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Catch share programs in developing countries: A survey of the literature

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ABSTRACT

The literature on catch shares is dominated by analyses of programs in developed countries. To address this research gap, this paper identifies and discusses programs in developing countries. The paper also investigates differences between countries that have and have not implemented programs across a number of relevant dimensions, including governance and resource value, and characterizes the relationship between catch share type (e.g., quota-based or space-based systems) and the species characteristics. The paper identifies programs in about 20 percent of coastal and developing countries and finds that countries with catch shares have higher governance rankings, stronger economies, more valuable fishery export industries, and fewer people employed in fisheries. For example, the average governance effectiveness rank is 38.7 for all coastal and developing countries and 60.8 for countries with quota-based fishing rights. Species managed under quota-based systems are also found to have the potential for strong recruitment externalities. The results support ideas from the fisheries economics literature on the pre-conditions that are more likely to lead to the adoption of a catch share program.

1. Introduction

In fisheries management, catch shares are incentive-based policies that confront the ecological and economic waste of traditional fisheries management by addressing the property rights issues that plague common pool resources [1]. Much of the literature dedicated to understanding and evaluating the impacts of catch shares focuses on programs in the developed world [2–6]. In summary, this literature shows that, although the economic waste is reversed [7], questions remain as to the degree to which the ecological conditions have improved [8,9].

At the same time, research on overcoming the common pool resources (CPR) problem in developing world fisheries often focuses on co-managed fisheries [10–13], where a co-managed fishery is defined as a fishery with the resource user group and a governing entity both sharing responsibility and authority over the fishery. Although co-managed fisheries can allocate property rights to resource users, property rights are not essential. And, in contrast to catch share fisheries, there is no ex-ante reason to believe that a co-managed fishery without property rights will provide economic benefits. Consequently, drawing broad conclusions from this literature is more difficult, but under the right conditions (e.g., Ostrom [14]), co-management is effective.

Given the two distinct strands of literature, a natural conclusion to reach is that catch shares are a developed country phenomenon and co-management is a developing country fishery management tool (see, however, Bonzon et al. [15]). Rather than take this premise as given, this paper identifies and reviews catch share programs that exist in developing countries, using World Bank country classification data to determine a country's development status.[2]

Understanding catch share programs in the developing world is important for the advancement of fisheries management worldwide. Developed nations may be able to borrow from the institutional features observed in developing world catch share programs and vice versa. Furthermore, if there are common characteristics between developing nations that have adopted catch share programs, identifying these patterns will improve the understanding of when and where successful catch shares can be implemented in other settings. To that end, in addition to cataloging catch shares, this paper looks for differences in characteristics between countries that adopt catch shares and non-adopters. The analysis focuses specifically on governance, economic characteristics, and species biology.

In summary, the paper shows that countries with output-based regulations in fisheries have higher governance rankings,

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[2] Note that the World Bank classification tables (data.worldbank.org/about/country-and-lending-groups) only consider countries with a population of 30,000 or more. Therefore, countries with fewer than 30,000 citizens are excluded from our analysis.

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stronger economies, and more valuable fisheries export industries but fewer people employed in fisheries. The findings are consistent with predictions from the literature regarding features needed to form and maintain fisheries property rights. For the most part, species managed with quota-based programs fit remarkably well with Copes' [16] description of when individual transferable quotas (ITQs) are likely to be most successful. Species managed under territorial use rights in fisheries (TURFs), a space-based program, fit with Christy's [17] description of ideal TURF species. However, some species and programs are outliers, and their implications are discussed later in the paper.

This paper is organized as follows. The next section presents a definition of catch shares and expands it to include a new category, denoted catch share *plus*. Section 3 describes the findings of the analysis, including the geographic location of the programs around the world, correlation between government performance and a country's catch share status, and correlations between the economic value of a country's fisheries and catch share adoption. This paper further examines the data looking at differences between countries with and without quota-based property rights and the species managed under both quota-based and space-based programs. Finally, Section 4 summarizes the findings and discusses the potential for future work.

2. Definitions and methods

Bonzon et al. [15] examine catch share programs around the world, regardless of development status, and define catch shares as follows:

> A catch share program allocates a secure privilege to harvest a specified amount of a fishery's total catch to an individual or group (groups can be community-based). Under a catch share program, managers establish a fishery-wide catch limit, assign portions of the catch, or shares, to participants and hold participants directly accountable to stay within the catch limit.[3]

With this definition, they record catch shares in 35 nations worldwide, 13 of which are for marine resources in developing countries.

Following Bonzon et al. [15], this paper categorizes catch shares into six different institutional types according to Table 1 below. TURFs are inherently different from the quota-based programs: in quota-based programs, resource users have property rights over a share of a species' total allowable catch (TAC), whereas in TURFs, property rights are assigned over a physical space. The management of TURFs and the incentives facing resource users, therefore, differ from those of quota-based catch shares. For example, the enforcement of TURFs often involves policing the boundaries of the TURF and protecting the space from potential outside users. Assigning fishermen property rights over a physical space rather than a quota of a single resource stock may increase stewardship incentives if TURF members internalize cross-species externalities or fishing location decision externalities.[4] Due to the potential differences, this paper distinguishes between quota-based and space-based catch share programs.

A critical feature of the definition proposed by Bonzon et al. [15] is an established fishery-wide catch limit. Bonzon et al. [15] discuss the possibility for sustainable catch share programs to exist using effort-based controls without a clear catch limit, but they note potential problems including: difficulty in knowing the optimal effort level, the ability for fishermen to innovate and increase the pressure on fish stocks while still complying with effort restrictions, and the need to continually assess the level of effort and its impact on the resource.

Table 1
Catch share types.

Type	Allocated to	Transferable?
Individual quota (IQ)	Individual	No
Individual transferable quota (ITQ)	Individual	Yes
Individual vessel quota (IVQ)	Vessel	Sometimes
Cooperative	Group	Sometimes
Community fishing quota	Community	Sometimes
Territorial use rights in fisheries (TURF)	Individual, group, or community	Sometimes

Note: In cooperative catch shares, a catch quota is allocated to a cooperative, whereas in cooperatively owned TURFs, cooperatives have property rights over space.

While acknowledging these problems, it is important to include fisheries using effective effort-based controls where social groups have de facto or established rights to the fisheries. Effective effort-based controls are those that protect stocks against fishermen's ability to innovate and increase fishing pressure. These programs have developed mechanisms to limit the number of fishing locations, gear, and fishing days, but they do not explicitly limit the fishery-wide catch limit, which is the criterion used by Bonzon et al. [15]. For example, Bangladesh, India, Sri Lanka, and Turkey all have fishermen-run programs that rotate fishermen over fixed net locations by lottery [19–21]. Because the fisheries do not have a fishery-wide catch limit, this paper classifies these fisheries management programs as catch shares *plus*. Countries in the catch share *plus* category meet two conditions.

- Fishermen have secure property rights to the resource or an allocated portion of the resource.
- Managers either set a fishery-wide catch limit or control the fishery-wide catch by dictating the number of fishing locations in a fixed-gear fishery.

By including catch share *plus* fisheries, it is acknowledged that, in many artisanal fisheries, communities possess a traditional and historical ecological knowledge regarding sustainable resource use upon which fisheries regulations are based. The inclusion of these fisheries is also consistent with the technology available in many artisanal fisheries, where participants can gauge a sustainable harvest by the amount of gear and type of gear used, but are not necessarily measuring escapement or harvest in the ways that developing nations typically do. For improved readability, the paper hereafter use acronyms CS and CSP to refer to catch shares and catch shares *plus* country categories, respectively.

The search for catch shares was conducted around the globe using the published and grey literature.,[5,6] The focus is on programs that are still in existence. Consequently, excluded from this paper, for example, is the sea cucumber ITQ program in the Galapagos Islands that was instituted in 2001. That program was successful in

[3] Bonzon et al. [15] define their use of the term *fishery-wide* as a participating group of individuals, allowing for the existence of nonparticipants targeting the same species.

[4] See Cancino, Uchida, and Wilen [18] for further discussion of the externalities residual to ITQs and addressed by well-designed TURF catch shares.

[5] Included in this analysis are coastal fisheries, estuaries, and lagoons.

[6] The literature search was conducted during June through September 2011 using several online databases (including Digital Library of the Commons, FAO Fishery and Aquaculture Country Profiles, Jstor, ScienceDirect, and Taylor & Francis Online) and search engines (including Google and Google Scholar). Key words used in the search were catch shares, ITQ*, IVQ*, fish* co-manage*, fish* cooperative*, fish* property rights, fish* quota*, and TURF*. Finally, references in the resulting literature were explored.

restricting resource extraction, but the program design was socially unpopular with fishermen, and thus ITQ management was retracted (fishing on sea cucumber has recently been banned or severely curtailed because of the collapse of the stock) [22].[7] Focusing on existing programs should not be a limitation to this study, but it is difficult to know for certain because typically very little literature is available on dismantled catch share or catch share *plus* programs.

In addition to data on the existence and type (Table 1) of catch share programs, this study compiles data from the World Bank on six governance indicators, from FAO on the export value of marine resources, and species-level data from FishBase [23] including: the biological characteristics (lifespan and migratory patterns) of species, information on whether the fish stock is classified as overfished, and species price categories.

In what follows, the paper presents summary data on catch shares and catch share *plus* fisheries. In the analysis, data is grouped according to whether a country has a quota-based or space-based (or both) program.

3. Results

This section examines a number of indicators in an attempt to characterize CS and CSP countries. The section illustrates where catch share and catch shares *plus* programs are in the developing world and characterizes CS and CSP countries in terms of their governance and fishing industries, comparing the results in the data to outcomes predicted in the literature on fisheries property rights. Finally, species characteristics are compared with those traits identified in the literature as being ideal for either quota-based or space-based programs.

3.1. Geography of catch share programs

Catch share and catch share *plus* programs exist on all continents (Fig. 1). Of the 109 coastal and developing countries, catch share programs are found in 17 countries, or about 15.6 percent of the countries in the sample.[8] For comparison, Bonzon et al. [15] find catch share programs in 18 out of 57 (or 31.6 percent) coastal countries classified as developed by the World Bank. When the analysis is expanded to include catch share *plus* programs, 5 nations are added (Bangladesh, India, Sri Lanka, Turkey, and Vietnam) for a total of 22 countries, or about 20 percent of the countries in the sample, still smaller than in the developed world.[9] (See the Appendix for descriptions of each catch share program.)

Within broad geographic regions, there are clusters of CS/CSP countries in South America, South Africa, and Asia and the Pacific (Fig. 2). In South America, for example, 3 out of a possible 10 coastal and developing countries have at least one catch share program. In Sub-Saharan Africa, only 4 out of 32 countries (12.5 percent), have marine catch share programs, and all 4 of these nations are clustered at the southernmost tip of the continent. In Asia and the Pacific, 9 out of 27 nations fit into the CSP category. In Europe and Central Asia, 3 out of 11 nations fit into the CSP category, two of which are Latvia and Lithuania. Outside of these clusters, there are programs in Grenada, Mexico, Morocco, and Turkey.

Spatial clusters of catch share programs exist within broader geographic regions, but within and across each region, there is considerable heterogeneity in the type of catch share program as well as the year in which each program was established (Fig. 3). Fig. 3 shows, not surprisingly, that cooperatively owned TURFs have a longer history than quota management, which is a relatively new instrument in the history of fisheries management.[10] What is notable, however, about the adoption dates of the quota-based programs in developing countries is that, for the most part, they lag the adoption of quota-based programs in Iceland, Canada, and New Zealand [3]. In some respects, the quota-based programs in developing countries are the second wave to implementation of ITQ and individual quota (IQ) programs.

In what follows, this paper briefly discusses the catch share and catch share *plus* programs in geographic regions including the Americas and the Caribbean, Africa, Europe and Central Asia, and Asia and Oceania.

3.1.1. Latin America and the Caribbean

In Latin America and the Caribbean, 5 out of a possible 28 coastal developing countries have at least one catch share program. In this region, there is a mixture of catch share types, including cooperatives, ITQs, individual vessel quotas (IVQs), and TURFs. In Grenada there are traditional TURFs in the beach seine fishery, where fishermen are allocated rights over 97 *hauls*, or small sections of the bay suitable for beach seining operations [24]. As of 2003, the government is still in the process of legalizing Grenada's traditional seine fishing system [24].

Mexican cooperatively owned TURFs, the earliest recorded catch shares in the region, have existed since the 1930s, when the government allocated abalone and lobster harvesting rights to cooperatives [25,26].,[11,12] However, several cooperatives were unable to effectively protect their TURFs from outside fishing pressure [27] and it was not until the 1960s that successful Mexican cooperatively-owned lobster TURFs were documented and in 1973 the government implemented TACs for abalone cooperatives [25,28]. Recently, in 2009, Mexico adopted another quota-based management program in its shrimp fishery. Each fishing cooperative is allocated a percentage of the TAC [29].

Chile, the next recorded adopter in the region, hosts a sizable menu of catch share programs. Chile's 1991 Fishery and Aquaculture Law No. 18892 established both TURFs and ITQs [18,30]. TURFs for Chilean abalone, or *loco*, are perhaps the most studied catch shares of the developing world. The space-based resource rights originally started as quota-based rights, but the government was unable to enforce the ITQ system [18,30]. This example illustrates the importance of selecting the appropriate management tool and the potential for TURFs to be self-enforcing. Argentina's 1998 Federal Fishery Act established ITQs for hake stocks. From 2000 to 2009, the Federal Fishery Council expanded its program to include Southern blue whiting and Patagonian toothfish.[13]

[7] See Toral-Granda [22] for a discussion of the fishermen's objections to the ITQ program design, which included allocations to inactive vessels and the inability to obtain needed cash advances.

[8] When applying the Bonzon et al. [15] definition, it is not entirely clear which countries to include. For example, Bonzon et al. [15] exclude quota programs in Mauritius, Morocco, and Mozambique that appear to match their definition of a catch share.

[9] The percentage of the world's countries that host a CS/CSP program is much greater than the percentage of the world's fisheries managed under property rights institutions, which according to Costello et al. [8] is 2 percent.

[10] Francis Christy is credited with developing the idea in a working paper published in 1976.

[11] See Levia et al. [25] for more detail on the history of Mexican abalone cooperative rights.

[12] In 1973, the Mexican government imposed a total allowable catch per cooperative (TACC), turning the Mexican TURFs into cooperatives (as defined in Table 1). See [26] for details about the evolution of the TACCs.

[13] See the Federal Fisheries Council website (http://www.cfp.gob.ar/index.php?inc=regimencitc_en&lang=en) for more details.

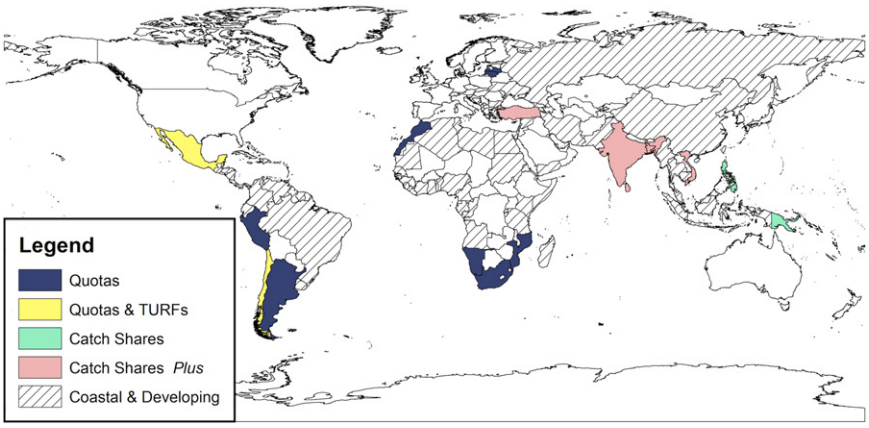

Fig. 1. Developing world catch share status. Note: catch share countries are mapped according to their most restrictive category. For example, although all quota-based catch shares are included in the CS and CSP categories, they are mapped here as nations with a quota catch share status.

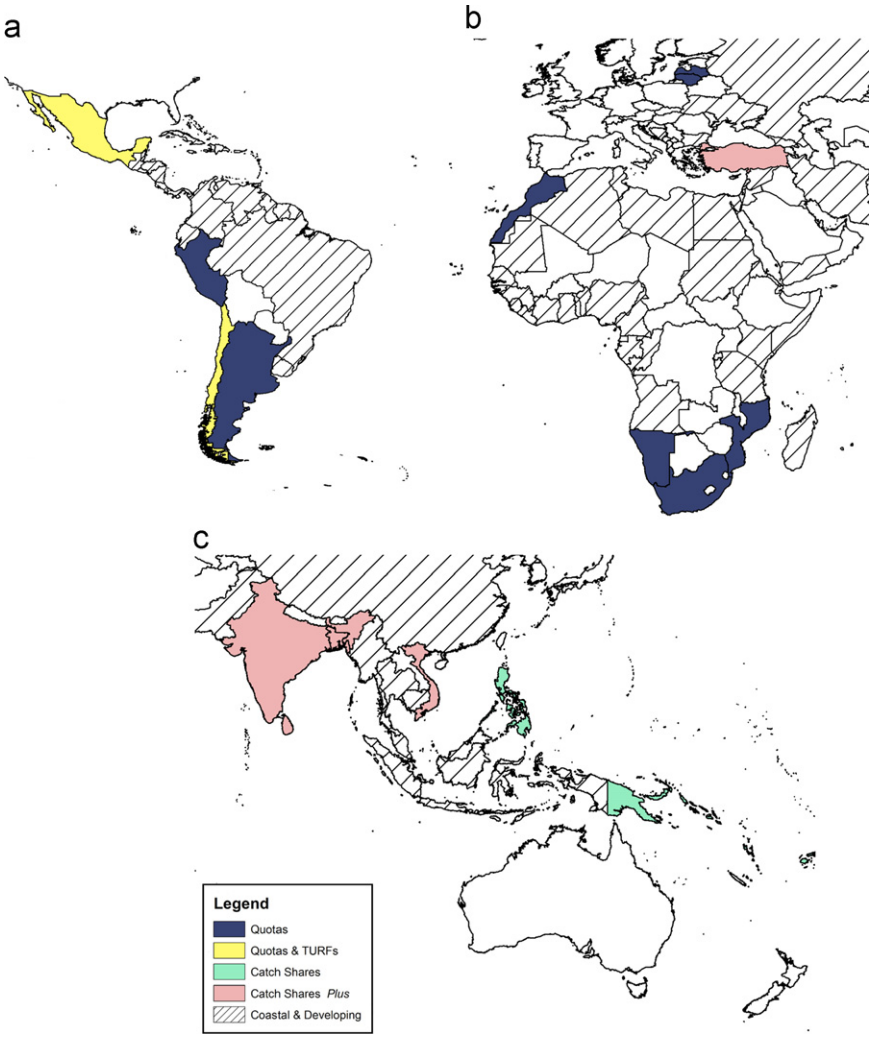

Fig. 2. Geographic Clusters of Catch Share and Catch Share Plus Programs. (a) Americas & the Caribbean. (b) Africa & Europe. (c) Asia & the Pacific. *Note:* Catch share countries are mapped according to their most restrictive category. For example, although all quota-based catch shares are included in the CS and CSP categories, they are mapped here as nations with a quota catch share status.

The South American programs share a top-down design and enforcement that is intended to protect commercial fisheries in danger of resource collapse [31,32]. Most recently, in 2008, Peru implemented IVQs for its anchovy stocks, which is one of the largest fisheries in the world in terms of volume. The fishery is notorious for its large population fluctuations due to fishing and environmental conditions (e.g., [33,34]).

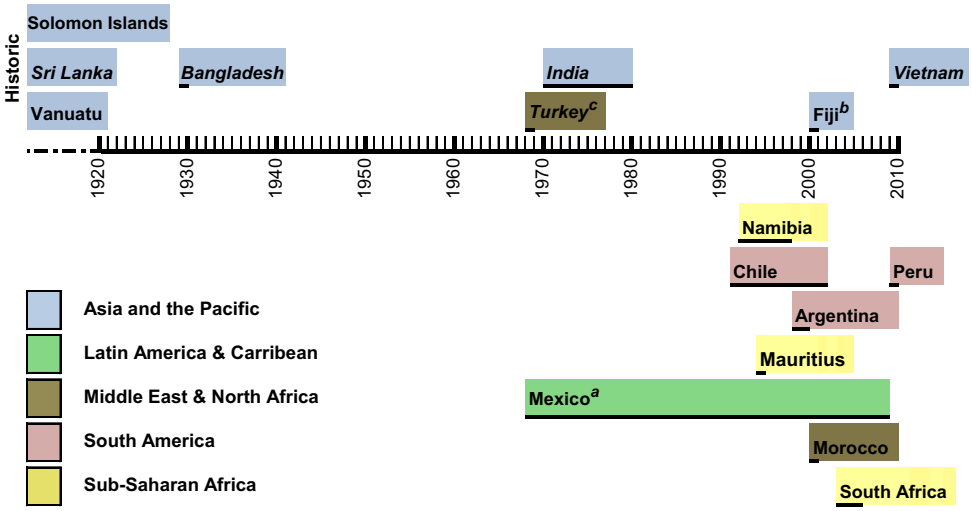

Fig. 3. Catch Share and Catch Share Plus Timeline. Notes: Italics denote a country that is included in the CSP category but excluded from the more restrictive CS category. [a]In the 1930s, the Mexican government grants exclusive space-based fisheries rights to cooperatives. The earliest documented space-based cooperative was formed in the 1960s (the Vigía Chico cooperative). Abalone cooperatives have been subject to TACs since the 1970s. Most recently, a rights-based cooperative formed in the Sinaloa Ribereño shrimp fishery in 2009. [b]Fijian customary rights were reestablished as locally managed marine areas in 2000. [c]Turkish fisheries cooperative law was established in 1968, although the formation date of the rights-based cooperatives is unknown.

3.1.2. *Africa*

Programs in Africa are similar in that they are quota-based and were established in highly concentrated industrial fisheries. In Mauritius, for example, the TAC for bank fisheries, located along the Mauritius–Seychelles ridge, is distributed as ITQs to six companies [35] and, as of 2002, the top five companies in South Africa held 74 percent of the deep-sea hake quota [36]. Similar characteristics are found in Mozambique [37],[14,15] and Namibia.[16] Namibia is at the forefront of recovering a share of the resource rents and fisheries management costs from catch share programs [39]. Specifically, the Namibian government uses five types of rights fees: quota fees, bycatch fees, research fees, license fees, and on-board observer fees [40–42]. Between 1994 and 1999, the fees accounted for an estimated 9 percent of industry revenue.

In 2000, the Moroccan government (with help from FAO) established fixed sector quotas for three fishing sectors in the cephalopod fishery (freezer, coastal, and artisanal sectors). The government further divided these sector quotas among individuals into ITQs, which are transferable within each sector [43].[17]

3.1.3. *Europe and Central Asia*

Latvia and Lithuania are the only two developing countries that border the Baltic Sea. Their IQ programs share many similarities. Latvian National Board of Fisheries has IQ programs for cod and herring [15,45] and the Lithuanian government allocates fishing quotas to fishing companies for several stocks including cod, flounder, herring, sprat, and turbot [15,46]. While the IQs are not transferable, IQ markets exist, because new entrants must purchase a company with quota rights [45]. In addition to the Latvian IQ program the government regulates days at sea for herring vessels to further ensure stocks will not be over-exploited. Governments in both countries collect quota fees although in Lithuania the quota fees are not considered to be a significant cost [45].

In Turkey, lagoon fisheries can be leased by the state and operated by a cooperative acting as a monopoly. Fikret Berkes [19] found that some fishing communities without lagoon monopoly rights use effective effort-allocation controls (e.g., rotating fishermen over a fixed number of fishing locations) to equitably distribute fishery rents. For example, the Alanya Cooperative develops internally enforced contracts that grant individual fishermen access to fishing net locations.[18] Without legal backing, the contract is enforced with social sanctions. Elinor Ostrom [14] used Turkey's cooperatively owned TURFs as a case study in an analysis seeking to characterize the conditions that must exist for successful community governance of a CPR.

3.1.4. *Asia and Pacific region*

Of the 27 developing nations in Asia and the Pacific, 10 fit into the CS/CSP categories. All of the CS/CSP countries in Asia and the Pacific have TURFs, the majority of which have been around for decades. Although several Asian and Pacific institutions related to fisheries property rights are rooted in longstanding tradition, adoption dates of the programs within the region are distributed over time (Fig. 3).

Bangladesh, India, and Sri Lanka have catch share *plus* programs that grant hereditary rights to resource use in fixed-gear net fisheries. All three programs also include systems that rotate fishermen over desirable fishing locations. Starting points of the rotations are determined by scheduled lotteries. In Bangladesh, the territorial management institutions that grant individual property rights are referred to as *faar*; the system has been adopted by at least two Hindu fishing castes and dates back to 1929. The community regulates the number of fishing locations and specifies the pattern of nets to allow for a portion of the migratory fish to escape, maintaining sustainable fish populations [21]. The Indian catch share program, in the Cochin Estuary, is referred to as a *padu* system; it is used by Hindu shrimp

[14] FAO lists species regulated by quota as prawn, gamba, pexie (linha), and peixie (arrasto).

[15] Sousa et al. [38] report that quotas in the Mozambique industrial shrimp fishery are rarely binding constraints and that effort controls are the regulatory tool used, suggesting that the catch share program for this species may be ineffectual.

[16] For more information on Namibia, see the Republic of Namibia's Ministry of Fisheries and Marine Resources website (http://www.mfmr.gov.na/).

[17] The Omnium Marocain de Peche entry on the Fish & Information Services website provides evidence that the Moroccan ITQ remains a functioning catch share [44].

[18] Each year, in September, the participants in the migratory species fishery submit requests to local officials, who allocate rights to regularly spaced net fishing sites. Rights to the fishing sites are paired with regulations on the terms of resource extraction.

Table 2
Governance Indicators.
Source: World Bank Governance Indicators (WGIs) dataset [59].

	Statistic	Voice and accountability	Political stability/ no violence	Govt. effective-ness	Regulatory quality	Rule of law	Control of corruption	Avg. WB score
Entire sample	Mean	42.7	41.2	38.7	38.1	38.5	39.5	39.8
	sd	24.4	26.8	22.4	22.3	22.9	23.0	20.2
	cv	0.57	0.65	0.58	0.59	0.59	0.58	0.51
Without quotas	Mean	40.9	40.0	36.2	35.3	36.6	37.3	37.7
	sd	24.6	27.2	21.8	20.9	22.4	22.8	19.7
	cv	0.6	0.7	0.6	0.6	0.6	0.6	0.5
Quotas	Mean	58.8	51.5	60.8	62.4	55.3	58.4	57.9
	sd	20.8	14.8	20.2	21.3	15.3	15.6	4.7
	cv	0.4	0.2	0.3	0.4	0.3	0.3	1.1
Without catch shares	Mean	40.1	39.5	36.2	35.5	36.5	37.1	37.5
	sd	24.9	27.2	22.0	21.1	22.7	22.8	19.9
	cv	0.62	0.69	0.61	0.60	0.62	0.61	0.53
Catch shares	Mean	56.6	50.0	51.9	51.9	49.2	51.7	51.9
	sd	15.6	23.3	20.2	24.2	21.7	20.9	17.7
	cv	0.28	0.47	0.39	0.47	0.44	0.40	0.34
Without CSP	Mean	40.4	40.6	35.7	35.2	35.9	36.9	37.5
	sd	25.3	27.3	22.2	21.5	23.0	23.2	20.4
	cv	0.63	0.67	0.62	0.61	0.64	0.63	0.54
CSP	Mean	51.9	43.3	50.6	49.2	48.8	49.2	48.8
	sd	18.3	25.2	19.4	22.5	19.7	20.0	17.2
	cv	0.35	0.58	0.38	0.46	0.40	0.41	0.35

Notes: cv, coefficient of variation; sd, standard deviation.

fishermen in the *Dheevara* caste [21]. Finally, Sri Lanka also has a *padu* system for a shrimp stake-net fishery in the Negombo Estuary. These Sri Lankan fishermen rotate daily over 22 fishing locations in two fishing sites. The catch share *plus* programs in all three countries distribute fishery rents among the participants in an egalitarian manner, using a lottery to equalize the expected value of fishery rents facing each resource user [21].

The remaining seven Asian CS/CSP countries are in the World Bank region of East Asia and the Pacific. TURFs in Fiji, the Solomon Islands, and Vanuatu are all historical hereditary fishing rights. Although hereditary rights in the Solomon Islands and Vanuatu are customary rights [47,48], the traditional customary rights in Fiji have now been codified. The Fijian government began mapping Fiji's customary fishing rights areas, *qoliqoli*, in 1989 and have recognized and helped to reestablish these locally managed marine areas [49].

More recently, governments in Papua New Guinea, the Philippines, and Vietnam have signed TURFs into law for reef ecosystems, mangrove ecosystems, and a lagoon shrimp fishery, respectively. In the Philippine Cogtong Bay, 25 families had held rights over mangrove plots since the 1940s. In the 1960s and 1970s mangrove resources began to be degraded; they were converted into fish ponds and suffered from the emergence of commercial fishing and a wave of immigration. The Philippine government instituted a mangrove reforestation program that provided legal rights over mangrove areas (TURFs) to families that were able to successfully reforest their mangrove plots [50]. Property rights in Vietnam's lagoon fishery were allocated to the Vinh Giang Fishery Association, which has dedicated 543 ha of the lagoon to 56 fish corrals. The design and arrangement of these fisheries are regulated by the association [51].

3.2. Governance

An early criticism of ITQs [16] was the potential incentives for quota owners to engage in high-grading and discarding [52–57]. Although the empirical data on the magnitude of these effects is sparse, the criticism is the basis of a common belief that if ITQs – or, more generally, catch shares – are to be successful, they must be combined with a strong regulatory institution that can monitor and enforce the rules. Applying this belief to the developing and developed world continuum, a natural supposition is that ITQs are a policy for countries of the developed world, which typically have better regulatory and governance systems. In fact, the poster children for successful ITQ programs are Iceland, Canada, New Zealand, and Australia [3]. An extension of the supposition is that catch share policies in the developing world will be found only in countries with relatively better governance. Leal [58] claims that within the developing world, lower-income countries have either non-existent or insufficient legal, fiscal, and management frameworks needed for catch shares implementation.

This paper investigates whether there is support for these hypotheses by examining the World Bank's Worldwide Governance Indicators (WGIs) data [59].[19] The analysis uses the latest WGIs (constructed from 2009 data), which measure six dimensions of governance: voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption. The data report percentile ranks, with 0 being the lowest and 100 being the highest rank. The WGI data show that these developing coastal economies rank below the 50th percentile in all six governance dimensions.

The data illustrate that countries with catch share, quota (ITQ, IVQ, and IQ), and catch share *plus* programs receive higher governance scores in all six categories. Table 2 summarizes the data for all countries and compares data between countries that do and do not fit into the three categories. For example, the average World Bank governance score, constructed from averaging across all six categories for each country, is 39.8 for all developing countries, 57.9 for countries with quota programs, 51.9 and 48.8 for countries in the CS and CSP categories,

[19] Although it is unlikely that a catch share program led to improved government performance over time, it is very likely that nongovernmental organizations, such as FAO, target aid for the development of catch share policies in countries with relatively better governance. This paper uses the most recent set of data for the analysis. A better data set would be measures at the time of adoption, but such a data set does not exist for most of the older programs.

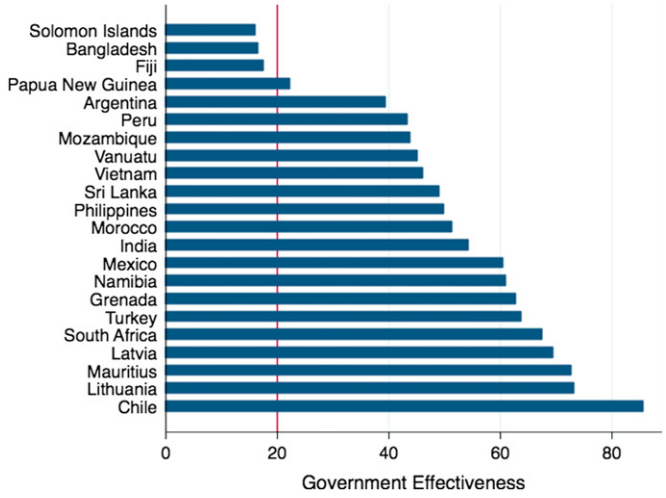

Fig. 4. Catch Shares *Plus* **and Government Effectiveness.** *Note:* The reference line represents the 25th percentile for government effectiveness in the sample.
Source: World Bank Governance Indicators (WGIs) dataset [59].

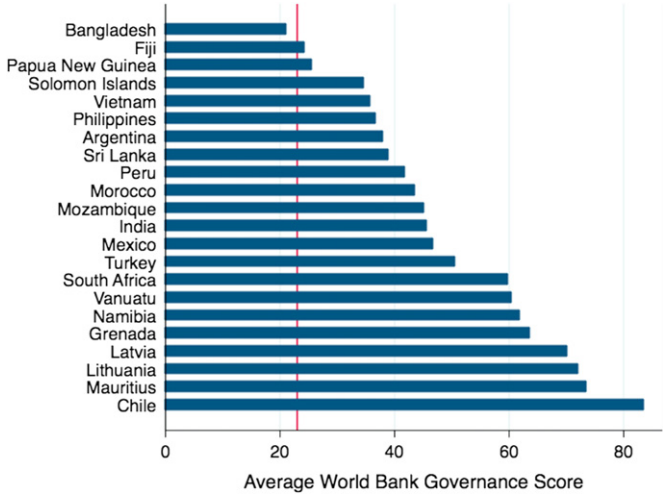

Fig. 5. Catch Shares *Plus* **and Average World Bank Governance Rank;** *Note:* The reference line represents the 25th percentile for government effectiveness in the sample.
Source: World Bank Governance Indicators (WGIs) dataset [59].

respectively. The results indicate that catch shares (using either of the definitions) are more likely to be found in countries with better governance, and countries with quota-based catch shares have the highest governance rankings.

The data also show less variation in governance scores within CS and CSP countries and within countries with quota systems. The coefficients of variation demonstrate that the results are not an artifact of outliers in the data; there is more homogeneity in the CS or CSP countries than there is in the entire sample of coastal developing countries. A *t*-test for a difference in means between countries with and without catch shares (or with and without catch shares *plus*) shows that nearly all of the differences are significant at the 5 percent level.[20] The exceptions are in the scores for political stability and absence of violence/terrorism, but the differences are significant at the 10 percent level. The findings suggest that countries with catch shares have better governance structures and are more homogenous, in terms of governance quality, than countries without catch shares. Therefore, there is statistical support for the rule-of-thumb relationship between property rights in fisheries and national governance performance.

Although the data are supportive overall, it is also instructive to consider the outliers in the data. That is, countries falling within the lower 25th percent quartile in the World Bank [59] data that also have catch share policies. Fig. 4 shows that five, or about 22.7 percent, of countries in the CSP category fall below the sample median for government effectiveness (39.5) and, only three fall below the 25th percentile (indicated by a reference line in Fig. 4). Fig. 5 reveals that only Bangladesh, falls below the 25th percentile for the average World Bank governance score. Notably, all of the outlier countries – Bangladesh, Fiji, and the Solomon Islands – have catch share *plus* programs that originate from historic customary rights, developed and enforced within fishing villages.[21] The concept of *kastom*, "custom" or "tradition," is important to Melanesian culture (Melanesian catch share countries in the sample include Fiji, Papa New Guinea, the Solomon Islands, and Vanuatu). Similarly, the Bangladeshi *faar* system assigns customary and hereditary rights over fishing locations and is enforced within fishing villages.

3.3. Economic Indicators

When fisheries managers are considering whether to adopt a catch share program, the decision hinges on the potential net benefits and the management costs. If the costs of managing and monitoring catch share programs are significant, then the higher value fisheries are potentially more likely to yield positive net benefits. Furthermore, countries with large fishing industries may be more likely to implement catch share programs, because commercial fisheries are an important economic driver for the country.

Without direct measures of the economic value of the fisheries, this analysis uses FAO [60] data on the value of fisheries exports – both unadjusted and adjusted for the size of the marine environment – to investigate whether countries with higher value fisheries are more likely to adopt catch share policies.[22] Three tests are performed here: tests for differences in selected economic indicators between countries with and without quotas, with and without catch shares, and with and without catch share *plus* programs.

This analysis does not attempt to establish causality. For example, one reason the data might support the hypothesis is that governments may have larger incentives for protecting high-value export fisheries; in other words, the resources attract catch shares. Another reason is that, once catch shares are established, participants have the ability to increase the value of their resources by making quality improvements; that is, the catch shares programs create value [3,61].[23]

Table 3 breaks down the data in three ways: comparing countries with and without quota-based programs, countries with and without catch share programs, and countries with and without catch share *plus* programs. Countries not falling into the CS or CSP categories have lower gross domestic product (GDP), lower per capita GDP, and less valuable marine export industries.[24]

[20] None of the t-tests conducted in this study assume equal variances in the two groups.

[21] The Fijian rights have since been legalized.

[22] FAO [60] export value data is missing for Cote D'Ivoire, Latvia, and North Korea.

[23] Two countries in the sample, Peru and Vietnam, established their catch share programs *after* 2008 (the most current export data are from 2008). Vietnam has the highest total value of marine species exports, and Peru has the third-highest export value per kilometer of coastline. For these countries, the data do not reflect any post — catch share value enhancement.

[24] GDP and per capita GDP are 2009 data in 2009 US$, whereas the value of marine exports is 2008 data in 2008 US$.

Table 3
Economic Indicators. .
Source: GDP and per capita GDP data are from the World Bank [59]. Export values are from the FAO's FishStatJ database [60]. Coastline length and exclusive economic zone area data are from the World Resources Institute [76].

	Statistic	GDP (Bn US$)	Per capita GDP (US$)	Number employed in fishing	Exports value (Th US$)	Value per km (Th US$)	Value per km^2 (Th US$)
All countries	Mean	$159	$3,856	306,558	$470,308	$97	$2.5
	sd	556.0	3,174.4	1409,454	1373,187	201	10
	cv	3.5	0.8	4.6	2.9	2.1	4.0
Without quotas	Mean	$157	$3,524	332,592	$394,166	$64	$1.5
	sd	583	2,993	1479,861	1369,719	136	5
	cv	3.7	0.8	4.4	3.5	2.1	3.5
Quotas	Mean	$177	$6,576	50,085	$1,201,267	$386	$11.1
	sd	883	11,474	262,401	4026,769	1120	79
	cv	257.5	3,454.9	77,662.5	1240,993.0	390.7	27.6
Without catch shares	Mean	$166	$3,585	345,886	$409,627	$68	$1.6
	sd	602.9	3,058.0	1534,434	1412,485	139.8	5.5
	cv	3.6	0.9	4.4	3.4	2.1	3.4
Catch shares	Mean	$125	$5,198	102,978	$811,641	$246	$6.5
	sd	219.3	3,488.7	239,946	1102,472.0	355.6	21.0
	cv	1.8	0.7	2.3	1.4	1.4	3.2
Without CSP	Mean	$149	$3,645	264,806	$346,117	$62	$1.1
	sd	603.9	3,061.6	1445,243	1373,217	138.3	4.9
	cv	4.1	0.8	5.5	4.0	2.2	4.4
CSP	Mean	$234	$4,870	464,075	$972,987	$226	$6.9
	sd	366.7	4186.5	1284,268	1284,021	317	18
	cv	1.6	0.9	2.8	1.3	1.4	2.7

Notes: BN, billion; cv, coefficient of variation; GDP, gross domestic product; km, kilometer; sd, standard deviation; Th, thousand.

On average, coastal developing nations earn $470.3 million in exports of marine fisheries resources, countries with catch shares export $811.6 million, and countries in the CSP category export $973 million worth of marine species. Countries with quota-based catch shares are the highest earners in the sample, averaging $1.2 billion in 2008 exports of marine resources. The difference in export industry values between countries with and without quota or catch shares *plus* programs is significant at the 5 percent level, whereas the difference between countries with and without catch shares programs is not significant at any standard reportable level.[25] This finding suggests that catch share adopters have larger fish export markets than countries without catch shares.

Although the analysis finds support for a relationship between the overall size of a nation's fisheries export industry and the adoption of a catch share program, it is instructive to consider whether the relationship holds after adjusting for size. To that end, this study scales the value of 2008 marine resource exports both by kilometers of coastline and by area (in kilometers squared) of exclusive economic zone (EEZ). The former provides a proxy measure of the value of nearshore fisheries and the latter a measure of offshore fisheries value.

On average, coastal developing countries earn about $97,000 per kilometer of coastline, and countries with catch shares earn roughly $246,000 per kilometer of coastline. The CSP countries, on average, earn slightly less, or about $226,000. Finally, countries with quota-based rights earn the most relative to their coastline, with $386,000 per kilometer. Similar patterns are found when considering fisheries export value per area of EEZ; CS and CSP countries have more valuable fisheries export industries than countries without any form of fisheries property rights, but countries with quota-based programs have the greatest earnings relative to their EEZs.[26] Therefore, even after adjusting countries' marine species export values for differences in coastline endowments, catch share countries are still found to be earning more from their resources.

Countries in the quota and CS categories have higher-value resources, but also employ fewer people in the fishing industry. The average number of fishermen in the sample is 306.6 thousand, nearly five times the number of fishermen in countries with quota-based catch shares. Again, the direction of causality is not clear here. Either catch shares (and quotas) are more easily applied to fisheries in which the number of participants is small (as predicted by Copes [16] and Ostrom [14] and several others), and/or the programs themselves lead to fleet consolidation.

Although overall there is support for the predicted relationship, there are also catch share programs in countries with relatively low-value total marine exports. To better understand the outliers in the data, CS and CSP countries are compared to the 50th sample percentiles based on the value of marine species exports in 2008 (see Figs. 6 and 7).

Grenada is the only CS/CSP country to fall below the sample's 50th percentile in the value of marine exports. Grenada's beach seine fishermen use traditional TURFs to protect their big eye scad and red tail scad stocks, which FishBase [23] ranks in the very high and medium price categories, respectively.[27] Grenada illustrates the idea that in the presence of valuable resources, fishermen may realize the benefit in protecting that value, whether or not the government plays a role in developing or enforcing the catch shares.

With the exception of Mozambique, all seven of the CS/CSP countries below the 50th percentile in fisheries export per kilometer of coast have property rights systems that originate from customary rights (Fig. 7). Additionally, only Bangladesh, India, and Sri Lanka, which have property rights systems originating from traditional customary rights, are above the 50th percentile in value of marine exports per kilometer of coastline.

[25] The result is driven by the inclusion of Vietnam in the CSP category.

[26] EEZ data are missing for 30 countries in this sample; 28 of these are not in any catch share category and two have quota-based catch shares. If missing EEZ data are correlated with the value of exports per square kilometer of EEZ, the conclusions presented here will be biased. We have no prior information on whether that is the case.

[27] In 1996, Finlay reports that fishermen were advocating for the legalization of their traditional rights. It is unclear whether these customary rights have been legalized [62].

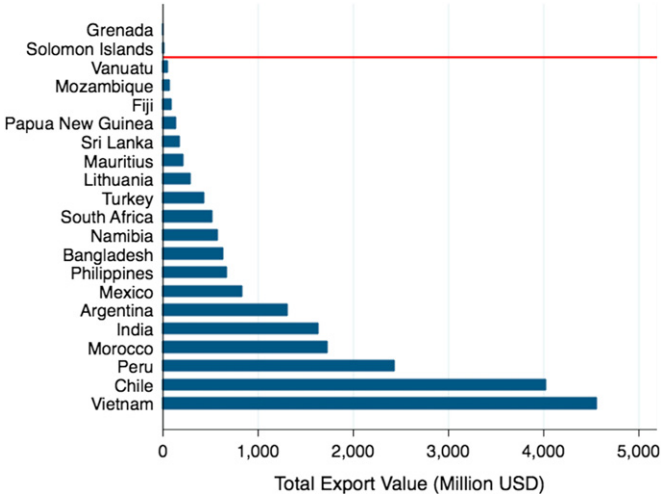

Fig. 6. Catch Shares *Plus* and Total Export Value. *Note:* The reference line represents the rank of the 50th percentile of marine resources export value per km of coastline.
Source: Export values are from the FAO's FishStatJ database [60]. Coastline length and exclusive economic zone area data are from the World Resources Institute [76].

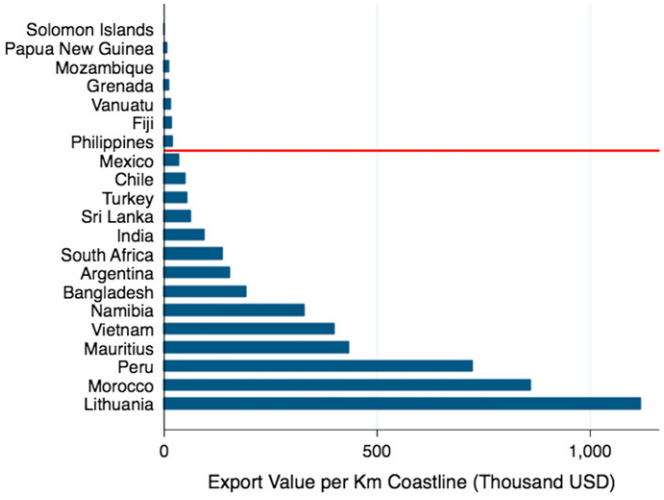

Fig. 7. Catch Shares *Plus* and Export Value per Kilometer of Coastline. *Note:* The reference line represents the rank of the 50th percentile of marine resources export value per km of coastline.*Source:* Export values are from the FAO's FishStatJ database [60]. Coastline length and exclusive economic zone area data are from the World Resources Institute [76].

3.4. Species — level indicators

Copes [16] discussed species characteristics that are potentially at odds with managing the species under an ITQ. In particular, he argued that species not well suited for quota-based management include: (a) those where escapement is targeted and the harvest is residual (e.g., salmon); (b) unstable stocks where the correct TAC is not known with certainty; and (c) short-lived stocks and flash fishery species (e.g., the British Columbia herring fishery). With respect to space-based programs, Christy [17] developed a set of species characteristics that would be favorable to TURF management. As far as the authors of this study are aware, there is no systematic analysis on whether the species currently in catch shares fit these descriptions. To this end, this paper summarizes several species-level indicators provided in the FishBase [23] dataset (including: migratory patterns, lifespan, and price category) in order to compare species characteristics believed to be compatible with the two property rights types (quota-based and space-based).

3.4.1. Quota-based programs

This section focuses on the characteristics of species managed by programs that set fishery-wide catch limits, which include 11 out of the 17 the countries in the CS category (none of the nations in the CSP category operate quota-based property rights).

The Environmental Defense Fund's Catch Shares Fisheries and Resources database [63] was queried for lists of species managed under catch shares in the sample of coastal and developing countries.[28] This species list was then supplemented with quota-managed species names from the literature when available. The resulting list shows catch share programs are being used to manage a total of 60 documented marine resource stocks; 48 of these are fish stocks and 12 are either mollusks or crustaceans. This paper next goes on to characterize the 34 fish stocks for which species-level data on migratory patterns, lifespan, and price category were found.[29]

This analysis finds that fish stocks managed with quota-based catch shares are typically oceanodromous, or they migrate within the ocean. In fact, only three fish species in the sample are not oceanodromous; these include the Chilean sardine (*Clupea bentincki*), Lithuanian flounder (*Lethrunus rubrioperculatus*), and the spotcheeked emperor reef fish in Mauritius (*Lethrinus rubrioperculatus*). Of these, the Lithuanian flounder is the only catadromous species, living in fresh water and migrating into the ocean to spawn, and the only species that could potentially have residual harvests as described by Copes [16]. Overall, the migration patterns observed in the data appear to be consistent with the desirable migratory patterns discussed in Copes [16].[30]

Consistent with Copes [16], this study does not find species with lifespans under one year managed with quota-based programs (Table 4). The species in the sample with the longest lifespan is the Namibian orange roughy (*Hoplostethus atlanticus*), which lives up to 140 years. The species with the shortest lifespan in the sample is the Peruvian anchovy (*Engraulis ringens*), with a maximum lifespan of three years. The median lifespan in the sample was 20 years, suggesting that governments are implementing quota-based management for those species with potentially significant recruitment externalities.[31] The finding is supported by Cheung et al. [64] species vulnerability score, which was 53.3 out of 100 for species in the sample, which according to FishBase [23] is considered a medium to high vulnerability.

In addition, 12 crustacean and mollusk stocks are managed with quota-based programs. Unfortunately, FishBase [23] does not provide lifespan data for these stocks.[32] Table 5 lists the

[28] The database was created as a supplement to the Bonzon et al. [15] report. Some catch share entries in the EDF's database indicate uncertainty over whether the quota system qualifies as a catch share despite inclusion in the Bonzon et al. [15] report. Included here are all species for countries listed as having catch shares in the report.

[29] Lifespan data were only available for 21 species.

[30] In addition the paper looks at depth range and trophic level finding that the fish stocks have an average depth range of 32–640 m (the average minimum through average maximum) and a tropic level of 3.61 (in the secondary consumer trophic class).

[31] Recruitment externalities occur if one individual's harvest in the current time period affects the resource abundance for everyone in future periods and the individual does not completely internalize the impacts of his or her actions.

[32] Noted, however, is that although Copes [16] argues that no benefits would result from restricting the harvest of species with no recruitment externalities, other externalities associated with resource exploitation may exist. For example, weekly vessel quotas were agreed on for the Swedish offshore shrimp fishery to prevent large harvests from driving down shrimp prices [65].Therefore, although stock externalities may be the driving force for ITQ (or IQ/IVQ) adoption, it is not necessarily the only source of waste in these fisheries.

Table 4
Lifespan frequency chart for quota-managed species.
Source: FishBase [23]

Lifespan	No. of species
< 3 years	0
3–10 years	3
11–15 years	3
16–20 years	5
21–25 years	5
26–30 years	4
> 30 years	1

Table 5
Quota-managed crustacean and mollusk stocks.
Source: Bonzon et al. [15], and Stewart [43]

Country	Scientific name	Common name	Catch share type
Argentina	*Vieira patagonica*	Yellow lobster	ITQ
Morocco	?	Cephalopods	IQ
Mexico	*Litopenaeus stylirostris*	Blue shrimp	Cooperative
Mexico	*Farfantepenaeus californiensis*	Brown shrimp	Cooperative
Mozambique	?	Prawn	IQ
Mozambique	?	Gamba	IQ
Namibia	*Jasus lalandii*	Cape rock lobster	IQ
Namibia	*Chaceon maritae*	Red crab	IVQ
South Africa	*Haliotis midae*	Abalone	IQ
South Africa	*Palinurus gilchristi*	Lobster	IQ
South Africa	*Jasus lalandii*	Rock lobster	IQ
South Africa	*Donax serra*	White mussel	IQ

Note: Question marks (?) denote missing data.

crustacean and mollusk stocks in quota-based catch share programs. In terms of lifespan, topshell species can live up to 30 years, South African white mussels have an average lifespan of 5 years, and rock lobsters typically have a lifespan of 5–7 years. Similar to the fish species, these stocks have the potential for significant recruitment externalities.

The FishBase [23] database classifies species by price category using the Sumaila et al. [66] data on ex-vessel fish prices. In this sample of fish stocks managed by quota-based catch share programs, the majority of fish species receive medium to very high prices (Table 6). The findings are consistent with the idea that catch shares are motivated by the value of the resource. If costs are associated with the development and enforcement of catch shares, designing these systems around low-value resources may yield negative net benefits to program adoption.

However, 12 of the fish stocks in quota-based catch shares are in the low-price category. These stocks include Chilean anchovy (*Engraulis ringens*), Chilean hake (*Merluccius gayi*), Chilean sardine (*Clupea bentincki*), Latvian Herring (*Clupea harengus*), Lithuanian herring (*Clupea harengus*), Lithuanian sprat (*Sprattus sprattus*), Namibian devil anglerfish (*Lophius vomerinus*), Namibian sardine (*Sardinops sagax*), Peruvian anchovy, South African sardine (*Sardinops sagax*), South African horse mackerel (*Trachurus capensis*), and South African herring (*Etrumeus whiteheadi*). These species may be valuable despite low per-pound prices. Seven of these species are sardines, anchovies, or herring and are commonly known as forage fish. Forage fish are typically harvested in large volumes; although thought to be resilient to fishing pressure, they are sensitive to environmental conditions and several are classified as fully exploited or overexploited [67].

Table 6
Price category frequency chart.
Source: Sumaila et al. [66]

Price category	No. of species
Low	12
Medium	11
High	4
Very high	7

3.4.2. TURFs

Christy [17] discussed a set of characteristics of marine species that lend themselves to TURF management as follows:

> Sedentary species can easily be made subject to territorial use rights—either on the bottom or when attached to rafts. Distinct biomes such as those associated with either natural or artificial reefs also have favourable territorial aspects. Localized TURFs can be created for species which can be raised in a physically enclosed space, such as fish pens and cages; for species which are attracted to, and aggregate around, artificial devices; and for anadromous and catadromous species (e.g., salmon and eels) which migrate into fresh water. (7)

Eight countries in the CS category manage a combined total of 102 species with space-based property rights. There are species-level data for an additional three countries and seven species that fit into the CSP category. This analysis compares the characteristics of species in these TURF programs to those described by Christy as being prerequisites to effective TURF management. The data show a remarkable fit between ideal characteristics for TURF management, as described by Christy, and the species characteristics in this sample.

Out of the 113 documented TURF species, 89 fit into at least one of Christy's characteristics. However, there are some exceptions. Out of 60 species managed under the Chilean TURF program, 48 are sedentary species. [33] TURFs in Bangladesh, Sri Lanka, and India have formed around shrimp species, which migrate from estuaries into open waters upon maturation. These migration patterns provide for the ability to establish TURFs over fixed fishing locations, similar to anadromous and catadromous species, as mentioned by Christy.

Table 7 categorizes the TURF-managed species in the sample according to Christy's observations. Question marks represent unknown information. For example, in Vietnam several species are raised in fish corrals, but species counts or species names for these fish were not available. They are included in Table 7 because there is information on species characteristics (in contrast, Turkey is not included in the table as a search found no information on Turkish TURF-managed species).

Although the majority of TURF species qualify for at least one of Christy's criteria, 24 species either do not meet Christy's criteria or have uncertain eligibility. Many of these species are shrimp fisheries managed by catch share *plus* programs. Whether or not shrimp species are suitable for TURFs depends on stock migration patterns and habitat range. In Japan, the sakuraebi shrimp stock is confined to the Suruga Bay, and has been cited as an example of successful TURF management [68]. Information regarding the habitat range for the shrimp species managed in the catch share *plus* programs is not readily available, but they are all harvested using fixed net fishing spots indicating that the shrimp do concentrate in space [20,21].

[33] Bonzon et al. [15] report 65 species managed under the Chilean TURF program, but their database records only 60 *unique* species.

Table 7
TURF Species characteristics.
Source: FishBase [23] data on habitat and migratory patterns and a literature review of the programs to determine which species were being raised in an enclosed space.

TURF countries	Documented species (shrimp)[a, b]	Sedentary[c, d]	Reef	Enclosed space	Catadromous or anadromous	Don't fit/ uncertain
Bangladesh	12 (4)	–	–	–	4	8
Chile	60 (0)	48	–	–	–	12
Fiji	4 (0)	4	–	–	–	–
Grenada	2 (0)	–	2	–	–	–
India	3 (3)	–	–	–	–	3
Mexico	4 (0)	2	2	–	–	–
Papua New Guinea	12 (0)	1	11	–	–	–
Philippines	3 (0)	1	2	–	–	–
Solomon Islands	6 (0)	3	3	–	–	–
Sri Lanka	1 (1)	–	–	–	–	1
Vanuatu	6 (0)	3	3	–	–	–
Vietnam	?	–	–	All	–	–
Catch shares Total	97 (0)	62	23	–	–	12
Catch shares *Plus* Total	113 (8)	63	23	?	4	24

[a] Shrimp species counts are provided in parenthesis.
[b] Question marks represent undocumented species counts.
[c] Abalone, algae, clam, limpets, oyster, scallops, sea snail, sea urchin, and tunicate species are all considered sedentary. Because of a lack of data, species are not cross-listed as sedentary and reef species.
[d] Hyphens are used when there are no known species in a given category.

4. Discussion

About one-fifth of the world's developing countries have adopted institutions that allocate fishery property rights and have the potential to effectively manage resource stocks. These programs are heterogeneous, but also share commonalities. African nations have adopted quota-based programs, whereas several space-based property rights are found in the Asia and Pacific region. This paper finds patterns consistent with property rights emerging in nations with higher World Bank governance rankings, high-value fishing industries, and in fisheries targeting species for which recruitment externalities are present. Across all of these dimensions, the results are stronger for quota-based catch share programs than for space-based programs.

The more pronounced differences (between countries with and without quota-based catch shares) are not necessarily surprising when one considers that quota-based programs do not necessarily evolve from bottom-up processes, but rather are often implemented by national or regional governing bodies. The implication is that because these programs entail significant costs in design and implementation, they are more likely found in places with better governance and high-valued fisheries.

The outliers in the data provide some insights into the nature of bottom-up processes that can prevail. For example, this study identifies communities (in the CSP category) that have been able to overcome weak national governments. Dietz, Ostrom, and Stern [69] discuss conditions favorable to effective local CPR governance: (a) resources and resource use can be monitored; (b) there are only moderate changes in resources, resource users, technology, and economic and social conditions; (c) close-knit communities are using the CPR; (d) outsiders can be excluded at low cost; and (e) users develop effective monitoring and enforcement mechanisms.[34] These conditions, which are rarely all satisfied in one place [69], essentially divorce the performance and management at the local level with the national government's performance, and may explain the outliers in the data.

The findings presented here raise a number of important questions for future research. For example, what is the role of neighboring countries in the adoption of catch share programs? If catch shares are more likely to be applied in high-valued fisheries, what are the options for fisheries reform in situations where the direct consumptive value is low but the other values potentially associated with the species or ecosystem (e.g., nonconsumptive values) are high? Is it worthwhile to engage in fisheries management reform in places with weak national governments and where the conditions of Dietz, Ostrom, and Stern [69] are not satisfied? Finally, and most importantly, are catch share programs in developing countries more likely or less likely than those in developed countries to successfully meet their goals? Future research attempting to disentangle the causes for adoption of catch share programs and their performance can help international efforts in targeting their resources to countries and fisheries more likely to adopt property right systems.

[34] The conditions have been paraphrased; see Dietz et al. [69] for the exact conditions and a discussion of each.

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Appendix

Program Descriptions; (See Table A1 below).

References

[1] Christy Jr FT. Property rights in the world ocean. Nat Resour J 1975;15:695.
[2] Newell RG, Sanchirico JN, Kerr S. Fishing quota markets. J Environ Econ Manage 2005;49:437–62.
[3] Sanchirico JN, Holland D, Quigley K, Fina M. Catch-quota balancing in multispecies individual fishing quotas. Mar Policy 2006;30:767–85.
[4] Chu C. Thirty years later: the global growth of ITQs and their influence on stock status in marine fisheries. Fish Fish 2009;10:217–30.
[5] Branch TA. How do individual transferable quotas affect marine ecosystems? Fish Fish 2009;10:39–57.
[6] Melnychuk MC, Essington TE, Branch TA, Heppell SS, Jensen OP, Link JS, et al. Can catch share fisheries better track management targets? Fish Fish 2011:1467–2979.
[7] Grafton RQ, Arnason R, Bjorndal T, Campbell D, Campbell HF, Clark CW, et al. Incentive-based approaches to sustainable fisheries. Can J Fish Aquat Sci 2006;63:699–710.

Table A1

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Country	World Bank region	Description	Sources	Catch share type	Established
Argentina	Latin America & Caribbean	IVQs in the Patagonian scallop fishery (Bonzon et al. 2010) and ITQs for hake (Melnychuk et al. 2011). ITQ regimes were approved for Southern blue whiting, Patagonian toothfish, longtail hake or Patagonian whiphake, and Argentine hake (http://www.cfp.gob.ar/index.php?inc=regimencitc_en&lang=en).	[6,15,70,71]	IVQ and ITQ	Hake: 1998 Others: 2000
Bangladesh	South Asia	A *faar* system, in which users have hereditary rights.	[20,21]	TURFs	1929
Chile	Latin America & Caribbean	In 1991 Chile implements TURFs and ITQs for a large variety of species, e.g. TURFs for octopus, loco, and sea urchin and ITQs for mackerel, sardine, and deep cod.	[15,18]	TURFS and ITQs	TURFs: 1991 ITQs: 1992–2002
Fiji	East Asia & Pacific	Locally Managed Marine Areas and Fijian customary *qoliqoli* rights system.	[15,49]	TURF	?
Grenada	Latin America & Caribbean	Seine fishery.	[15]	TURF	?
India	South Asia	Lobe and Berkes (2004) describe a *padu* system for the Kerala shrimp fishery (in the Cochin Estuary), where access rights to 78 sites are issued by annual lottery. Coulthard (2011) describes a shrimp *padu* system in the Pulicat Lagoon.	[72,73]	TURF	1970s
Latvia	Europe & Central Asia	IQ rights for cod and herring.	[15,45]	IQ	?
Lithuania	Europe & Central Asia	IQ rights for offshore cod and for several nearshore species.	[15,45]	IQ	?
Mauritius	Sub-Saharan Africa	A TAC for bank fisheries, distributed as quotas to six local private companies using 10–12 motherships. Quotas can be internally transferred.	[35]	ITQ	1994
Mexico	Latin America & Caribbean	The government allocates species and area-based property rights to cooperatives. The shrimp fishery also has cooperative quotas.	[15,29]	Cooperatives/ TURFs	TURFS: 1968 Cooperatives: 2009
Morocco	Middle East & North Africa	FAO provided assistance to the Moroccan Ministry of Maritime Fisheries to develop a quota management system for the cephalopod fishery. The TAC is divided between the freezer, coastal, and artisanal segments.	[4,43]	ITQ	2000
Mozambique	Sub-Saharan Africa	The government allocates quotas based on a TAC.	[4,37]	ITQ	?
Namibia	Sub-Saharan Africa	The government sells IQs.	[15,37]	IQ	1992–1997
Papua new Guinea	East Asia & Pacific	TURFS for Sea Cucumber and reef fish.	[15]	TURFs	?
Peru	Latin America & Caribbean	Anchovy quota implemented in 2008.	[15,74]	IVQ	2009
Philippines	East Asia & Pacific	In 1991 local government units were put into law, granting local municipalities the exclusive authority to grant fisheries privileges and to impose fees, rentals, and charges.	[15,50]	TURFs	1991
Solomon Islands	East Asia & Pacific	Hereditary rights to fish within the territory of the kin group.	[15,47]	TURFs	Historic
South Africa	Sub-Saharan Africa	Quota rights for anchovy, mainly held by a few corporations, although the government has pledged to increase access to new entrants.	[15,36]	IQ	2003–2006
Sri Lanka	East Asia & Pacific	A *padu,* or a system where a lottery is used for the starting points of a rotational system, for the Negombo stake-net shrimp fishery.	[72,73]	TURFs	Historic
Turkey	Europe & Central Asia	Cooperatives — —some that lease lagoons from the state and operate as a monopoly (Berkes, 1986), and some nonlagoon coastal cooperatives that act as harvesters' cooperatives, restricting the number of net sites.	[19,75]	TURFs	?
Vanuatu	East Asia & Pacific	Ownership of nearshore areas (coral reefs) is hereditary.	[15,48]	TURF	Historic
Vietnam	East Asia & Pacific	The government allocates 993 ha of lagoon space to the Vinh Giang Fishery Association. Formal rights allocations have recently been granted in three more sites in the lagoon — Loc Binh and Loc Tri (Phu Luc district) in March 2010, and Phu My (Phu Vang district) in September 2010.	[51]	TURF	2009

Note: Question marks (?) represent missing data.

[8] Costello C, Gaines SD, Lynham J. Can catch shares prevent fisheries collapse? Science 2008;321:1678–81.
[9] Essington TE. Ecological indicators display reduced variation in North American catch share fisheries. PNAS USA 2010;107:754–9.
[10] Evans L, Cherrett N, Pemsl D. Assessing the impact of fisheries co-management interventions in developing countries: a meta-analysis. J Environ Manage 2011;92:1938–49.
[11] Pomeroy RS, Katon BM, Harkes I. Conditions affecting the success of fisheries co-management: lessons from Asia. Mar Policy 2001;25:197–208.
[12] Sen S, Raakjaer Nielsen J. Fisheries co-management: a comparative analysis. Mar Policy. 1996;20:405–18.
[13] Wilson DCK, Ahmed M, Delaney A, Donda S, Kapasa CK, Malasha I, et al. Fisheries co-management institutions in Southern Africa: a hierarchical analysis of perceptions of effectiveness. Int J Commons 2010;4:643–62.
[14] Ostrom E. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press; 1990.
[15] Bonzon K, McIlwain K, Strauss CK, Van Leuvan T. Catch Share Design Manual: A Guide for Managers and Fishermen. 2010.
[16] Copes P. A critical review of the individual quota as a device in fisheries management. Land Econ 1986;62:278–91.
[17] Christy FT. Territorial use Rights in Marine Fisheries: Definitions and Conditions. Food and Agriculture Organization; 1982.
[18] Cancino JP, Uchida H, Wilen JE. TURFs and ITQs: collective vs. individual decision making. Mar Resour Econ 2007;22:391.
[19] Berkes F. Local level management and the commons problem. Mar Policy 1986;10:215–9.
[20] Deb AK. 'The Slaves of Water': Socio-cultural Construction of the Community-based Coastal Resource Management in the South-eastern Bangladesh. 2008.
[21] Deb AK. 'Voices of the Fishantry': Learning on the Livelihood Dynamics from Bangladesh: University of Manitoba; 2009.
[22] Toral-Granda V. Galapagos Islands: a hotspot of sea cucumber fisheries in Latin America and the Caribbean. FAO Fisheries and Aquaculture Technical Paper. 2008;516.
[23] Froese R, Pauly D. FishBase. World Wide Web electronic publication; 2011.
[24] McConney P. Grenada case study: legalisation of beachseine traditional rules at Gouyave. Caribbean Coastal Co-management Guidelines Project Caribbean Conservation Association, Barbados. 2003.
[25] Leiva GE, Castilla JC. A review of the world marine gastropod fishery: evolution of catches, management and the Chilean experience. Reviews in Fish Biology and Fisheries. 2001;11:283–300.
[26] Ramade-Villanueva MR, Lluch-Cota DB, Lluch-Cota SE, Hernandez-Vazquez S, Espinoza-Montes A, Vega-Velazquez A. Fisheries-an evaluation of the annual quota mechanism as a management tool in the Mexican abalone fishery. J Shellfish Res 1998;17:847–52.
[27] McGoodwin J.R. Conflicts over shrimp rights in a Mexican fishery. A sea of small boats. 1989.
[28] Sosa-Cordero E, Liceaga-Correa MLA, Seijo JC. The Punta Allen Lobster Fishery: current status and recent trends. In: Townsend R, Shotton R, Uchida H, Eds.. Case Studies in Fisheries Self-governance. Rome: FAO Fisheries Technical Paper No. 504; 2008. p. 451.
[29] Dubay K, Tokuoka S, Gereffi G. A value chain analysis of the Sinaloa, Mexico Shrimp Fishery. Retrieved from Duke University-Center of Globalization and Governance and Competitiveness (CGGC) website: 〈http://cggc.duke.edu〉; 2010.
[30] Gelcich S, Hughes TP, Olsson P, Folke C, Defeo O, Fernandez M, et al. Navigating transformations in governance of Chilean marine coastal resources. PNAS USA 2010;107:16794–9.
[31] Gelcich S, Edwards-Jones G, Kaiser MJ. Importance of attitudinal differences among Artisanal Fishers toward Co Management and Conservation of Marine Resources. Conserv Biol 2005;19:865–75.
[32] Thorpe A, Ibarra AA. The new economic model and marine fisheries development in Latin America. World Dev 2000;28:1689–702.
[33] Chavez FP, Ryan J, Lluch-Cota SE, Ñiquen C. From anchovies to sardines and back: multidecadal change in the Pacific Ocean. Science 2003;299:217.
[34] Ibarra AA, Reid C, Thorpe A. Neo-liberalism and its impact on overfishing and overcapitalisation in the marine fisheries of Chile, Mexico and Peru. Food Policy 2000;25:599–622.
[35] Hollup O. Structural and sociocultural constraints for user-group participation in fisheries management in Mauritius. Mar Policy 2000;24:407–21.
[36] Nielsen JR, Hara M. Transformation of South African industrial fisheries. Mar Policy 2006;30:43–50.
[37] FAO, Food and Agricultural Organization. Inf Fish Manage Republic of Mozambique. 2004.
[38] Sousa LPd Brito A, Abdula S, Caputi N. Research assessment for the management of the industrial shallow-water multi-species shrimp fishery in Sofala Bank in Mozambique. Fish Res 2006;77:207–19.
[39] Bjorndal T, Bezabih M. Resource rents and management regimes: the case of the western channel sole fishery. Mar Res Econ 2010;25:325–31.
[40] Arnason R. A review of international experiences with ITQs. Annex to Future Options for UK Fishing Management, Report to the Department for the Environment, Food and Rural Affairs, CEMARE, University of Portsmouth, UK. 2002.
[41] Oelofsen B. Fisheries management: the Namibian approach. ICES J Mar Sci: Journal du Conseil 1999;56:999.
[42] Wiium V, Uulenga A. Fisheries Management Costs and Rent Extraction, the case of Namibia. unpublished paper for Ministry of Fisheries and Marine Resources. 2001.
[43] Stewart C. Legislating for property rights in fisheries: Food and Agriculture Organization of the UN; 2004.
[44] FIS, Fish and Information Services. Omnium Marocain de Peche. access date: 10/2011.
[45] MRAG, IFM, CEFAS, A. Tecnalia & PolEM (2009) An analysis of existing Rights Based Management (RBM) instruments in Member States and on setting up best practices in the EU. Final Report London: MRAG Ltd. 2009:3.
[46] FAO, Food and Agricultural Organization. FAO Fishery Country Profile — The Republic of Lithuania. 2005.
[47] Hviding E. Contextual flexibility: present status and future of customary marine tenure in Solomon Islands. Ocean and Coastal Management. 1998;40:253-69.
[48] Naviti W, James A. Status of coral reef and reef fish resources of Vanuatu. Regional Symposium on Coral Reefs in the Pacific: Status and Monitoring; Resources and Management. Noumea, New Calcedonia. 2000.
[49] DeMers A, Kahui V. An overview of Fiji's fisheries development. Mar Policy 2012;36:174–9.
[50] Maliao RJ, Polohan BB. Evaluating the impacts of mangrove rehabilitation in Cogtong Bay, Philippines. Environ Manage 2008;41:414–24.
[51] Armitage D, Marschke M, van Tuyen T. Early-stage transformation of coastal marine governance in Vietnam? Mar Policy 2011;35:703–11.
[52] Anderson LG. An economic analysis of highgrading in ITQ fisheries regulation programs. Mar Res Econ 1994;9:209–26.
[53] Arnason R. On catch discarding in fisheries: University of Iceland. Faculty of Economics and Business Administration 1994.
[54] Hatcher A. On the microeconomics of quota management in fisheries. Mar Resour Econ 2005;20:77–99.
[55] Turner MA. Value-based ITQ's. Mar Resour Econ 1996;11:59–70.
[56] Turner MA. Quota-induced discarding in heterogeneous fisheries. J Environ Econ Manage 1997;33:186–95.
[57] Vestergaard N, Universitetscenter S. Discard behaviour, highgrading and regulation: the case of the Greenland shrimp fishery. Mar Resour Econ 1996;11:247–66.
[58] Leal D. The Political Economy of Natural Resource Use: Lessons for Fisheries Reform. Washington D.C.: World Bank; 2010.
[59] World Bank. The Worldwide Governance Indicators (WGI) project, 〈http://info.worldbank.org/governance/wgi/index.asp〉, Access Date 09/2011. 1996.
[60] FAO, Food and Agricultural Organization. Fisheries commodities production and trade 1976-2008 In: FAO, Food and Agricultural Organization, editor. Rome 2010.
[61] Casey KE, Dewees CM, Turris BR, Wilen JE. The effects of individual vessel quotas in the British Columbia Halibut Fishery. Mar Resour Econ 1995;10:211–30.
[62] Finlay J. Community-level sea use management in the Grenada beach seine net fishery: current practices and management recommendations. M.Sc. Thesis, University of the West Indies, Cave Hill, Barbados. 1995.
[63] EDF, Environmental Defense Fund. Catch Shares of the World. In: Environmental Defense Fund, editor. New York. 2010.
[64] Cheung WWL, Pitcher TJ, Pauly D. A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing. Biol Conserv 2005;124:97–111.
[65] Eggert H, Rights Ulmestrand MTenure. and Stewardship of Marine Resources: a co-managed Swedish shrimp fishery in a marine reserve. Case Studies in Fish Self-governance 2008;504:21.
[66] Sumaila UR, Marsden AD, Watson R, Pauly D. A global ex-vessel fish price database: construction and applications. J Bioeconomics 2007;9:39–51.
[67] Alder J, Campbell B, Karpouzi V, Kaschner K, Pauly D. Forage fish: from ecosystems to markets. Annu Rev Environ Resour 2008;33:153–66.
[68] Uchida H, Makino M. Japanese coastal fishery co-management: an overview. Case Studies in Fisheries Self-governance 2008:221–9.
[69] Dietz T, Ostrom E, Stern PC. The struggle to govern the commons. Science 2003;302:1907.
[70] Hilborn R, Orensanz J, Parma AM. Institutions, incentives and the future of fisheries. Philos Trans R Soc B: Biol Sci 2005;360:47.
[71] Federal Fishery Council. Individual Transferable Quota Catch Management Regime (CITC). Buenos Aires: Federal Fishery Council; 2010.
[72] Coulthard S. More than just access to fish: the pros and cons of fisher participation in a customary marine tenure (Padu) system under pressure. Mar Policy 2011;35:405–12.
[73] Lobe K, Berkes F. The padu system of community-based fisheries management: change and local institutional innovation in south India. Mar Policy 2004;28:271–81.
[74] Coriat SD.. Peru & Our Industry. In: (COPEINCA) CPI, editor. 15th Annual Latin America CEO Conference. Cancun, Mexico: Corporacion Pesquera Inca (COPEINCA); 2011.
[75] Ünal V, Güçlüsoy H, Franquesa R. A comparative study of success and failure of fishery cooperatives in the Aegean, Turkey. J Appl Ichthyology 2009;25:394–400.
[76] WRI, World Resources Institute. EarthTrends Environmental Information. In: WRI, World Resources Institute, editor. Washington D.C.: World Resources Institute; 2007.

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Corrigendum

Corrigendum to "Catch share programs in developing countries: A survey of the literature" [Mar. Policy 2012;36 (6),1242–1254]

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See Table 3.

Table 3
Economic indicators.
Source: GDP and per capita GDP data are from the World Bank [59]. Export values are from the FAO's FishStatJ database [60]. Employment in fishing, coastline length, and exclusive economic zone area data are from the World Resources Institute [76].

Statistic	GDP (Bn USD)	Per capita GDP (USD)	Number employed in fishing	Value of marine exports (Th USD)	Value of per Km (Th USD)	Value per Km^2 (Th USD)
All countries						
mean	$159	$3856	306,558	$470,308	$97	$2.5
sd	556.0	3174.4	1,409,454	1,373,187	201	10
cv	3.5	0.8	4.6	2.9	2.1	4.0
Without quotas						
mean	$157	$3524	332,592	$394,166	$64	$1.5
sd	583	2993	1,479,861	1,369,719	136	5
cv	3.7	0.8	4.4	3.5	2.1	3.5
Quotas						
mean	$177	$6576	50,085	$1,201,267	$386	$11.1
sd	258	3455	77,663	1,240,993	391	28
cv	1.5	0.5	1.6	1.0	1.0	2.5
Without catch shares						
mean	$166	$3585	345,886	$409,627	$68	$1.6
sd	602.9	3058.0	1,534,434	1,412,485	139.8	5.5
cv	3.6	0.9	4.4	3.4	2.1	3.4
Catch shares						
mean	$125	$5198	102,978	$811,641	$246	$6.5
sd	219.3	3488.7	239,946	1102472.0	355.6	21.0
cv	1.8	0.7	2.3	1.4	1.4	3.2
Without catch shares plus						
mean	$149	$3645	264,806	$346,117	$62	$1.1
sd	603.9	3061.6	1,445,243	1,373,217	138.3	4.9
cv	4.1	0.8	5.5	4.0	2.2	4.4
Catch shares plus						
mean	$234	$4870	464,075	$972,987	$226	$6.9
sd	366.7	4186.5	1,284,268	1,284,021	317	18
cv	1.6	0.9	2.8	1.3	1.4	2.7

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