fishery in the Gulf of Mexico had a mean $\tilde{R}$ of about 27% during the first two years of the ITQ program. Though biologically similar, the implicit revocation probability in the Red Snapper fishery is much higher. In the following section, we control for interest rates and a variety of other factors that could affect ($\tilde{R}$).

In Figure 2 for each New Zealand species under ITQ management we show a scatter plot of

[9]In New Zealand, ex-vessel prices are not available for the entire time period. Following Newell, Sanchirico and Kerr (2005), we calculate greenweight tonnage prices using export price data for each year, and conversion factors from Clement and Associates.

[10]At this time, data from the Alaskan Crab fishery are not available. Furthermore, we are unaware of any data on quota prices in the Atlantic Surf Clam / Ocean Quahog fishery.

[11]Data for Alaskan Halibut and Sablefish ITQs leases are not available past 2006.

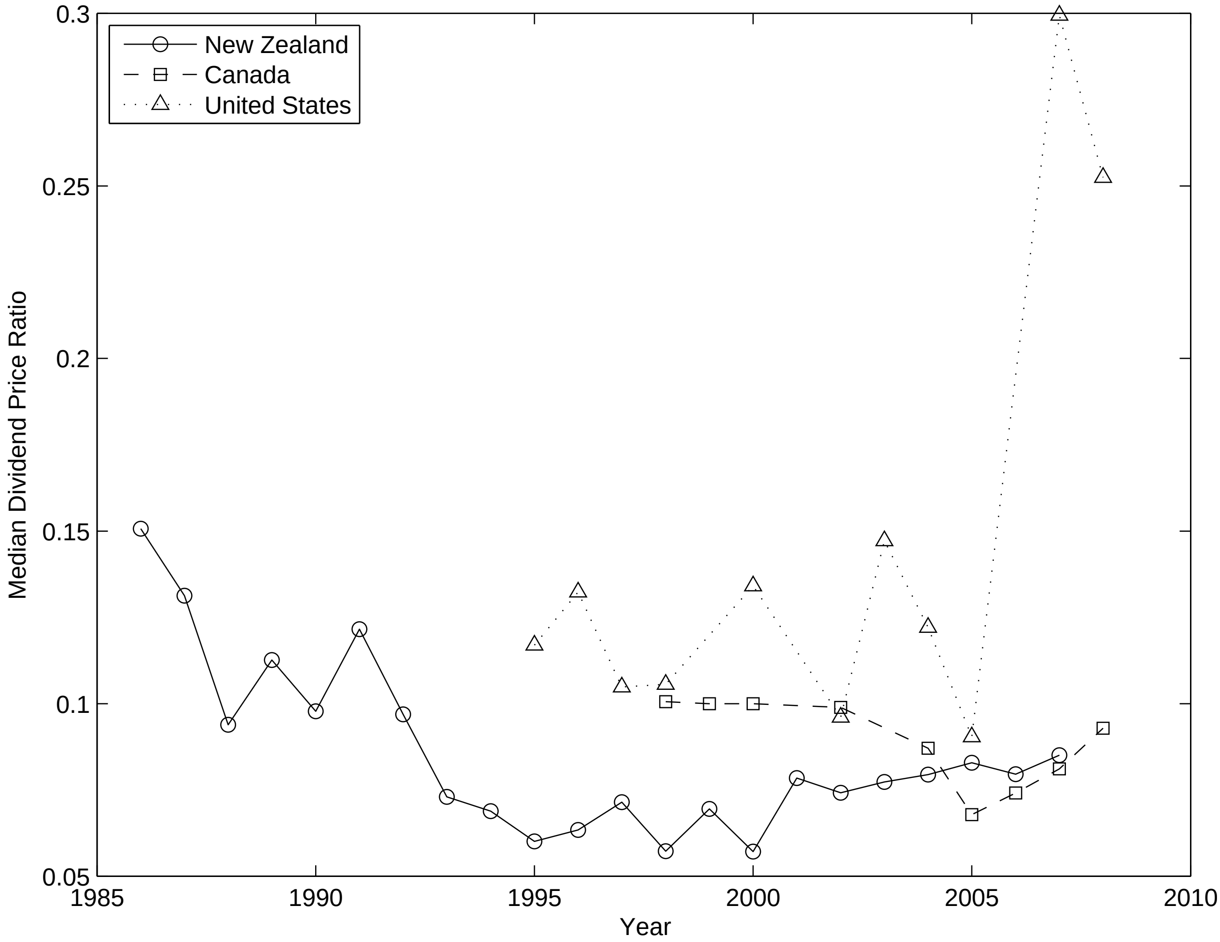

Figure 1: Median dividend price ratios for New Zealand, Canada, and United States.

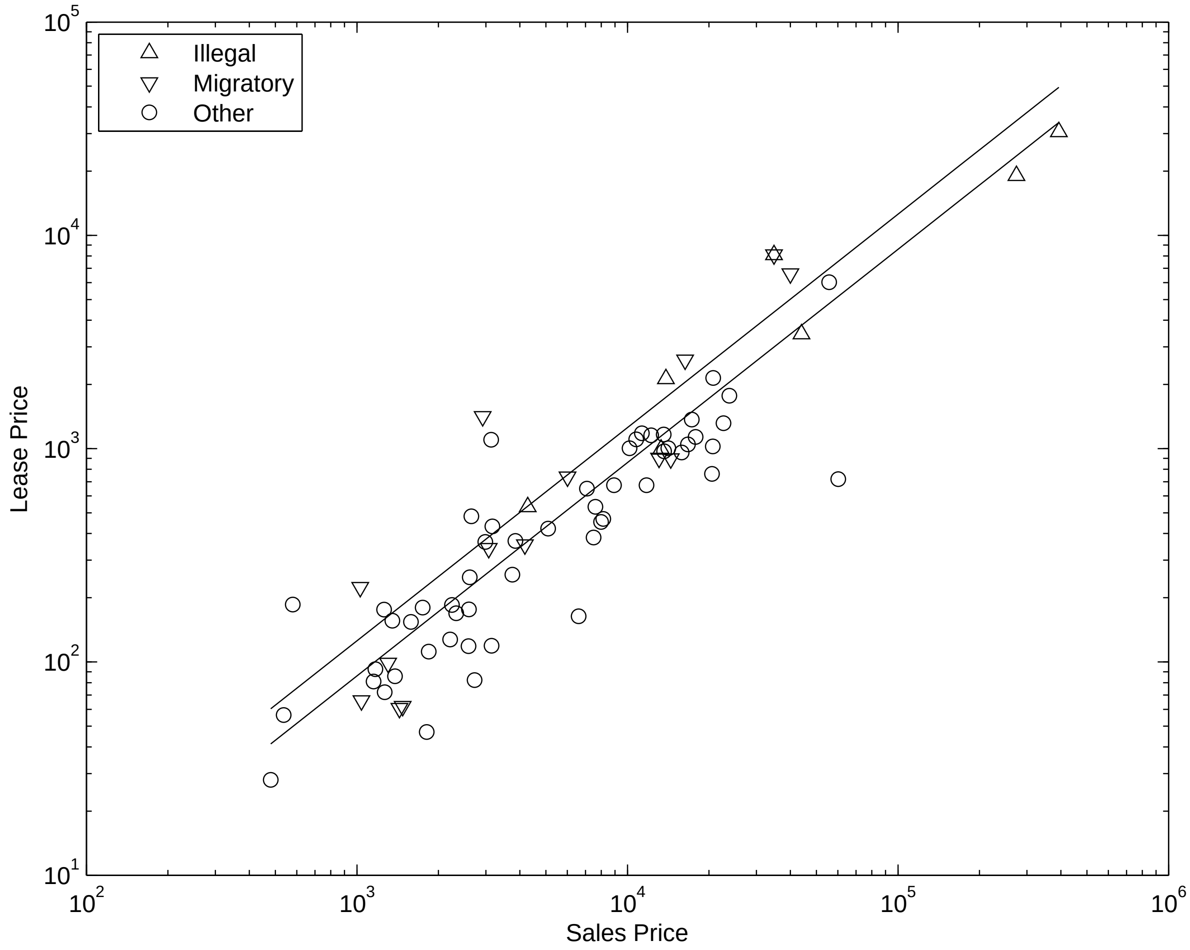

Figure 2: Scatter of lease and sales prices for New Zealand fisheries. Each fishery is represented by a single dot. Triangular dots indicate illegal or highly migratory fisheries. Circles indicate all other fisheries. Lines indicate mean dividend price ratio for illegal and highly migratory (.12) and other (.08) fisheries.

the sales and lease prices of quota since 2002.[12] The graph is arranged as follows. Each dot represents the median lease and median sales value for a particular New Zealand species under ITQ management since 2002. Species above and to the left have higher dividend price ratios $\tilde{R}$. We distinguish between stocks with high illegal take (upward triangle), highly migratory stocks (downward triangle), and other stocks (open circle). The mean $\tilde{R}$ for the latter category is about 8%, and is graphed by the lower line. The mean $\tilde{R}$ for the former categories is about 12% and is graphed by the upper line. While this simple graphical illustration fails to account for other factors which affect sales and lease prices of fisheries quota, it is suggestive of the intra-country effects of property rights strength. Species with high illegal catches and/or are highly migratory tend to have higher ratios. These characteristics may reflect weaker property rights to the ITQ holder. The importance of exclusivity of property rights will be discussed further in the next section.

[12]Newell, Sanchirico and Kerr (2005) provide similar plots in their study, but focus on market functionality and liquidity, not the value of stronger property rights.

5 Empirical Results

5.1 Cross-Country Evidence

As described above, there is substantial variation in the property rights underlying ITQs across countries. Characterizing each of the four "sticks" in a bundle may be possible qualitatively for each fishery, but comparing these property rights characteristics across countries is difficult. Here we take a more agnostic approach, estimating reduced-form equations to test for systematic differences in property rights across countries. Controlling for relevant fishery- and country-specific characteristics, we estimate the conditional mean $\tilde{R}$s in three countries with property-rights based fisheries.

The dependent variable throughout this section is the dividend price ratio of ITQs, ($\tilde{R}$). We exploit the panel-structure of the data and estimate country fixed-effects, which we use to test the null hypothesis that there is no systematic difference in implicit discount rates across countries. We estimate several equations, including controls for market conditions, biological characteristics, and year fixed effects to control for time-varying unobservables.

The most basic specification regresses $\tilde{R}$ on country fixed effects and year fixed effects:

$$\tilde{R}_{it} = \alpha_1 + \alpha_2 US_{it} + \alpha_3 Canada_{it} + \phi_t + \epsilon_{it}, \tag{5}$$

where $\tilde{R}_{it}$ is the average dividend price ratio of quota in fishery i in year t. The results are in column (1) of Table 3. The results suggest that, on average, $\tilde{R}$ in the United States is about 6.3 percentage points larger than in New Zealand. $\tilde{R}$ in Canada is not significantly different from New Zealand in this specification, but the difference between the United States and Canada is statistically significant.

Part of this variation may be attributable to changes in interest rates over time in each country (Equation 2). In an alternative specification, we control for average annual interest rates for 90 Day Treasury securities in each country. Because interest rates are collinear with year fixed effects, we include only the interest rates in this specification. These results are similar, though in this specification the ratio in Canada is significantly larger than in New Zealand.

Expectations about the future TAC and ex-vessel prices would dictate future profitability, and hence quota sales prices. We attempt to control for these expectations by including trends for harvest and ex-vessel prices. Specifically, we control for the ratio of this year's harvest to last year's harvest (in that fishery), and the ratio of this year's average ex-vessel price to last year's average ex-vessel price. These estimates are in column (3) and (4) of Table 3. These variables are not significant, and the results are similar to those in columns (1) and (2).

In columns (5) and (6) we add biological characteristics of each fishery, which could influence the horizon over which stocks rebuild. We control for years to maturity, length at maturity, and the maximum age of a species. Finally, the dynamics of a ratio within a fishery over time suggest that the ratio of lease to sales prices decrease with the tenure of an ITQ program. For each fishery, we calculate the number of years since the first year of ITQ management. We also include a quadratic term to account for nonlinear relationships. Conditional on these factors, our results are similar. The dividend price ratios for ITQs is significantly higher in the United States.

The cross-country regression results all suggest that ITQ fisheries in the United States have a significantly higher $\tilde{R}$. When adding control variables, the ratio in the United States is higher than in Canada, which, in turn, is higher than New Zealand, though the results for Canada are not robust across specifications. Because we are controlling for fishery-specific characteristics and market factors, we argue that property rights strength explain the difference in discounting behavior across these countries.

5.2 Within-Country Evidence

5.2.1 Migratory Species and Exclusivity

For within-country evidence, we now look to data from New Zealand. The "sticks" such as disposition, use, and possession do not vary significantly across fisheries within New Zealand, but there is variation in exclusivity. This variation is not policy-induced, but rather is a function of the characteristics of the species. While some species do not move significantly across space, highly migratory species move in and out of New Zealand waters, where they are subject to fishing pressure outside the control of the Quota Management System.

Tunas found within New Zealand waters, as well as some other large pelagic species, migrate long distances. The New Zealand Ministry of Fisheries characterizes some species as "highly migratory", and provides maps of the ranges of some key species.[13] Because highly migratory species are subject to fishing pressure that is unregulated by New Zealand's quota management system, the exclusivity of the right is arguably weaker than for species that stay within New Zealand's waters.

Our approach here formalizes what is seen in Figure 2. As shown in Figure 2, highly migratory species tend to have higher $\tilde{R}$. Table 4 provides within-country estimates for New Zealand. In these specifications we are able to control for a host of factors, including the 90-Day Treasury rate, trends for catch and greenweight prices, time to maturity, length at maturity, maximum age, fishery type (inshore, offshore, or shellfish) and whether or not the Ministry characterizes a species as recreationally or customarily "significant". In an alternative specification, we include year fixed effects instead of the interest rate. Conditional on the control variables, $\tilde{R}$ is between .8 and 1 percentage points higher for highly migratory species.

5.2.2 Illegal Harvest and Insecure Property Rights

Evidence of illegal harvests in some stocks would suggest a weaker property right due to lack of enforcement. For each commercial species in the Quota Management System in New Zealand, the 2008 Plenary Report from the Ministry of Fisheries discusses any known evidence of illegal harvests. Of the 75 species with sufficient data for the analysis here, there are six instances where illegal takes are believed to occur. If fishermen are also aware that some fish are illegally harvested from these stocks, it is reasonable to believe that they would place a lower value on the future value of quota holdings. In columns (2) through (4) of Table 4, we include a dummy variable equal to one if that species has been prone to illegal harvesting. The point estimates suggest that these stocks have dividend price ratios that are around 2.8 percentage points larger than other stocks.

5.2.3 Quota Buybacks and the Treaty of Waitangi

Finally, there were a series of policy shocks in New Zealand between 1989 and 1992 that one would expect to have a significant impact on beliefs about ITQ security within New Zealand. In 1986, the initial allocations in the QMS system were in terms of tonnes, not as a percentage of the total allowable catch. When it became clear that the initial allocation was too high for many stocks, the Ministry of Fisheries proceeded to redefine the right as a percentage of the total allowable catch. After much debate, the government honored the property rights by issuing a buyback of quota where the initial allocation was too high. As quotas were relatively new in New Zealand (and around the world), this action by the government likely served as a signal that it would treat quotas as legal assets. The buybacks began in 1989 and were finalized in the next two years.

[13]In Table 1, the fourth column indicates whether the Ministry of Fisheries classifies each species as highly migratory; we adopt their definition.

Around the same time, there was a debate about how the Maori people, native New Zealanders, were being treated under the QMS system. The Maori people had traditionally relied on the ocean's resources, and there was a concern that the quota system did not take into account the significance of the fisheries to the native people. In 1992 there were concessions citing the Treaty of Waitangi of 1840, which formalized the government's position, and removed uncertainty about the security of quota ownership. The Maori people were allocated 20% of the TAC for some key stocks. In column (3) of Table 4, we estimate a regression with the same controls as in column (1), but also including an indicator variable that equals one for all years including 1992 and thereafter. The point estimate suggests that post-reforms there was a 3.8 percentage point decrease in the average ratio, controlling for interest rates and fishery-specific characteristics.

6 Conclusion

This paper provides the first empirical evidence that stronger property rights lead to lower dividend price ratios ($\tilde{R}$) in fisheries. Our cross-country evidence is based on descriptive accounts of ITQs as property rights in New Zealand, Canada and the United States. In our cross-country regressions, the point estimates suggest that $\tilde{R}$ for quota in the United States is nearly twice as large as in New Zealand. The average ($\tilde{R}$) for quota in Canada is 1 percentage point larger than in New Zealand in some specifications. Our estimates are consistent with the general view that ITQs as property rights are more secure in New Zealand than in North American fisheries.

We then exploit important differences in the exclusivity of property rights within countries to determine the effect of stronger rights on $\tilde{R}$. Where the exclusivity of the catch share is limited by migratory species or illegal harvesting, $\tilde{R}$ is significantly higher than similar fisheries, even when controlling for biological and other fishery-specific characteristics. This lends insight into the importance of strong property rights, but also suggests that coordination across jurisdictions and better enforcement of these property rights would lead to lower implicit discount rates and greater economic value.

Rights-based management in fisheries can lead to significant economic gains by eliminating the race to fish and providing incentives for good stewardship of the resource. Our results suggest that stronger property rights would lead to even greater gains. Furthermore, relatively weak property rights may be decreasing the incentive for good stewardship of the resource by increasing the average implicit discount rate in fisheries.

Table 1: New Zealand ITQ Fisheries in the Analysis

Common Name	QMS Code	First Year	Migratory Species	Illegal Harvests
Freshwater Eel	ANG	2000		
Barracouta	BAR	1986		
Blue Cod	BCO	1986		
Bigeye Tuna	BIG	2004	Yes	
Bluenose	BNS	1986		
Butterfish	BUT	2002		
Blue Shark	BWS	2004	Yes	
Alfonsino	BYX	1986		
Black Cardinalfish	CDL	1998		
Spiny Lobster	CRA	1990		Yes
Elephant Fish	ELE	1986		
Blue Mackerel	EMA	2002		
Flatfish	FLA	1986		
Frostfish	FRO	1998		
Garfish	GAR	2002		
Green-lipped Mussel	GLM	2004		
Grey Mullet	GMU	1986		Yes
Giant Spider Crab	GSC	2005		
Dark Ghost Shark	GSH	1998		
Pale Ghost Shark	GSP	1998		
Red Gurnard	GUR	1986		
Hake	HAK	1986		Yes
Hoki	HOK	1986		
Groper	HPB	1986		
John Dory	JDO	1986		
Jack Mackerels	JMA	1987		
Kahawai	KAH	2004		
Kingfish	KIN	2003		
Lookdown Dory	LDO	2004		
Leatherjacket	LEA	2003		
Freshwater Eel	LFE	2004		
Ling	LIN	1986		
Mako Shark	MAK	2004	Yes	
Blue Moki	MOK	1986		
Moonfish	MOO	2004	Yes	
Oreo	OEO	1986		
Orange Roughy	ORH	1986		
Dredge Oyster Nelson/Marlborough	OYS	1996		
Dredge Oyster Foveaux Strait	OYU	1997		Yes

Table is continued on next page.

Table 1 Continued

Common Name	QMS Code	First Year	Migratory Species	Illegal Harvests
Paddle Crab	PAD	2002		
Parore	PAR	2004		
Paua	PAU	1987		Yes
Pilchard	PIL	2002		
Porae	POR	2004		
Porbeagle Shark	POS	2004	Yes	
Ray's Bream	RBM	2004	Yes	
Rubyfish	RBY	1998		
Red Cod	RCO	1986		
Ribaldo	RIB	1998		
Rough Skate	RSK	2003		
Red Snapper	RSN	2004		
Southern Blue Whiting	SBW	1999		
Scallops coromandel	SCA	1992		
School Shark	SCH	1986		
Freshwater Eel	SFE	2004		
Gemfish	SKI	1986		
Snapper	SNA	1986		Yes
Spiny Dogfish	SPD	2004		
Sea Perch	SPE	1998		
Rig	SPO	1986	Yes	
Arrow Squid	SQU	1987		
Smooth Skate	SSK	2003		
Stargazer	STA	1986		
Southern Bluefin Tuna	STN	2004	Yes	Yes
Kina	SUR	2003		
Silver Warehou	SWA	1986	Yes	
Swordfish	SWO	2004	Yes	
Tarakihi	TAR	1986		
Pacific Bluefin Tuna	TOR	2004	Yes	
Trevally	TRE	1986		
Trumpeter	TRU	1998		
Blue Warehou	WAR	1986	Yes	
White Warehou	WWA	1998	Yes	
Yellow-Eyed Mullet	YEM	1998		
Yellowfin Tuna	YFN	2004	Yes	

Species and species groups in the dataset for New Zealand. First Year denotes the first year under the Quota Management System. Highly Migratory is determined by the Ministry of Fisheries. Illegal harvests denotes species that the Plenary Reports discuss the problem of evidence of illegal harvests for that species.

Table 2: US and Canadian ITQ Fisheries in the Analysis

Country	Species	Area	First Year Under ITQ	First Year With Data
USA	Halibut	Alaska	1995	1995
USA	Sablefish	Alaska	1995	1995
USA	Red Snapper	Gulf of Mexico	2007	2007
USA	Striped Bass	Virginia	1998	2008
Canada	Sablefish	B.C.	1990	1996
Canada	Halibut	B.C.	1990	1996
Canada	Groundfish (uncut)	B.C.	1997	1999
Canada	Arrowtooth Flounder	B.C.	1997	2006
Canada	Coastwide Hake	B.C.	1997	1997
Canada	Gulf Hake	B.C.	1997	1999

Table 3: Cross-Country Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
USA (dummy)	0.0621***	0.0649***	0.0601***	0.0595***	0.0692***	0.0556**
	(0.0122)	(0.0105)	(0.0121)	(0.0142)	(0.0233)	(0.0248)
Canada (dummy)	0.0007	0.0196***	-0.0005	0.0169**	0.0125	0.0298***
	(0.0087)	(0.0088)	(0.0092)	(0.0084)	(0.0117)	(0.0095)
90-Day Treasury Rate	–	0.0047***	–	0.0036***	–	0.0027**
		(0.0004)		(0.0005)		(0.0011)
$Catch_t/Catch_{t-1}$			0.0004	0.0006	0.0007	-0.0015
			(0.0025)	(0.0026)	(0.0026)	(0.0027)
$Price_t/Price_{t-1}$			-0.0002	0.0017	0.0018	0.0021
			(0.0028)	(0.0026)	(0.0023)	(0.0027)
Years to Maturity					0.0007	0.0005
					(0.0006)	(0.0006)
Length to Maturity					-0.0001	-0.0000
					(0.0001)	(0.0001)
Maximum Age					-0.0001	-0.0001
					(0.0002)	(0.0002)
Years of ITQ Program					-0.0000	-0.0065***
					(0.0015)	(0.0023)
$Years^2$					-0.0000	0.0003***
					(0.0001)	(0.0001)
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Intercept	–	0.0518***	–	0.0593***	–	0.1032***
		(0.0045)		(0.0059)		(0.0253)
N	2,093	2,093	1,584	1,584	1,103	1,103
F-Test (p-value)	0.0001	0.0060	0.0002	0.0086	0.0024	0.1927
H_0 : USA = Canada						

The dependent variable is average $\tilde{R}$ for individual transferable quotas. Standard errors (in parentheses) are clustered on country/species-group.

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Table 4: Within-Country Evidence: New Zealand Regressions

	(1)	(2)	(3)	(4)
Highly Migratory	0.0081*	0.0104**	0.0078*	
	(0.0048)	(0.0046)	(0.0046)	
Significant Illegal Harvest	0.0277***	0.0281***	0.0284***	
	(0.0072)	(0.0072)	(0.0074)	
"Significant Species"	-0.0108**	-0.0142***	-0.0142***	
	(0.0045)	(0.0045)	(0.0045)	
90 Day Treasury Rate	0.0028***	–	-0.0004	
	(0.0008)		(0.0012)	
$Catch_t/Catch_{t-1}$	0.0027	-0.0022	0.0007	
	(0.0033)	(0.0037)	(0.0034)	
$Price_t/Price_{t-1}$	0.0023	0.0018	0.0026	
	(0.0032)	(0.0033)	(0.0034)	
Years to Maturity	0.0011*	0.0011*	0.0011	
	(0.0007)	(0.0006)	(0.0007)	
Length to Maturity	-0.0001	-0.0001*	-0.0001	
	(0.0001)	(0.0001)	(0.0001)	
Maximum Age	-0.0002	-0.0002	-0.0002*	
	(0.0001)	(0.0001)	(0.0001)	
Years of ITQ Program	-0.0066***	0.0045	-0.0056***	
	(0.0015)	(0.0030)	(0.0015)	
$Years^2$	0.0003***	-0.0002	0.0002***	
	(0.0001)	(0.0002)	(0.0001)	
Post-1992			-0.0380***	
			(0.0093)	
Year Fixed Effects	No	Yes	No	

There are 1,034 observations. Robust standard errors in parentheses. All regressions also include "type" fixed effects, where the types are offshore, inshore, and shellfish (the excluded category is freshwater).