




International Fisheries Access Agreements and Trade

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Abstract

International fishery access agreements allow fishermen from one country to harvest fish in another country's waters. We empirically examine why countries sign fisheries access agreements with each other and compare these to the characteristics of countries that choose to undertake international trade. Using a unique global panel dataset, we show that access agreements and fish exports are driven by two key motives: a pattern of comparative advantage in fishing, which depends on fish stocks and fishing capacities; and gravity factors of economic size and distance. Our results suggest that most gravity factors work similarly for the dual pathways of agreements and exports: larger countries that are closer to each other are more likely to sign access agreements or to trade. However, the pattern of advantage is determined differently: source countries with larger fishing capacity are more likely to export fish, while source countries with lower fishing capacity are more likely to sign agreements.

Keywords Access agreements · Fishing services · International fisheries · International trade

JEL Classification Q22 · Q27 · F13 · F14 · F18

1 Introduction

Fishermen seeking abundant stocks outside their nation's territorial waters from which to harvest fish has occurred throughout history.¹ Over time, distant water fishing has expanded on a significant scale, with up to three quarters of the fleet in areas of the Pacific being distant water vessels. The challenge faced by the countries that have these relatively

¹ In fact, the relative abundance of cod off the North East coast of North America was an important element in the early European settlement of those shores (Kurlansky 1998) as were the whale stocks in the southern oceans for Australia and New Zealand (Prickett 2002).

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abundant fish stocks is how to take best advantage of providing these fish to consumers in other countries. One way is to use, or develop, their own fishing industry to harvest the fish and then engage in trade. A counterpart is to undertake an access agreement to allow fishermen from another country to legally harvest the fish directly. These agreements are popularly seen as being purely exploitative whereas a World Bank report (Arthur et al. 2014) describes them simply as a type of trade in fishing services.² In an era where approximately half of the world's oceans have some form of foreign fishing arrangement and more than one-third of fishery production is traded, it is important to understand the factors that lead countries to undertake these agreements and conduct trade. Moreover, this knowledge can assist with adaptation in the face of shifting areas of fisheries abundance due to climate change and increasingly politicised international trade.³

Our paper is the first to empirically examine both fisheries access agreements and fish exports as dual pathways to provide fish products from the waters of the source countries to consumers in destination countries. Unlike the previous literature that focus on case studies, our analysis is based on a unique global panel dataset, which allows us to draw general conclusions on differences in the determinants of fisheries agreements and fish trade. In addition to commonly used gravity factors of economic size and distance, we identify a novel key motive to explain these dual pathways—comparative advantage in fishing. Our results suggest that the pattern of advantage in fishing is indeed determined differently for access agreements and fish trade, with the countries' fishing capacities being the key difference.

For our empirical analysis, we construct a global panel of agreements and trade country-pair-year observations by combining data on international fisheries access agreements, fish stock status and fish catch with data on fish trade and data on gravity country-pair characteristics. Our baseline sample contains 256,163 country-pair-year observations in the period 1962–2000, with 5.7% having an access agreement, 20.1% engaging in a trade relationship and 3.9% having both. Using a simple conceptual environment, we identify two key motives for countries signing an access agreement or trading in fish products, these are gravity factors and comparative advantage in fishing. Our empirical results show that while the gravity factors work in a similar way for both agreements and fish exports, that is, larger and closer countries are more likely to sign access agreements and trade in fish, there is a key difference in the role of comparative advantage in fishing. We find that source countries with a larger fishing capacity are more likely to export fish products, while source countries with a lower fishing capacity are more likely to sign agreements. We also find that fish stock status plays an important role—a higher fish stock status in the source country increases the probability of both access agreement and fish exports, while a lower fish stock status in the destination country increases the probability of fish imports. We explore the role of historical fishing relationships and find that, while important, these do not change our baseline results. Finally, we examine the differences between reciprocal and non-reciprocal relationships and find that fishing advantage plays an important role only for non-reciprocal agreements or fish trade, while the reciprocal relationships are more likely to be between similar countries.

Our empirical investigation is the first to study both access agreements and fish exports using a global panel dataset. The closest paper to ours is Hammarlund and Anderson

² See commentary by Greenpeace (2012) or in the movie *The Cove* (2009) for examples of popular perception.

³ FAO (2018a, b) outline the current and predicted status of global fisheries production.

(2019), a pioneering empirical analysis of agreements and fish trade using a panel data of African countries. They investigate the impact of agreements on trade with the EU and find that the existence of exports falls when agreements become inactive. Unlike our paper, their Africa–EU analysis does not consider agreements and trade as dual pathways and does not include stock capacity as a measure of comparative advantage. Natale et al. (2015) estimate a gravity model of seafood trade which is similar to our empirical model. However, they only investigate trade, not access agreements, and do not include fish stock status and fishing capacity as explanatory factors.

Our paper is related to an emerging literature on the impact of trade or fishery agreements on fishery management and overfishing. For example, Erhardt (2018) demonstrates that trade openness reduces overuse of fish species in countries with lax governments and does not impact overuse in countries with higher governance levels.⁴ Our paper proposes that the abundance of fish, as measured by fish stock status, is a measure of fishing comparative advantage and, hence, an explanatory factor of fish exports and access agreements. In this regard, our paper is complimentary to this literature on trade openness and fish stock overuse.⁵

The rest of the paper proceeds as follows. We start with a brief background on access agreements in Sect. 2. Then in Sect. 3 we outline a simple conceptual environment to derive testable predictions for our empirical analysis. The distinctive dataset with which these predictions are tested is described in Sect. 4. The empirical analysis and results of our agreement and trade incidence estimations are given in Sect. 5. Finally, Sect. 6 discusses the conclusions that comparative fishing advantage and gravity factors are important for the dual pathways of international fisheries access agreements and trade.

2 Background on Fisheries Access Agreements

Fish are some of the most traded goods in the world: the total value of fish exports increased tenfold from USD 8 billion in 1976 to USD 85.9 billion in 2006 (Swartz et al. 2010). Existing research on fish trade is varied, however, the literature on distant water fishing and fisheries access agreements is still sparse. In this section we provide a brief background to introduce some key features of fisheries access agreements.

Access agreements establish the rules for one nation to fish in another nation's waters. These agreements are typically bilateral, with some exceptions, for instance, agreements that have the European Union acting as a single entity and the agreement between the United States and the Pacific Islands Forum Fisheries Agency. Access agreements come in a variety of forms: some set exact limits on specific species, others allow access to vessels that traditionally harvested in areas prior to the extension of exclusive economic zones,

⁴ Vetemaa et al. (2006) consider a case study of Estonian fisheries which faced significant overuse after the collapse of the Soviet Union. In another case study, Bayramoglu and Jacques (2012) document a negative pressure of trade openness on fish stock in Turkish fisheries.

⁵ The resource literature also looks at broader international issues related to fisheries. For example, Asche et al. (2015) and Watson et al. (2017) investigate the relationship between food security and evolution of fish trade flows between developed and developing countries. The general consequences of international sharing in fisheries have been examined by McWhinnie (2009) and Rus (2012). There are also multiple case studies of various issues in international trade in fishery products, such as international fish market integration (Tveteras and Asche 2008) and product competitiveness (Hoshino et al. 2015; Norman-Lopez et al. 2013).

and others grant blanket access rights. In return for access rights, the harvesting countries may reciprocate with access to their own waters, provide fisheries science and development funds, build ports or undertake fisheries joint ventures, or simply pay cash. Average fees collected by source countries are 6% of the value of the catch.⁶ The contracts generally have a short (1- to 5-year) timeframe and the source country retains the right to manage the fishery optimally, if they so desire. To provide some further context, we briefly describe some major access agreements which involve four key players in global fishing: the European Union, the United States, Japan, and China.

The EU has a network of agreements in the Atlantic Ocean, the Indian Ocean and more recently in the Pacific.⁷ As described by Le Manach et al. (2013), the EU has had non-reciprocal agreements with 20 countries in Africa and Oceania since the first agreement with Guinea-Bissau and Senegal in 1980. Currently, the EU fleet is comprised of 700 fishing vessels, with more than half engaged in distant water fishing. The EU agreements target either tuna or coastal and demersal species such as crustaceans, cephalopods, and small pelagic fish. Most of the EU agreements with non-EU countries were not reciprocal and included financial compensation to the source country, where the payment is based on the number and type of vessels for a specified period of time. Le Manach et al. (2013) estimate that the payments to the source countries represent 2–3.2% of the value of the catch. In 2016, the total EU payments were approximately €130 million (European Commission 2016). The EU member countries also have a history of reciprocal agreements with Norway, Iceland and the Faeroe Islands, as well as with each other, even prior to the Common Fisheries Policy.⁸

The US has had a major multilateral agreement since 1988 with Pacific Island states, negotiated through the Forum Fisheries Agency (FFA). This agreement targets only tuna and includes a fixed amount of financial compensation. The first agreement was negotiated for an initial period of five years and was extended twice with ongoing negotiations to extend until a new agreement was signed to cover the period 2017–2022. In 2017, the US flagged purse seine vessels were offered the right to fish up to 4150 days in the region in return for a payment worth up to US\$70 million made up jointly of industry fees and US government contributions (Forum Fisheries Agency 2016; United States of America 2016). The US has also a history of bilateral, and some reciprocal, fisheries agreements with Canada, including the 1985 Pacific Salmon Treaty and its antecedent, the International Pacific Salmon Fisheries Commission established in 1937 (Pacific Salmon Commission 2016). US vessels also fish via private arrangement in Caribbean waters, for instance the sea bob fishery in Guyana (Mbithi Mwikya 2006).

Japan has operated an extensive fleet of distant water vessels for many decades, including the so-called floating factories that conduct significant on-board processing. Currently, Japan has access agreements in the Atlantic, Indian and Pacific Oceans that target mostly tuna and tuna-like species and are not reciprocal. In 2005, thirty five Japanese purse seines and 103 long liners were registered to fish in FFA waters in the Pacific, paying

⁶ See Mbithi Mwikya (2006). Though these sums are small, they make a significant contributions to some of the source economies. For instance, Havice (2010) documents that fisheries access fees contribute 30 to 50% of GDP in Kiribati and Tuvalu.

⁷ We use the name European Union for consistency throughout but acknowledge that the name and membership altered across the time period covered in this paper.

⁸ For instance, France had reciprocal agreements with both Spain and the United Kingdom whereby vessels from Spain or the United Kingdom were permitted to fish in French waters and vice versa.

approximately 5% of the value of their catch (Havice 2010). Unlike the EU and US agreements, many of Japan's fisheries agreements are not directly negotiated by the Japanese government. In these cases, the Japanese vessels operate under private access agreements negotiated between the private sector associations and the governments of the source countries. The financial compensation agreed is then considered a private agreement between both parties and the agreements are referred to as closed agreements as they are not published (Mbithi Mwikya 2006).⁹ Our dataset also includes years where Japan had reciprocal agreements with China, Korea and the USSR.

China, the world's largest producer of fish products, started to engage in distant water fishing in the 1980s to relieve unemployment in the fishing industry. In 1985, the China National Corporation had 13 boats fishing in West Africa. Today China has the largest distant water fleet in the world with 1,989 boats operating in 35 countries (Mallory 2013).¹⁰ In terms of targeted species, Chinese vessels catch squid (32.9% of total catch) and tuna (14.6%) and China exports approximately half of its catch to high-income countries.

3 Conceptual Environment

In this section we outline a simple conceptual environment to derive testable predictions on the determinants of international access agreements and international trade in fish products for our empirical analysis. It is important to note here that our empirical analysis is constrained by the available data on access agreements, which allows us to observe only the incidence of agreements but not the value of catch. Therefore, in our environment we focus on the determinants of incidence of access agreements and fish exports.

Our empirical analysis has a relatively stronger focus on access agreements. This stems from the fact that international trade in fish products has been considered empirically to some degree, but there is no comprehensive empirical analysis of access agreements. Our conceptual environment, however, incorporates both access agreements and exports of fish products for completeness.

We start with the idea that access agreements and exports of fish products are essentially two dual pathways to provide consumers in one country, which we call a *destination country* d , with fish products sourced from the waters of another country, which we call a *source country* s . For simplicity we assume that the benchmark case is autarkic, that is, there is no international relationship between countries d and s , and hence the domestic market in the destination country is served by its local fishery.

Next, we note that there are two key motives for countries signing a fishery access agreement or entering a trade relationship. The first motive is driven by a pattern of comparative advantage in fishing while the second motive is related to gravity factors of size and distance between the countries, commonly used in the empirical trade literature.

The pattern of comparative advantage in fishing depends on the interplay of two different factors. The first factor is positively related to fish abundance in a country's waters. We

⁹ Some recent access agreements involve the Japanese government more directly. For example, an agreement with Morocco that establishes Japan's access for 15 tuna longline vessels in the Moroccan EEZ for an access fee of 49,500 MAD in 2017. We are grateful to an anonymous reviewer for providing us with this recent example.

¹⁰ The Chinese distant water fleet is the largest in terms of the number of fishing vessels but the production capacity is smaller than the capacity of other fishing countries.

assume that each country has an exogenously given fish stock, $Stock_i$ with $i \in \{d, s\}$.¹¹ The assumption that a better fish stock status makes fishing easier and decreases the per unit cost of fish production can be derived from a standard bioeconomic model of fishing. For instance, the Gordon–Schaefer model (Gordon 1954; Schaefer 1957) has harvest depending on effort and stock in a complementary fashion that, along with non-decreasing marginal cost of effort, gives the result that marginal cost of harvest is decreasing in fish stock. Hence, a larger fish stock creates an advantage in fishing, no matter which country the fishermen are from.

The second factor that affects the direction of fishing advantage is the capacity of the country's fishing industry, $Capacity_i$ with $i \in \{d, s\}$, which we assume is also exogenously given. A higher capacity can be thought to influence advantage in fishing via at least two processes. First, if there are scale economies in the fishing industry then a larger industry can increase catch per unit of variable effort in a bioeconomic model like the Gordon–Schaefer model (Gordon 1954; Schaefer 1957). Alternatively, in a model of excess capacity, such as Clark and Munro (2003), the fishing industry will grow until rents are dissipated. Thus if there is existing capacity in one country that can move to another fishery elsewhere, it will be cheaper for this existing capacity to harvest than for a new industry to cover the fixed costs of operation to enter. Hence, via either process, existing fishing capacity will lead to advantage in fishing, independent of where the fish stock is harvested from.

Now consider the factors from a standard gravity model which explain bilateral international trade. It is more likely that fish products will flow from the source country to consumers in the destination country if demand in the destination market is sufficiently large, which is positively related to income and population size. In addition, a larger source country economy is more likely to engage in international relations. Finally, fish products will be more likely to flow from source to destination if the countries are closer to each other, geographically and culturally. Clearly, the impact of closeness on access agreements or exports may depend upon how closeness is measured as the supply chain functionality will be different for each pathway.

Next, we discuss how the two motives of comparative advantage in fishing and gravity operate for international access agreements and international trade.

3.1 International Fishery Access Agreements

First, let us consider the probability of a fishery access agreement for a pair of countries that currently have no economic international relationships in fish products. Such an agreement allows fishermen from the destination country to catch fish in the source country's waters.

The pattern of comparative advantage that makes such an agreement more likely is realized if the source country waters are more abundant in fish than the waters of the destination country, and if the destination country has a higher fishing capacity than the source country. Hence, we expect the fishery access agreement to take place if $Stock_s$ and $Capacity_d$ are sufficiently high while $Stock_d$ and $Capacity_s$ are low.

¹¹ Note that our environment is a simple static set-up where the fish stock status does not depend on the catch. Clearly, fish stock status is endogenous in a richer dynamic model of trade in renewable resources.

With respect to the gravity factors, a larger economic size of the destination country means that its domestic fishery earns a higher profit and hence will make an agreement more attractive to the destination country. The degree of closeness between the source country and the destination country will depend upon the distance the destination country's fishermen have to travel and the costs of reaching an agreement, which we collectively call the distance costs of foreign fishing. Clearly an agreement is more likely if these foreign fishing costs are sufficiently low.

Empirical Prediction 1 The probability that an international fishery access agreement exists between a source country and a destination country:

- (a) increases (decreases) with the fish stock status of the source (destination) country and decreases (increases) with the fishing capacity of the source (destination) country;
- (b) increases with the economic size of the destination country and decreases with the distance costs of foreign fishing.

3.2 International Trade of Fish Products

Next, consider the probability that two countries use the counterpart pathway of trade to provide fish from the source country to consumers in the destination country, that is exports of fish products from country s to country d .

In this case, the source country needs to have a sufficiently strong comparative advantage in fish products to be an exporter of fish. As in the case of access agreements, the higher is the fish stock status in the source country, the more efficient is fishing in the source country waters and, hence, exports from source to destination are more likely. In contrast, however, the higher is the fishing capacity of the source country's industry and the lower is the fishing capacity of the destination country, the more efficient is the source country fishing industry relative to the fishing industry in the destination country. Hence, we expect exports from the source country to the destination country to take place if $Stock_s$ and $Capacity_s$ are sufficiently high while $Stock_d$ and $Capacity_d$ are low.

Turning to the gravity factors, as with agreements, a higher economic size of the destination country leads to a higher demand for fish products and hence makes a trade relationship more likely. A higher economic size of the source country means that the total fishery output in the source country is large, which also makes exporting more likely. In the case of trade, it is the source country which must now incur the distance costs of exporting the fish products to consumers in the destination country. Clearly lower distance costs of trade will make trade relationship between two countries more likely.

Empirical Prediction 2 The probability that a source country exports fish products to a destination country:

- (a) increases (decreases) with the fish stock status of the source (destination) country and increases (decreases) with the fishing capacity of the source (destination) country;
- (b) increases with the economic sizes of the source country and the destination country and decreases with the distance costs of trade.

Our empirical predictions are essentially a variation of a gravity equation, that is a model of bilateral interactions in which economic size and distance effects enter multiplicatively, augmented with determinants of comparative advantage in fishing. Gravity equations have been used as a workhorse for analyzing the determinants of bilateral trade flows, as well as other types of flows and interactions between countries, for 50 years since being introduced by Tinbergen (1962).¹² Most of the gravity literature explores the determinants of the volume of bilateral flows between countries. However, the fact about half of the country pairs do not trade with one another, led to an emerging trade literature which emphasizes the importance of studying the incidence of zero trade flows. Helpman et al. (2008) utilize a Heckman-based approach to zero trade flows which involves a first stage probit estimation of the probability of positive trade incidence between a pair of countries. Their results show that the very same variables that impact export volumes also impact the probability of exports, that is, zero trade flows are more likely between distant and/or small countries.¹³

There are two distinctive important points to make for our analysis.

First, in our conceptual environment, we note a crucial point that comparative advantage is not uniquely defined when there is more than one input and inputs are potentially mobile. In the case of fishing, comparative advantage is related to both the natural resource and its extractive industry. The ability to separate the contribution of two key components of production, fish stock and fishing capacity, is important in international fisheries but it also has implications for other industries where production can be separated into components.

Second, it is also important to highlight that there are likely to be some common factors in determining both the distance costs of foreign fishing and the distance costs of trade. For example, a larger physical distance between two countries reduces the probability of both access agreements and trade. However, there are also likely to be some factors that influence distance costs of a particular type of international transactions in fish products but have very limited influence on the distance costs for the other type. For example, if two countries share a maritime border, then fishermen can move directly from one fishing ground to another, so, holding distance equal, this is likely to reduce distance costs associated with the foreign fishing more than reducing distance trade costs. Hence, the dual pathways do have some similar drivers but might also have important differences depending upon where and how often international transactions occur. In our empirical analysis we use various variables to measure geographical and cultural distance between countries to understand how these varying characteristics of closeness may impact upon different types of international product flow relationships in different ways.

4 Data and Key Variables

Our empirical analysis requires data on a variety of components. As such, we combine data from multiple sources: data on international fisheries access agreements, fish stock status and fish catch from the Sea Around Us project (Pauly and Zeller 2015; Zeller et al. 2016); data on fish trade from the NBER-United Nations Trade Data (Feenstra et al. 2004); and data on gravity country-pair characteristics from the CEPII Gravity Data (Head et al. 2010). Each of these components and the key variables are described below.

¹² See Head and Mayer (2014) for an extensive discussion of the gravity literature.

¹³ Baldwin and Harrigan (2011) find a similar pattern of zeroes using the US product-level trade data.

4.1 Fisheries Access Agreements

The dataset on agreements from the Sea Around Us project (Pauly and Zeller 2015; Zeller et al. 2016) includes countries in the agreement, agreement type (non-reciprocal, reciprocal, multilateral or unknown) and years in force from 1950–2007.¹⁴

Details regarding the exact degree of access, species covered and compensation are not consistently available. Therefore in our empirical analysis the dependent variable is a binary measure of whether there exists a fisheries access agreement between a source country s and a destination country d in a given year t :

$$A_{sdt} = \begin{cases} 1, & \text{if there is an agreement between countries } s \text{ and } d \text{ in year } t \\ 0, & \text{otherwise} \end{cases}$$

Figure 1a depicts the number of access agreements over time globally. The number of agreements increase across the 1970s and the 1980s, with the peak in early 1990s when more than 500 access agreements took place globally. Figure 1b depicts the number of destination and source countries over time which represents the extensive margin of the change in the global number of agreements. From the late 1970s until early 1990s there is a pronounced increase in the number of participating countries. The likely reason for the increase in agreements is an anticipation of the United Nations Convention on the Law of the Sea (1982), which extended national property rights out to 200 nautical miles from shore. Likely causes of the decrease in agreements since the mid-1990s are the rising concerns about fish stock decline and an increase in domestic fishing capacity in some countries.

4.2 Incidence of Fish Trade

To construct our second dependent variable, fish trade incidence, we use data on trade flows in fish products from the NBER-United Nations Trade Dataset (Feenstra et al. 2004).

This dataset contains bilateral trade data by commodity for the period 1962–2000. The data are organized by the 4-digit Standard International Trade Classification. First, we aggregate the data on value of exports of all fish-related products (with 4-digit SITC=03**) from the source country s to the destination country d in year t . Then, we create a binary variable which indicates whether there are exports of fish-related products from country s to country d in a given year t :¹⁵

$$T_{sdt} = \begin{cases} 1, & \text{if there are exports from country } s \text{ to country } d \text{ in year } t \\ 0, & \text{otherwise} \end{cases}$$

Analogously to Fig. 1a, b for the incidence of fisheries access agreements, Fig. 2a, b depict the incidence of fish exports globally and the number of exporting and importing countries

¹⁴ If listed as unknown we conservatively code it as non-reciprocal. For multilateral agreements, we take the following approach. The database codes each country within the EU having an agreement with outside parties if the agreement is negotiated under the common fisheries policy. Similarly, each country in the FFA is coded as having an agreement with the USA. We examine this further in the empirical section.

¹⁵ To account for changes in product definitions or mismeasurement, we also considered a specification with trade incidence equal to one if the value of exports was larger than \$5000, which did not affect the results. The estimation results are not reported but are available upon request.

over time. Of interest is the sharp drop in the number of trade pairs in 1984. Upon examination, the data indicates that the drop in pairs is due to member countries of the European Union reducing the number of trade partnerships outside of the EU. This is likely to be explained by the 1983 agreement establishing the new generation Common Fisheries Policy (European Communities 1983) in combination with the common organization of the market in fishery products, effective from 1982 (European Communities 1981). Given the limited impact on the number of countries importing and exporting fish products globally seen in Fig. 2b, a fairly constant total value of EU trade, and a low value of the partnerships dropped, it seems that the EU countries responded to the more coordinated fisheries policy by dropping smaller trade partners, at least in the short term.¹⁶ In our empirical analysis, we control for any Common Fisheries Policy effects by considering a corresponding indicator variable, as our sample does include the EU countries and the discussed time period.

Finally, we note that fish production from aquaculture is increasing and hence is relevant for how we measure fish exports. The trade statistics are reported using consumption definitions (for example, frozen or fresh, whole fish or fillets) so we are unable to distinguish between trade in capture or aquaculture production, nor can we identify species traded from this country-pair data. To get a sense of whether countries produce both capture and aquaculture fish products, we used the production statistics from FishStatJ (FAO 2016) and identified that only Lesotho produced aquaculture without capture. As Lesotho is a landlocked country, this is unsurprising and means it is already excluded from our dataset. As our measure of trade is an indicator for the incidence of trade, rather than the value or volume, as long as at least some of the trade is from capture fisheries, we will be using the appropriate variation.

4.3 Comparative Advantage in Fishing

Our empirical predictions state that two components measuring the extent of fishing advantage, fish stock status and fishing capacity, are key factors in explaining the likelihood of countries signing a fishery access agreement or trading in fish products. We use the marine trophic index as a measure of fish stock status and the past total catch by a fishing country as a proxy for fishing capacity, both from the Sea Around Us project (Pauly and Zeller 2015).

First, we describe how we construct a variable to measure the fish stock status using the marine trophic index. The marine trophic index was originally developed by Pauly et al. (1998) and is one of eight measures chosen by the Conference of the Parties to the Convention on Biological Diversity (2004) as an indicator of biodiversity loss. The index is constructed back to 1950 as the following:

$$MTL_{it} = \frac{\sum_z TL_z Y_{zit}}{\sum_z Y_{zit}},$$

where TL_z is the trophic level of species (or species group) z and Y_{zit} is the landings of species z in country i in time t . The trophic level of species z indicates where this species is in the food chain. A value of one is given to plants and detritus, a value of two to herbivorous

¹⁶ The value of the EU partnerships that were dropped in 1984 made up 0.2% of all 1983 trade. While the total value of the EU trade fell by 3.3% from 1983 to 1984, it rose by 13.8% in 1985.

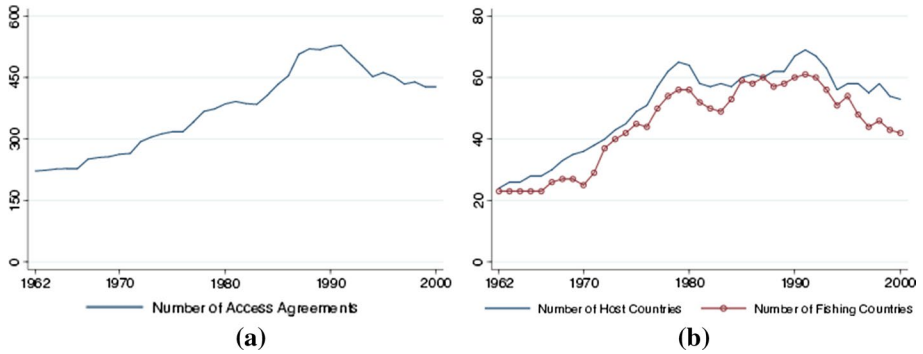


Fig. 1 Access agreements 1962–2000

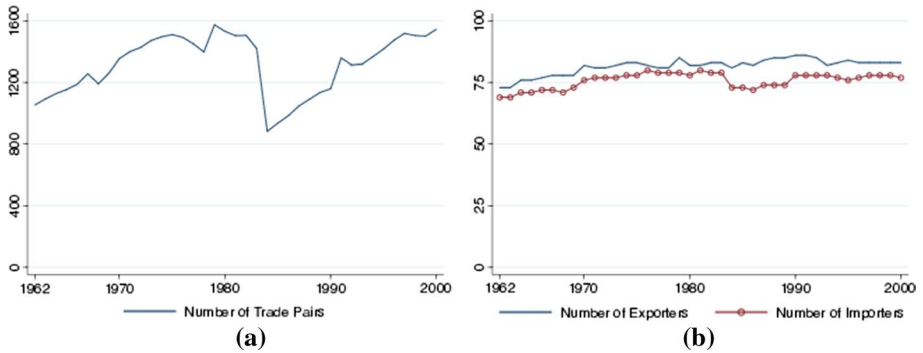


Fig. 2 Fish trade incidence 1962–2000

fish who consume value one species, a value of three to fish that eat herbivorous fish, and so on. Fish typically have a trophic level between two and four.

Pauly et al. (1998) showed a smoothly declining trend for *MTL* in most areas. Based on the assumption that the relative abundance of species in the landing data is correlated with the relative abundance of the same species in the ecosystem, these findings are interpreted as representing a decline in the abundance of high-trophic-level fishes relative to low-trophic-level fishes. This implies that there is ‘fishing down the marine food web’ and reduction in biodiversity. Hence, the marine trophic index can be used as a proxy of the measure of ocean area health. From an economic perspective, the *MTL* may be thought of as representing the status of the economically exploitable stock.

Given its ecological focus, the Sea Around Us stock status measures are reported by ocean area, rather than simply by country. For instance, the east, west and arctic regions of Canada and the Pacific and Caribbean regions of Central American countries like Costa

Rica and Nicaragua are reported separately. To match with the economic variables that are based on terrestrially-defined countries, we aggregate the *MTL* of each sub-national region using the proportions of catch as weights.¹⁷ In our analysis, we use the marine trophic index calculated at the country level as our measure of country *i*'s aggregate fish stock status in time *t*:

$$Stock_{it} = MTL_{it}.$$

The *MTL* serves as an indicator of overall stock status that is available for exploitation. As some distant water countries are likely to be focused on a subset of the targeted species, an alternative approach would be to estimate our empirical model at the species-specific level. There are several important reasons why we choose a general measure of stock status such as the *MTL* as a proxy for the underlying advantage in fishing.

Firstly, our measure of overall stock status matches the degree of aggregation of our dependent variables, that is, indicators for the existence or not of an agreement or trade, not quantity or value or targeted species.¹⁸ While there are notable agreements that target tuna and tuna-like species (for example, the US and Japanese agreements), there are many mixed-species agreements (for example, the EU agreements) and our analysis requires a consistent measure for all.¹⁹ In addition, there is a problem of by-catch of species not directly listed in agreements that nonetheless contributes value to those agreements.²⁰

Secondly, even if we were able to identify species covered by agreements or trade transactions, this would only apply to observations that do have agreements or trade, that is, the observations with A_{sdt} or T_{sdt} equal to one on the left-hand side of our regressions. This would leave the conundrum of determining the relevant species that would hypothetically be covered by an agreement or traded between two countries that do not currently have an agreement or trade, that is, the observations with A_{sdt} or T_{sdt} equal to zero. As we do not know which species would be covered when there is no agreement or no trade, an aggregate measure of stock status is most appropriate for these country-pairs.

Finally, there is no available measure of stock status at the species level that is consistent and available for all countries. Erhardt (2018) uses an alternative measure of stock status derived from the stock status plots of the Sea Around Us project (Pauly and Zeller 2015). This measure uses historical catch to determine the stock status categories, which is potentially endogenous in our analysis and may not be robust at the stock level. As such, similarly to our use of the *MTL*, the measure Erhardt (2018) uses is also calculated at an aggregate level, not at the species level and is available for only a subset of countries that have a large number of reported stocks.

We also note, that our empirical model includes fixed effects for source and destination countries, which, to some degree, takes into account unobservable species-specific

¹⁷ We also generated *MTL* for the USSR and Yugoslavia by aggregating over the relevant countries prior to 1991 or 1992 as relevant.

¹⁸ The agreements data does not provide details on the targeted species or groups. To categorize even to broad species groups we would need to examine the legal text of each agreement. Unfortunately, not all agreements list the species covered and, moreover, not all agreements are publicly available. The bilateral fish trade data is also not reported at the species-level as it is reported by consumption categories (for example, fresh or frozen). Thus, we are unable to assign targeted or traded species to observations with agreements or trade.

¹⁹ The mixed agreements include various targeted species such as mackerels, cod, pollock, sardines, octopi, pilchards, flatfishes, grenadiers, billfishes, and crabs.

²⁰ Some reports indicate that in Mauritania and Senegal by-catch in squid and shrimp fisheries can be five times larger than the catch of the targeted species (Bonfil et al. 1998).

characteristics of the targeted stock such as abundance which are relevant to access agreements and bilateral fish exports.

Next, we use data on the past total catch by a fishing country as a measure of fishing capacity. The Sea Around Us project (Pauly and Zeller 2015) reports catch from 1950 both by the source area where fish is caught and by the country of the fishermen performing the fishing. We calculate the total tonnes caught by fishermen from each country. Then, we use 10-year lags of total tonnes caught as a measure of the harvesting capacity of each country i :

$$Capacity_{it} = Total\ Tonnes\ Caught_{it-10}.$$

Contemporaneous catch could be jointly determined by fishing capacity and by existence of access agreements, however, fishing industry capital is of highly durable nature. Therefore, we use 10-year lags as a globally consistent and comparable measure of the current fishing potential.

We also considered an alternative specification to measure the *excess* fishing capacity available for distant water fishing. We calculated excess fishing capacity as the difference between catch in time t and the maximum catch in any year prior to t . As this measure of excess capacity is less appropriate for understanding the motives for trade, we use catch capacity as the measure to retain consistency across specifications.²¹

4.4 Gravity Variables

To account for the standard gravity variables used in the trade literature, we use data on country-pair characteristics from the 2017 version of the CEPII Gravity Data (Head et al. 2010). The dataset covers pairs of countries globally, for the period 1948–2015.

Our conceptual environment predicts that the economic size of each country and the distance between two countries are important determinants of both access agreements and trade. We use data on GDP per capita and population to account for the economic size of the countries. To control for distance, we include several standard variables, augmented to account for maritime closeness. Our measures of geographic closeness include: population weighted bilateral distance between countries s and d ; an indicator variable for countries sharing a land border; and an indicator variable for the pair of countries sharing a maritime border.²² Our measures of cultural closeness between the pair of countries include indicator variables for being members of the same free trade area, having the same currency, ever being colonized by the other or by the same third country, having a common legal origin, having the same official language, and sharing a major religion.²³

²¹ The sign and statistical significance of the coefficients of excess capacity for both source and destination countries with an agreement are the same as for the measure of capacity, and other coefficients are very similar as well. Results are available upon request.

²² The indicator variable for countries sharing a maritime border is constructed by authors. We thank Kofi Otumawu-Apreku for providing valuable research assistance on this point using information from the Sea Around Us Project (2015) and the Flanders Marine Institute (2014).

²³ We drop all “countries” that are still colonies as they typically do not have consistently reported measures of access agreements. This means that we are likely to be underestimating the number of access agreements. For some colony–colonist relationships this will be unfair as the colony may be extremely autonomous with respect to fisheries management and should therefore be considered as separate. However, we had to draw the line somewhere as some states or islands that are part of the same country are also quite autonomous with respect to fisheries management.

Table 1 List of variables

| | |
|---|--|
| Dependent variables | |
| A_{sdt} | =1 if there is an agreement between s and d in year t |
| T_{sdt} | =1 if there are positive exports of fish products from s to d in year t |
| Explanatory variables: advantage in fishing | |
| $Stock_{it}$ | The mean trophic level of country i in year $t - 1$ |
| $Capacity_{it}$ | Total tonnes caught by country i in year $t - 10$ |
| Explanatory variables: gravity | |
| $GDP/capita_{it}$ | GDP per capita of country i in year $t - 1$, in current US\$ |
| $Population_{it}$ | Population of country i in year $t - 1$, in millions |
| $Maritime\ Border_{sdt}$ | =1 if s and d share a maritime border |
| $Land\ Border_{dst}$ | =1 if s and d share a land border |
| $Distance_{sd}$ | Population weighted bilateral distance between s and d , in km |
| $Legal_{sd}$ | =1 if s and d have common legal origins |
| $Religion_{sd}$ | Sum of the products of the shares of Catholics, Protestants and Muslims in s and d ; between 0 and 1 |
| $Common\ Colonist_{sd}$ | =1 if s and d had a common colonizer post 1945 |
| $Colony_{sd}$ | =1 if s and d ever in colonial relationship |
| FTA_{sdt} | =1 if s and d are in the same free trade area (using <i>fta_wto</i> measure) |
| $Currency\ Union_{sdt}$ | =1 if s and d have a common currency |
| $Language_{sd}$ | =1 if s and d have a common official or primary language |

4.5 Summary Statistics

Our baseline sample includes all source and destination countries that ever had at least one international access agreement with any other country and ever had trade in fish products with any other country in the time period 1962–2000.²⁴ We use this as our universe throughout to have a consistent set of country-pairs to estimate both the determinants of access agreements and the determinants of fish exports.²⁵

Combining data from such a variety of sources has left us with 256,163 country-pair-year observations in our baseline sample. There are 14,571 country-pair-year observations that have an access agreement, $A_{sdt} = 1$, which is 5.7% of all observations. There are 51,437 observations with positive fish product trade, $T_{sdt} = 1$, which is 20.1% of observations.

Table 1 provides a list of the main variables used in this paper. Table 2 shows the summary statistics by whether or not a country-pair-year combination has an access agreement (the first and the second columns), by whether or not a country-pair-year combination has positive fish trade (the third and the fourth columns), and for the full baseline sample (the last column).

²⁴ The full universe of possible pair-year combinations is greater than our baseline sample as we exclude countries that never had agreements with anyone. This is because landlocked Lesotho not having a fisheries access agreement with landlocked Austria is different than New Zealand not being a source country to Costa Rica. This universe definition issue also arises in the trade literature where Australia not importing apples from Iceland stems from different reasons than Australia not importing apples from New Zealand.

²⁵ In our empirical analysis, we address a potential concern of sample selection issue by reestimating our empirical model for alternative samples.

Table 2 Summary statistics: means and standard deviations

| | Agreement | No agreement | Trade | No trade | Total |
|---------------------------------------|---------------------|--------------------|--------------------|--------------------|--------------------|
| Agreement incidence | 1 (0) | 0 (0) | 0.192 (0.394) | 0.023 (0.149) | 0.057 (0.232) |
| Trade incidence | 0.679 (0.467) | 0.172 (0.377) | 1 (0) | 0 (0) | 0.201 (0.401) |
| Stock source | 3.528 (0.199) | 3.501 (0.266) | 3.493 (0.240) | 3.505 (0.268) | 3.503 (0.263) |
| Stock destination | 3.506 (0.192) | 3.501 (0.296) | 3.490 (0.233) | 3.504 (0.304) | 3.501 (0.291) |
| Capacity source (thou tonnes) | 1277.6 (1900.7) | 1055.4 (2166.9) | 2052.0 (2846.2) | 820.8 (1860.6) | 1068.0 (2153.3) |
| Capacity destination (thou tonnes) | 1906.4 (2824.3) | 998.0 (2123.4) | 1751.4 (2750.9) | 873.4 (1971.8) | 1049.7 (2179.5) |
| GDP/capita Source | 9393.2 (9377.6) | 3448.6 (6190.6) | 6193.5 (8290.8) | 3182.0 (5896.2) | 3786.7 (6560.6) |
| GDP/capita Destination | 10025.7 (9507.6) | 3486.1 (6284.6) | 7762.9 (9193.7) | 2877.1 (5466.4) | 3858.1 (6684.7) |
| Population source (millions) | 38.89 (94.91) | 46.58 (139.7) | 67.59 (163.2) | 40.76 (129.7) | 46.15 (137.5) |
| Population destination (millions) | 58.30 (143.7) | 46.79 (142.1) | 54.55 (128.8) | 45.66 (145.3) | 47.45 (142.2) |
| Distance (popn weighted km) | 3294.1 (2980.4) | 8178.3 (4298.2) | 6718.5 (4239.9) | 8197.4 (4368.0) | 7900.5 (4382.8) |
| Maritime border | 0.217 (0.412) | 0.024 (0.154) | 0.082 (0.274) | 0.023 (0.151) | 0.035 (0.184) |
| Land border | 0.116 (0.320) | 0.017 (0.129) | 0.041 (0.198) | 0.018 (0.132) | 0.023 (0.148) |
| Legal | 0.377 (0.485) | 0.397 (0.489) | 0.383 (0.486) | 0.399 (0.490) | 0.396 (0.489) |
| Religion | 0.269 (0.291) | 0.160 (0.230) | 0.192 (0.264) | 0.160 (0.227) | 0.166 (0.235) |
| Colony | 0.089 (0.284) | 0.018 (0.132) | 0.082 (0.274) | 0.007 (0.082) | 0.022 (0.146) |
| Common colonist | 0.019 (0.137) | 0.065 (0.246) | 0.022 (0.147) | 0.072 (0.259) | 0.062 (0.242) |
| FTA | 0.358 (0.479) | 0.014 (0.118) | 0.098 (0.297) | 0.018 (0.132) | 0.034 (0.180) |
| Currency union | 0.017 (0.129) | 0.012 (0.107) | 0.014 (0.115) | 0.011 (0.106) | 0.012 (0.108) |
| Language | 0.110 (0.313) | 0.167 (0.373) | 0.173 (0.378) | 0.162 (0.368) | 0.164 (0.370) |
| Observations | 14571 | 241592 | 51437 | 204726 | 256163 |

Casual observation shows that capacity is higher for countries with access agreements and for countries that trade in fish products, particularly for destination countries in the country pairs with access agreements and for countries that are exporters of fish products. The gravity variables indicate that, on average, countries that have access agreements or trade in fish have higher GDP per capita and are more likely to have a shorter distance between them, share a maritime border or a land border, be a part of the same regional trade agreement, have been in a colonial relationship in the past, and share a religion or currency.

5 Empirical Analysis

Our goal in this section is to test the Empirical Predictions from Sect. 3 by estimating the importance of the comparative advantage in fishing motive, that is, the interplay of the stock abundance and the fishing industry capacity, and the importance of the gravity motive, that is, the economic size and distance effects.

5.1 Estimating Equation

Our main estimating equation relates the existence of an access agreement (A_{sdt}) or a trade relationship (T_{sdt}) between the source country s and the destination country d in time period t to fish stock status, fishing industry capacity, and to gravity variables:

$$\Pr(X_{sdt} = 1) = \alpha_0 + \beta'F_{sdt} + \gamma'G_{sdt} + \alpha_S I_s + \alpha_D I_d + \alpha_T I_t + \varepsilon_{sdt}, \quad (1)$$

where X_{sdt} is a generic representation of the dependent binary variable, which is either A_{sdt} or T_{sdt} . As our dependent variables are binary and equal to either zero or one, we estimate a probit model.

Equation 1 includes a vector of explanatory variables related to the pattern of fishing comparative advantage, denoted by F_{sdt} , which consists of variables *log Stock* and *log Capacity* for the source country and for the destination country. Equation 1 also includes a vector of explanatory gravity variables, denoted by G_{sdt} , which consists of variables *log GDP / capita*, *log Population*, *log Distance*, *Maritime Border*, *Land Border*, *Legal*, *Religion*, *Colony*, *Common Colonist*, *FTA*, *Currency Union* and *Language*, as described in Table 1.²⁶

In estimating a gravity equation, it is essential to control not just for bilateral resistance, that is the distance barrier between a pair of countries, but also to control for multilateral resistance, that is the distance barriers that each country faces with *all* its trading partners.²⁷ Following the modern approach used in the trade literature, we include a full set of fixed effects for source and destination countries, denoted by I_s and I_d . This approach does not involve strong structural assumptions on the underlying model as fixed effects will account for any unobservables that shape each country's position as either a source or a destination country. Using fixed effects also yields consistent estimates. In addition, we

²⁶ Note that we use a 1-year lagged values of Stock, GDP/Capita and Population variables in our estimations, as defined in Table 1.

²⁷ See Anderson and van Wincoop (2003) for more on the importance of controlling for multilateral trade resistance.

include year fixed effects, denoted by I_t , and cluster the error term ε_{sdt} at the country-pair level.²⁸

5.2 Results: International Fisheries Access Agreements

We begin by estimating Equation 1 with access agreement incidence, A_{sdt} , as the dependent variable.

5.2.1 Agreements: Baseline Specification

The estimation results of our baseline specification are reported in Table 3 where the estimated coefficients are in the first column and the marginal effects are shown in the second column. For indicator variables, (d) indicates that the marginal effect is a change from 0 to 1.

First, let us consider the estimated coefficients of the fishing comparative advantage variables. The coefficient on the stock status of the source country is positive and statistically significant. As the overall probability of an agreement existing in the data is 5.7%, the 0.0036 marginal effect of the mean tropic level of the source country rising by one increases the probability of an agreement by 6.1%. Our results show that a higher stock status in the destination country is also positively and significantly associated with having an agreement, but the coefficient is only two-fifths as large in magnitude. The coefficient on fishing capacity of the destination country is positive and significant, as predicted by our conceptual environment. That is, a larger industry capacity of the source country increases the likelihood of being in an agreement. Capacity of the source country has no statistically significant impact. These results support our Empirical Prediction 1(a) that the resource abundance in the source country and fishing capacity of the destination country are important drivers of access agreements.

Next, we consider the estimated effects of the gravity variables. The estimated coefficients on the economic size characteristics of the destination country are positive and statistically significant, that is, countries that have higher GDP per capita and that are more populous are more likely to enter access agreements as destination countries. We also find that economically larger source countries, both in terms of GDP per capita and population, exhibit a positive relationship with having an agreement, but the magnitude of the estimated coefficients for the destination country dominates. The coefficients on the measures of costs of foreign fishing typically enter as expected. That is, being less geographically distant, sharing a maritime border, having a common legal origin or common religion, being a past colony and being part of the same trade agreement are positively related to having an access agreement. Hence, these empirical results support our Empirical Prediction 1(b) that the gravity factors are important determinants of fishery access agreements.

Interestingly, we find that sharing a language is negatively associated with having an access agreement while having a land border or a common currency has no statistically significant impact. These findings could be explained in the following way. Under the access

²⁸ As our data set spans many years, it would be preferable to include time-varying fixed effects for source and destination countries. However, in this case it would be impossible to estimate the effects of all time-varying country-specific variables of our interest such as fish stock status, fishing capacity or GDP per capita.

Table 3 Fisheries access agreements I

| | Pr (agreement) | Marginal effects | EU CFP | Agt < 82 | Catch < 82 |
|-----------------------|----------------|------------------|-------------|-------------|-------------|
| Log stock | 1.9449*** | 0.0036*** | 2.0763*** | 2.2354*** | 1.9052*** |
| Source | (0.4082) | (0.0010) | (0.4077) | (0.4678) | (0.4077) |
| Log stock | 0.7822** | 0.0014** | 1.0410*** | 0.8075* | 0.7648** |
| Destination | (0.3699) | (0.0007) | (0.3699) | (0.4350) | (0.3700) |
| Log capacity | - 0.0569 | - 0.0001 | - 0.0562 | - 0.0865* | - 0.0602 |
| Source | (0.0410) | (0.0001) | (0.0422) | (0.0465) | (0.0406) |
| Log capacity | 0.0708** | 0.0001* | 0.0684* | 0.0805** | 0.0785** |
| Destination | (0.0360) | (0.0001) | (0.0369) | (0.0409) | (0.0359) |
| Log GDP/cap | 0.0973** | 0.0002** | 0.1058** | 0.0922* | 0.1010** |
| Source | (0.0442) | (0.0001) | (0.0437) | (0.0499) | (0.0442) |
| Log GDP/cap | 0.2121*** | 0.0004*** | 0.2031*** | 0.2129*** | 0.2105*** |
| Destination | (0.0420) | (0.0001) | (0.0417) | (0.0494) | (0.0419) |
| Log popn | 0.6173*** | 0.0011*** | 0.4401*** | 0.9127*** | 0.5672*** |
| Source | (0.1594) | (0.0003) | (0.1584) | (0.1795) | (0.1576) |
| Log popn | 1.4010*** | 0.0026*** | 1.2119*** | 1.9118*** | 1.4249*** |
| Destination | (0.1975) | (0.0005) | (0.1941) | (0.2400) | (0.1985) |
| Log distance | - 0.9381*** | - 0.0017*** | - 0.8088*** | - 0.8294*** | - 0.9103*** |
| | (0.0500) | (0.0003) | (0.0533) | (0.0450) | (0.0504) |
| Maritime | 0.5423*** | 0.0024** | 0.5897*** | 0.4137*** | 0.5347*** |
| Border (d) | (0.1195) | (0.0011) | (0.1252) | (0.1071) | (0.1185) |
| Land | - 0.2714 | - 0.0003** | - 0.1732 | - 0.1777 | - 0.2535 |
| Border (d) | (0.1680) | (0.0001) | (0.1680) | (0.1463) | (0.1672) |
| Legal (d) | 0.3113*** | 0.0007*** | 0.3765*** | 0.3086*** | 0.3084*** |
| | (0.0720) | (0.0002) | (0.0709) | (0.0654) | (0.0718) |
| Religion | 0.4239*** | 0.0008*** | 0.3569** | 0.4059*** | 0.4372*** |
| | (0.1493) | (0.0003) | (0.1488) | (0.1332) | (0.1481) |
| Colony (d) | 0.4930*** | 0.0021** | 0.6276*** | 0.4353*** | 0.4869*** |
| | (0.1204) | (0.0010) | (0.1205) | (0.1082) | (0.1210) |
| Common | - 0.0004 | - 0.0000 | 0.0308 | - 0.0480 | 0.0048 |
| Colonist (d) | (0.1890) | (0.0003) | (0.1775) | (0.1678) | (0.1882) |
| FTA (d) | 0.5872*** | 0.0029*** | 0.4270*** | 0.4069*** | 0.5900*** |
| | (0.0821) | (0.0010) | (0.0859) | (0.0820) | (0.0824) |
| Currency | - 0.0553 | - 0.0001 | - 0.0795 | - 0.1525 | - 0.0684 |
| Union (d) | (0.1977) | (0.0003) | (0.2069) | (0.2062) | (0.1974) |
| Language (d) | - 0.2513** | - 0.0004*** | - 0.3192*** | - 0.2421*** | - 0.2541** |
| | (0.1068) | (0.0001) | (0.1062) | (0.0929) | (0.1073) |
| EU CFP | | | 0.9984*** | | |
| | | | (0.1608) | | |
| Agt Prior | | | | 1.5316*** | |
| 1982 (d) | | | | (0.0809) | |
| Catch Prior | | | | | 0.2666*** |
| 1982 (d) | | | | | (0.0658) |
| Constant | - 11.882*** | | - 11.707*** | - 13.856*** | - 12.042*** |
| | (1.3896) | | (1.3644) | (1.5950) | (1.3947) |
| Observations | 256163 | 256163 | 256163 | 256163 | 256163 |
| Pseudo R ² | 0.644 | 0.644 | 0.650 | 0.676 | 0.645 |

Table 3 (continued)

Dependent variable: access agreement (1) or not (0)

Year, source and destination country controls are included but coefficients are not reported

Significance levels: *10% **5% ***1%. Standard errors are clustered at the country-pair level

agreement, the transportation of the product is all by sea, hence sharing a land border is not as important as sharing a maritime border. Also, apart from the agreement itself, all transactions along the journey from fish-in-the-ocean to filet-on-a-plate can be conducted in the currency and language of the destination country. This eliminates any currency and language barriers between harvesters or producers and consumers. Hence, these variables have less of an impact on the costs associated with foreign fishing. We contrast this with results for fish trade in the next subsection.

5.2.2 Major Access Agreements

As discussed in Sect. 4.1, the European Union is an important organization in the analysis of fishery access agreements as the member countries negotiate access agreements under the Common Fisheries Policy (CFP). To control for this, we create an indicator variable, *EU CFP*, that equals one if the country-pair-year had at least one agreement covered by the Common Fisheries Policy. The estimation results are reported in the third column of Table 3. The coefficient on the CFP variable is positive and statistically significant. All other variables retain the same sign and significance and have similar magnitudes as the benchmark specification.

Similarly to the EU, the South Pacific Forum Fisheries Agency (FFA) countries also negotiate access agreements multilaterally as a group. We reestimate our equation with an indicator variable that equals one if the source country is one of the FFA countries. This indicator variable does not have a statistically significant coefficient, however, while all other variables have the same sign and statistical significance levels as in the baseline estimation. In addition to the EU and the FFA countries, there are several major distant water fishing (DWF) nations—Japan, Russia, South Korea, Ukraine, USA and, previously, the USSR—who send significant fleets to access fishing grounds in the high seas and other countries waters. To control for any effects specific to those nations, we create an indicator variable that equals one if the destination country is one of the aforementioned major DWF nations. Again, inclusion of this control variable does not change the results in our baseline estimation and nor does this indicator variable have a statistically significant coefficient.²⁹ It is not surprising to have statistically insignificant coefficients on these indicator variables as our specification already includes source country and destination country fixed effects. These results indicate that our baseline results are not driven by only the EU, the FFA or major DWF countries.

5.2.3 Historical Fishing Relationships

An important policy change for international fisheries (and other marine resources) occurred in 1982 when the United Nations Convention on the Law of the Sea (UNCLOS 1982) extended jurisdiction from a usual three to a 200 nautical mile exclusive economic

²⁹ Estimation results with FFA Source and DWF nation indicators are not reported but are available upon request. We also estimate an alternative specification with all three indicator variables included, which has similar results.

zone around a nation. We would expect that the number of agreements would rise after 1982 as now an agreement is needed to legally harvest in another country's economic zone. Interestingly, we observe multiple access agreements prior to 1982. This could indicate that a historical relationship between the source and destination countries may be an important determinant of these countries having access agreements after 1982. We use this information to create an indicator variable, *Agt Prior 1982_{sdt}*, which is equal to one if there was an agreement between countries *s* and *d* prior to 1982 and if the observation year, *t*, is after 1982 and zero otherwise. The results of accounting for agreements prior to UNCLOS are reported in the fourth column of Table 3. The coefficient on *Agt Prior 1982_{sdt}* is positive and statistically significant, which suggests that having a historical fishing relationship is an important determinant of two countries signing an access agreements after the UNCLOS extended the jurisdiction of the exclusive economic zone. The coefficients on all other variables retain the same signs and statistical significance as in the baseline estimation, except that the negative coefficient on the fishing capacity of the source country becomes significant at 10% level, thus reinforcing our prediction regarding the importance of the pattern of fishing advantage.³⁰

To investigate further the importance of historical distant water fishing, we note that prior to UNCLOS foreign fishing legally occurred in what would later become exclusive waters. Using catch data from the Sea Around Us (2015) we create an indicator for historical catch analogous to the agreements one above. That is, the indicator *Catch Prior 1982_{sdt}* equals one if there was catch prior to 1982 by country *d* in what would become country *s*'s waters and if the observation year, *t*, is after 1982, and zero otherwise. These results are presented in the final column of Table 3. The coefficient on *Catch Prior 1982_{sdt}* is positive and statistically significant indicating that historical catch also matters for agreements.³¹

5.2.4 Reverse Causality and Sample Selection

Our empirical predictions are that a higher fish stock status in the source country will increase the likelihood of agreements or trade. Some causality could, however, operate in reverse: having an agreement could potentially affect the stock status in the source country. If this were true, having an agreement would mean that more fishing is done in the source country, which therefore could lead to a *lower* stock status in the source country. In this case we would observe a *negative* relationship between access agreement incidence and the source country's stock status. However, our empirical results above show that the observed relationship is in fact positive. This indicates that the potential issue of reverse causality is either not important or, at least, is not large enough to overturn our results.

We do explore the potential problem of reverse causality a bit further. Ideally, one would do a counterfactual analysis of what stocks would be like in the absence, or presence, of agreements or trade. As we clearly do not have such counterfactual observations, we address this by estimating an alternative specification using 10-year lag on stock status. The 10-year lag is chosen to match the 10-year lag measure of catch capacity and

³⁰ While UNCLOS officially came into force in 1982, a number of coastal countries unilaterally declared 200 nautical mile limits prior to this. An alternative measure using 1977 as the cut-off gives similar results, although sharing a land border becomes statistically significantly negative.

³¹ Alternative specifications using 1977 or 1962, the start of our sample, as the cut-off give similar results, available upon request.

because current agreements or trade should not have an impact on past stock status. The results are reported in the first column of Table 4. The magnitude of the coefficient on the 10-year-lagged stock status of the source country is now smaller but the coefficient is still positive and statistically significant. The coefficient on the stock status of the destination country is now statistically insignificant. All other coefficients are similar to the baseline specification.

Another potential estimation concern is a sample selection issue. Our baseline sample contains all source and destination countries that ever had an agreement with any other country *and* ever had trade in fish products with any other country in the period 1962–2000. We use this as our universe throughout to have a consistent set of country-pairs to estimate both the determinants of access agreements and the determinants of fish exports. It does, however, mean that some countries that had an agreement but did not have trade, or vice versa, were not included. In particular, the NBER-United Nations Trade Data (Feenstra et al. 2004) does not report some smaller island countries separately so they are excluded due to lack of trade data. To investigate whether the baseline results are driven by our sample selection, we reestimate Eq. 1 using a larger sample of agreements data, that is, a sample of 299,389 observations that includes all countries that ever had an agreement, irrespective of whether they ever had trade. The results are reported in the second column in Table 4. The magnitudes, signs and statistical significance of the estimated coefficients are the same as in our baseline estimation so we focus on estimations using our baseline sample.

5.2.5 Reciprocal Versus Non-reciprocal Agreements

Finally, our database of access agreements includes non-reciprocal and reciprocal agreements, which are potentially of a different nature. We now consider different measures of agreements by considering specifications with only non-reciprocal and with only reciprocal agreements to explore whether the motivation for reciprocal agreements is different than the motivation for non-reciprocal agreements. For instance, reciprocal agreements may be made not due to overall stock status differences but to allow for species-specific specialization or due to recognition that the stocks are intermingled across borders.

To explore these potential differences, we construct two different subsamples by utilizing information from the Sea Around Us dataset on whether the access agreement between countries s and d is reciprocal or not. Of the 14,571 country-pair-year observations with at least one kind of agreement, 11,745 observations had at least a non-reciprocal agreement and the remaining 2826 only have a reciprocal agreement. In the first subsample, we only include countries that ever had a non-reciprocal access agreement and ever had trade in fish products with any other country in period 1962–2000. This sample has 170,644 observations with 6.9% having a non-reciprocal agreement. Note that even though our sub-sample includes all countries that ever had a non-reciprocal fishery agreement, there are country-pair-year observations with a current reciprocal agreement as some countries do have both types of agreements. In this specification, the observations with a reciprocal agreement are coded as zeroes, thus, we compare observations with non-reciprocal agreements to

Table 4 Fisheries access agreements II

| | Lag stock | Full sample | Non-reciprocal | Reciprocal |
|-----------------------|-------------|-------------|----------------|-------------|
| Log stock | 1.0812*** | | | |
| Source t-10 | (0.3778) | | | |
| Log stock | - 0.1623 | | | |
| Destination t-10 | (0.4169) | | | |
| Log stock | | 2.0866*** | 1.1567** | 3.7871*** |
| Source | | (0.3914) | (0.4692) | (0.8761) |
| Log stock | | 1.0153*** | - 1.1119*** | 3.6270*** |
| Destination | | (0.3516) | (0.4060) | (0.8653) |
| Log capacity | - 0.0304 | - 0.0509 | - 0.0561 | - 0.1449 |
| Source | (0.0420) | (0.0391) | (0.0436) | (0.0927) |
| Log capacity | 0.0665* | 0.0771** | 0.1646*** | - 0.1376 |
| Destination | (0.0366) | (0.0346) | (0.0383) | (0.0933) |
| Log GDP/cap | 0.1102** | 0.1135*** | - 0.0480 | 0.3009*** |
| Source | (0.0443) | (0.0432) | (0.0523) | (0.0853) |
| Log GDP/cap | 0.2236*** | 0.2176*** | 0.2967*** | 0.2843*** |
| Destination | (0.0419) | (0.0405) | (0.0535) | (0.0872) |
| Log popn | 0.6489*** | 0.6152*** | 1.1457*** | - 0.1912 |
| Source | (0.1599) | (0.1551) | (0.1875) | (0.2872) |
| Log popn | 1.4433*** | 1.4455*** | 1.4031*** | - 0.1005 |
| Destination | (0.1974) | (0.1932) | (0.2725) | (0.2883) |
| Log distance | - 0.9389*** | - 0.9462*** | - 1.2610*** | - 0.6494*** |
| | (0.0498) | (0.0445) | (0.0689) | (0.0790) |
| Maritime | 0.5390*** | 0.4149*** | 0.3879** | 0.9139*** |
| Border (d) | (0.1195) | (0.1078) | (0.1744) | (0.1628) |
| Land | - 0.2682 | - 0.1703 | - 0.5602** | 0.5373** |
| Border (d) | (0.1678) | (0.1597) | (0.2463) | (0.2300) |
| Legal (d) | 0.3124*** | 0.3348*** | 0.0493 | 1.0447*** |
| | (0.0719) | (0.0684) | (0.0965) | (0.1232) |
| Religion | 0.4227*** | 0.4202*** | 0.9990*** | - 0.6233*** |
| | (0.1493) | (0.1350) | (0.1673) | (0.2395) |
| Colony (d) | 0.4952*** | 0.4620*** | 0.4699** | 0.8763*** |
| | (0.1201) | (0.1080) | (0.1839) | (0.1867) |
| Common | 0.0008 | 0.0392 | 0.5743** | - 0.0159 |
| Colonist (d) | (0.1884) | (0.1572) | (0.2256) | (0.2347) |
| FTA (d) | 0.5810*** | 0.5572*** | 1.3079*** | - 0.5826*** |
| | (0.0819) | (0.0803) | (0.1047) | (0.1906) |
| Currency | - 0.0604 | - 0.1090 | - 0.0126 | - 0.0696 |
| Union (d) | (0.1971) | (0.1775) | (0.2513) | (0.3053) |
| Language (d) | - 0.2524** | - 0.2422** | - 0.3877*** | - 0.3655** |
| | (0.1065) | (0.0970) | (0.1419) | (0.1795) |
| Constant | - 10.240*** | - 12.612*** | - 8.632*** | - 20.424*** |
| | (1.4364) | (1.3418) | (1.6650) | (2.5404) |
| Observations | 256163 | 299389 | 170644 | 133877 |
| Pseudo R ² | 0.644 | 0.637 | 0.698 | 0.556 |

Table 4 (continued)

Dependent variable: access agreement (1) or not (0); column 3 non-reciprocal agreement (1) or not (0); column 4 reciprocal agreement (1) or not (0)
 Year, source and destination country controls are included but coefficients are not reported
 Significance levels: *10% **5% ***1%. Standard errors are clustered at the country-pair level

observations with reciprocal ones and observations with no agreements. The results of this estimation are reported in the third column of Table 4.

Next we consider a sample of all countries that ever had a reciprocal access agreement, as well as a fish trade relationship with any country. This sample has 133,877 observations with 2.1% having a reciprocal agreement.³² The results of this estimation are reported in the last column of Table 4.

We do find that the results are very different for these two sub-samples. A notable difference is that comparative fishing advantage seems to play an important role only for non-reciprocal agreements. Our estimations show that the coefficient on destination country stock status is now negative and statistically significant for non-reciprocal agreements. In contrast, for reciprocal agreements the coefficients on stock status for destination and source countries are both positive, statistically significant, and similar in magnitude. Hence, the difference in stock status is an important component of non-reciprocal agreements, whereas similarity is important for reciprocal agreements. There is also an important distinction in the role of fishing capacity. For non-reciprocal agreements, a larger fishing capacity of the destination country is an important indicator, while for reciprocal agreements, the coefficients on neither the source nor destination capacity are statistically significant.

There are also notable differences in the role of the gravity factors. For non-reciprocal agreements, the coefficient on GDP per capita is only statistically significant for the destination country. In contrast, for reciprocal agreements, coefficients on GDP per capita for both source and destination country are positive, statistically significant and similar in magnitude. This suggests that reciprocal access agreements are signed by countries that have similar high income per capita levels, while in the non-reciprocal agreements the source countries are from a spectrum of income levels.

With respect to distance variables, a larger physical distance between countries reduces the probability of any agreement but the magnitude of this effect is almost twice as large for non-reciprocal ones. Sharing a maritime border increases the probability of either type of agreement and the magnitude of the effect is more than twice as large for reciprocal agreements. Sharing a land border negatively affects non-reciprocal agreements but positively affects reciprocal agreements. Together these physical closeness results suggest contiguity of land or sea is extremely important for reciprocal relationships, perhaps more indicative of shared stocks or industries.

Cultural closeness characteristics such as sharing a common legal origin, religion, having a common colonist and being part of the same free trade agreement also have differing impacts. For example, having a common legal origin has a positive and significant effect

³² The observations with a non-reciprocal agreement are coded as zeroes in this specification, thus, we compare observations with reciprocal agreements to observations with non-reciprocal ones and observations with no agreements.

only for reciprocal agreements, which provides further evidence that reciprocal agreements are signed between countries with similar economic environment. One having been a colony of the other has a positive coefficient for both types of agreements but having a common colonist or sharing a religion are only positively associated with non-reciprocal agreements suggesting that historical similarities might be also driving non-reciprocal agreements, not just the present circumstances.

To summarize, our evidence suggests that indeed reciprocal and non-reciprocal agreements have different motivations. Non-reciprocal agreements are mostly driven by a pattern of comparative advantage in fishing, whereas reciprocal agreements are signed between contiguous countries with similar economic environments.

5.3 Results: International Fisheries Trade Incidence

In this section we estimate Eq. 1 with the incidence of trade, T_{sdt} , as the dependent variable.

5.3.1 Trade: Baseline Specification

The coefficients and marginal effects for the baseline estimation are reported in the first two columns of Table 5. Similar to the results for access agreements, the coefficient on fish stock status in the source country is positive and statistically significant. As the overall probability of a country-pair-year observation having trade is 20.1%, the 0.1564 marginal effect of the mean tropic level of the source country rising by one increases the probability of trade by 77.8%. The notable difference is that the sign on the coefficient of destination country stock status is now negative, that is, destination countries with a lower fish stock status are more likely to import fish products.

With respect to fishing capacity, the coefficient for the source country is positive while the coefficient for the destination country is negative, and both coefficients are statistically significant at 1% level. That is, a larger fishing capacity of the source country and a lower capacity of the destination country increases the probability of trade. These results on the pattern of fishing comparative advantage and fish exports are in line with our Empirical Prediction 2(a).

Examining the importance of gravity factors, we find that the coefficients on GDP per capita for source and destination countries are both positive, which supports our predictions regarding economic size.³³

The results on our measures of distance costs between two countries yield interesting contrasts between agreements and trade. For some variables such as physical distance, having a common legal origin, common religion and having colonial ties in the past, the coefficients retain the signs as for agreements. The coefficient on the physical distance for trade incidence is a third smaller than for the agreement incidence. The higher sensitivity of agreements to larger physical distance is likely due to the frequency of trips. That is, trade in fish products can occur along with trade in other goods so the distance cost can be shared over multiple goods, whereas the distance cost of fish caught under an access agreement is only borne by the fish products.

³³ As the coefficient on population of the destination country is negative, we also estimate a version with GDP, rather than GDP per capita and population. In this estimation, the coefficient on economic size of the destination country is positive.

Table 5 Fisheries trade I

| | Pr (trade) | Marginal effects | EU CFP | Agt < 82 | Catch < 82 |
|-----------------------|-------------|------------------|-------------|-------------|-------------|
| Log stock | 1.3244*** | 0.1564*** | 1.3244*** | 1.3054*** | 1.3053*** |
| Source | (0.2259) | (0.0267) | (0.2260) | (0.2249) | (0.2253) |
| Log stock | - 0.4241 * | - 0.0501* | - 0.4241* | - 0.4343* | - 0.4380** |
| Destination | (0.2220) | (0.0262) | (0.2220) | (0.2218) | (0.2217) |
| Log capacity | 0.1193*** | 0.0141*** | 0.1193*** | 0.1274*** | 0.1220*** |
| Source | (0.0230) | (0.0027) | (0.0230) | (0.0229) | (0.0231) |
| Log capacity | - 0.0690*** | - 0.0081*** | - 0.0690*** | - 0.0685*** | - 0.0664*** |
| Destination | (0.0222) | (0.0026) | (0.0222) | (0.0220) | (0.0221) |
| Log GDP/cap | 0.1767*** | 0.0209*** | 0.1767*** | 0.1750*** | 0.1883*** |
| Source | (0.0255) | (0.0030) | (0.0255) | (0.0254) | (0.0256) |
| Log GDP/cap | 0.4967*** | 0.0587*** | 0.4967*** | 0.4941*** | 0.4860*** |
| Destination | (0.0261) | (0.0032) | (0.0261) | (0.0261) | (0.0260) |
| Log popn | 1.0876*** | 0.1284*** | 1.0877*** | 1.1373*** | 1.1008*** |
| Source | (0.1010) | (0.0119) | (0.1011) | (0.1008) | (0.1012) |
| Log popn | - 0.7894*** | - 0.0932*** | - 0.7894*** | - 0.7138*** | - 0.7757*** |
| Destination | (0.0974) | (0.0116) | (0.0980) | (0.0979) | (0.0970) |
| Log distance | - 0.5756*** | - 0.0680*** | - 0.5756*** | - 0.5615*** | - 0.5636*** |
| | (0.0227) | (0.0029) | (0.0227) | (0.0228) | (0.0228) |
| Maritime | - 0.0893 | - 0.0099 | - 0.0893 | - 0.1113 | - 0.0961 |
| Border (d) | (0.0785) | (0.0081) | (0.0785) | (0.0788) | (0.0784) |
| Land | 0.1844* | 0.0249 | 0.1844* | 0.1915* | 0.1961* |
| Border (d) | (0.1087) | (0.0166) | (0.1084) | (0.1083) | (0.1088) |
| Legal (d) | 0.0647** | 0.0077** | 0.0647** | 0.0636** | 0.0655** |
| | (0.0319) | (0.0039) | (0.0319) | (0.0317) | (0.0319) |
| Religion | 0.2417*** | 0.0285*** | 0.2417*** | 0.2336*** | 0.2439*** |
| | (0.0646) | (0.0077) | (0.0646) | (0.0644) | (0.0645) |
| Colony (d) | 0.7859*** | 0.1570*** | 0.7859*** | 0.7753*** | 0.7786*** |
| | (0.0725) | (0.0210) | (0.0725) | (0.0717) | (0.0723) |
| Common | 0.2178*** | 0.0298*** | 0.2178*** | 0.2095*** | 0.2202*** |
| Colonist (d) | (0.0735) | (0.0115) | (0.0735) | (0.0730) | (0.0735) |
| FTA (d) | - 0.2603*** | - 0.0254*** | - 0.2603*** | - 0.3626*** | - 0.2743*** |
| | (0.0673) | (0.0053) | (0.0660) | (0.0713) | (0.0677) |
| Currency | 0.4697*** | 0.0778*** | 0.4697*** | 0.4739*** | 0.4803*** |
| Union (d) | (0.0863) | (0.0188) | (0.0864) | (0.0868) | (0.0870) |
| Language (d) | 0.2009*** | 0.0263*** | 0.2009*** | 0.2077*** | 0.2045*** |
| | (0.0456) | (0.0066) | (0.0456) | (0.0454) | (0.0456) |
| EUmember (d) | | | 0.0000 | | |
| | | | (0.0439) | | |
| Agt Prior | | | | 0.4333*** | |
| 1982 (d) | | | | (0.0616) | |
| Catch Prior | | | | | 0.2018*** |
| 1982 (d) | | | | | (0.0373) |
| Constant | - 5.7569*** | | - 5.7570*** | - 6.1129*** | - 5.9644*** |
| | (0.7616) | | (0.7585) | (0.7581) | (0.7627) |
| Observations | 256163 | 256163 | 256163 | 256163 | 256163 |
| Pseudo R ² | 0.510 | 0.510 | 0.510 | 0.512 | 0.511 |

Table 5 (continued)

Dependent variable: trade incidence (1) or not (0)

Year, source and destination country controls are included but coefficients are not reported

Significance levels: *10% **5% ***1%. Standard errors are clustered at the country-pair level

Interestingly, unlike the results for agreements, sharing a maritime border does not have a statistically significant impact on the probability of trade in fish products. On the other hand, sharing a land border, a colonist, a currency, or a language now have statistically significant positive effects on trade incidence. A counter-intuitive estimation result is that being in the same FTA reduces the probability of fish trade between the pair of countries. De Benedictis and Taglioni (2011) suggest that the negative sign for the FTA indicator variable in a standard specification can be explained either by the existence of a significant time trend non-orthogonal to the FTA indicator or by a correlation between the FTA and border-sharing variables. In this case, the solution is to include time-variant exporter and importer fixed effects as well as time-invariant pair fixed effects. However, such a specification is not feasible for our analysis as we would then not be able to estimate the effects of all time-varying country-specific variables of our interest, such as fish stocks and fishing capacities, nor the time-invariant pair-specific variables, such as distance.

These results are supportive of our hypothesis that agreements and trade are acting, at least in part, as substitute pathways depending upon how important those characteristics are along each path.

5.3.2 The European Union

Recall the sharp drop in the number of fish trade pairs in 1984, due to member countries of the European Union reducing the number of trade partnerships outside of the EU, as depicted in Fig. 2a. Next, we explore this issue in more detail, that is how being a member of the European Union has implications for trade in fish. To do this we create an indicator variable, *EU member*, that equals one if at least one of the countries in the country-pair was an EU member in the relevant year. The estimation results of including this control variable are reported in the third column of Table 3. In contrast to the positive effect of the *EU CFP* variable on access agreements, the coefficient of the *EU member* variable is not statistically significant.³⁴ This is likely to be due to the different specifications: in the agreements data, the *EU CFP* variable was specifically controlling for whether at least one agreement between the country-pair in a particular year was due to the Common Fisheries Policy so the relationship between the dependent and independent variables was tighter. In the trade specification, we simply control for whether one of the countries in the pair was an EU member. In addition, we already control for importer and exporter fixed-effects, thus, the additional variation for the *EU member* variable to capture is limited.

5.3.3 Historical Fishing Relationships

Next, we explore how the existence of historical fishing relationship might have affected the incidence of fish exports after 1982 when UNCLOS has extended jurisdiction for

³⁴ Similarly to the estimation results for agreements, including the *EU member* indicator does not alter the other results.

the exclusive economic zone. We reestimate Eq. 1 with an additional control variable $Agt\ Prior\ 1982_{sdt}$, which is equal to one if there was an agreement between countries s and d prior to 1982 and if the observation year, t , is after 1982 and zero otherwise. We also reestimate our equation using a variable $Catch\ Prior\ 1982_{sdt}$, for catch prior to 1982 by d in what would become s 's area to control for the history of distant water fishing prior to UNCLOS. These estimation results are reported in the final columns of Table 5. Having had a fishery access agreement prior to 1982 is positively associated with having trade in fish products after 1982, although the magnitude of this effect only a third as large as for agreements. Having historical catch prior to 1982 is also positively associated with having trade after 1982.³⁵ Considering the results from both the agreements and the trade specifications together, it seems that both trade and agreements have responded to the change in jurisdiction over historical fishing grounds.

5.3.4 Reverse Causality and Sample Selection

Similarly to our estimations for access agreements, our results for trade incidence might be affected by the reverse causality issue. Our prediction is that a higher stock status in the source country and a lower stock status in the destination country will make trade in fish products more likely. If the causality were running the other way, then exports of fish products would affect the fish stock status of the source country. However, in this case exporting fish products will put downward pressure on the source country stocks, which would lead to a negative relationship between trade incidence and the source country stock status. Our results in Table 5 show that the observed relationship is, in fact, positive, which provides some support that the reverse causality problem is not large enough to overturn our results.

As with agreements, we investigate this issue further by reestimating our Equation using 10-year lags of stock status. The results are reported in the first column of Table 6. We can see that the signs and statistical significance of the coefficients on stock status do not change, in fact the magnitude of the effect becomes larger for both destination and source countries stocks.

Next we address a potential problem of estimation bias due to a sample selection issue. Recall that our baseline sample includes all source and destination countries that ever had an agreement with any other country and ever had trade in fish products with any other country in the period 1962–2000. We reestimate Equation 1 using a larger sample which now includes all the countries that ever had any trade in fish products either as an exporter or as an importer, irrespective of having an agreement. This doubles the size of the sample as we recall from Figs. 1b and 2b that there are more countries that ever traded than that ever had an agreement. The estimation results are reported in the second column in Table 6. We can see that the results are similar in sign and statistical significance to the baseline specification so sample selection does not significantly affect our results.

5.3.5 Reciprocal and Non-reciprocal Exports

Finally we investigate how the motives for non-reciprocal trade relationships might be different from the motives for reciprocal relationships. We construct an indicator variable that is equal to one if there are both positive exports and positive imports of fish products from country s to country d , and equal to zero otherwise. We reestimate Equation 1

³⁵ Alternatives using 1977 or 1962 as the cutoff dates as described in Sect. 5.2 gave similar results.

Table 6 Fisheries trade II

| | Lag stock | Full sample | Non-reciprocal | Reciprocal |
|-----------------------|-------------|-------------|----------------|-------------|
| Log stock | 1.4841*** | | | |
| Source t-10 | (0.2293) | | | |
| Log stock | - 0.8451*** | | | |
| Destination t-10 | (0.2419) | | | |
| Log stock | | 0.9977*** | 1.6187*** | 0.4149 |
| Source | | (0.1672) | (0.2551) | (0.3153) |
| Log stock | | - 0.3253** | - 0.2916 | - 0.2946 |
| Destination | | (0.1590) | (0.2558) | (0.3143) |
| Log capacity | 0.1542*** | 0.1414*** | 0.1744*** | 0.0349 |
| Source | (0.0246) | (0.0170) | (0.0246) | (0.0349) |
| Log capacity | - 0.0803*** | - 0.0815*** | - 0.0988*** | 0.0027 |
| Destination | (0.0231) | (0.0162) | (0.0249) | (0.0330) |
| Log GDP/cap | 0.1742*** | 0.1222*** | 0.1637*** | 0.3412*** |
| Source | (0.0255) | (0.0189) | (0.0274) | (0.0384) |
| Log GDP/cap | 0.5022*** | 0.4900*** | 0.4588*** | 0.5728*** |
| Destination | (0.0260) | (0.0201) | (0.0282) | (0.0392) |
| Log popn | 1.0804*** | 0.9062*** | 1.2480*** | 0.5057*** |
| Source | (0.1014) | (0.0724) | (0.1135) | (0.1448) |
| Log popn | - 0.7642*** | - 0.4569*** | - 0.8361*** | - 0.1932 |
| Destination | (0.0977) | (0.0626) | (0.1062) | (0.1482) |
| Log distance | - 0.5767*** | - 0.6125*** | - 0.5210*** | - 0.7904*** |
| | (0.0227) | (0.0163) | (0.0279) | (0.0308) |
| Maritime | - 0.0898 | - 0.0518 | - 0.0695 | - 0.1320 |
| Border (d) | (0.0786) | (0.0612) | (0.1059) | (0.1018) |
| Land | 0.1857* | 0.1904** | 0.0309 | 0.2616* |
| Border (d) | (0.1087) | (0.0823) | (0.1289) | (0.1501) |
| Legal (d) | 0.0657** | 0.0670*** | 0.0205 | 0.1095** |
| | (0.0319) | (0.0229) | (0.0358) | (0.0453) |
| Religion | 0.2409*** | 0.2718*** | 0.2362*** | 0.2573*** |
| | (0.0646) | (0.0456) | (0.0738) | (0.0987) |
| Colony (d) | 0.7879*** | 0.6842*** | 0.6792*** | 1.1191*** |
| | (0.0727) | (0.0543) | (0.1041) | (0.0857) |
| Common | 0.2189*** | 0.1487*** | 0.2175*** | 0.1686 |
| Colonist (d) | (0.0734) | (0.0469) | (0.0770) | (0.1157) |
| FTA (d) | - 0.2652*** | - 0.1262** | - 0.4380*** | - 0.2743*** |
| | (0.0673) | (0.0572) | (0.0982) | (0.0833) |
| Currency | 0.4715*** | 0.4133*** | 0.3857*** | 0.6508*** |
| Union (d) | (0.0866) | (0.0648) | (0.0990) | (0.1144) |
| Language (d) | 0.2002*** | 0.2487*** | 0.2791*** | 0.1303** |
| | (0.0456) | (0.0321) | (0.0521) | (0.0614) |
| Constant | - 5.7567*** | - 5.4786*** | - 6.7105*** | - 6.3462*** |
| | (0.8133) | (0.5540) | (0.8493) | (1.1299) |
| Observations | 256163 | 506869 | 206578 | 231198 |
| Pseudo R ² | 0.511 | 0.517 | 0.444 | 0.649 |

Table 6 (continued)

Dependent variable: trade incidence (1) or not (0); column 3 non-reciprocal trade (1) or not (0); column 4 reciprocal trade (1) or not (0)

Year, source and destination country controls are included but coefficients are not reported

Significance levels: *10% **5% ***1%. Standard errors are clustered at the country-pair level

for two different subsamples. In the first subsample, we include countries that ever had a non-reciprocal (one-way) trade relationship and ever had a fisheries access agreement with any other country in period 1962–2000. This sample contains 206,578 observations with 12.1% of them exhibiting positive, only one-way, exports.³⁶ The results of this estimation are reported in the third column of Table 6. In the second subsample, we include all countries that ever had reciprocal (two-way) trade in fish products, as well as a fishery access agreement with any country. This sample includes 231,198 observations with 11.4% ever having had positive two-way exports.³⁷ The results of this estimation are reported in the last column of Table 6.

As with agreements, the nature of non-reciprocal and reciprocal trade seems to be different and the pattern of advantage in fishing plays a role only for non-reciprocal trade in fish. We find that a higher source country fish stock, a higher source country fishing capacity and a lower destination country fishing capacity have a statistically significant effect on countries having a non-reciprocal trade relationship. However, these variables do not influence the probability of reciprocal trade in fish products.

With respect to the gravity variables, we find that higher GDP per capita in both source and destination countries has a positive and statistically significant effect on probability of either type of trade relationship. Also, countries that are physically closer to each are more likely to engage in fish trade, both reciprocal and non-reciprocal. The cultural closeness characteristics of having a common legal system is positively associated with reciprocal trade but not non-reciprocal while having a common colonist is positively related to non-reciprocal trade but has no statistically significant impact upon reciprocal trade. These suggests that reciprocal trade occurs between more similar countries and is perhaps allowing more specific specialization than our annual, aggregate data is able to illuminate.

6 Conclusion

In this paper we empirically examine the characteristics of pairs of countries who use the dual pathways of access agreements and trade to provide fish from one country's waters to consumers in another. We build a unique, global dataset that allows us to distinguish between the contribution of two key factors that determine comparative advantage in fishing and consider standard gravity factors that affect international relationships.

We find that fish stock status influences the probability of fisheries agreements and trade similarly but that fishing capacity operates differently on these two types of fish flows.

³⁶ In this specification, all observations with a two-way trade are coded as zeroes. That is, we compare observations with non-reciprocal fish exports to observations with reciprocal exports and observations with no trade.

³⁷ In this specification, all observations with one-way exports are coded as zeroes.

While some characteristics of distance affect both agreements and trade similarly, there are interesting contrasts. For instance, sharing a maritime border is positively associated with agreements but land borders are what matter for trade, and cultural distance variables that affect the cost of transactions, such as currency and language, matter more for trade where these transactions are more numerous.

Our results suggest that the usual suspects from a popular perspective, resource abundance and fishing capacity, do play a role in characterizing which countries make agreements with each other, but that they form only part of the story. Including in the analysis the standard factors from a trade perspective, economic size and closeness, and considering the pathway of trade, has meant that we can shed a different light upon who makes access agreements with whom. Moreover, these results are consistent with the position of the World Bank report (Arthur et al. 2014) that agreements are functioning as trade in fishing services and hence the two pathways need to be considered together.

In our analysis, we have taken a global view of access agreements and trade. The advantage of this is that we can see broader trends and draw conclusions for the factors that drive agreements or trade that are more robust than individual country profiles. This is particularly relevant as climate change and geopolitical forces are likely to shift comparative advantage and impact the costs of trade. The disadvantage is that we are unable to consider the, often fascinating, details of particular agreement or trade partnerships. Future work can use our broader trends to identify particular countries or regions for more detailed analysis that would complement this study. Considering the most appropriate options for countries with abundant fish stocks but lower fishing capacity to reap the gains from their resources would also be rewarding and important.

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