Can U.S. import regulations reduce IUU fishing and improve production practices in aquaculture?

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Abstract

Illegal, Unreported, and Unregulated (IUU) fishing is a significant challenge to sustainable seafood production which is difficult to address in traditional governance systems. Recently, the U.S. has implemented a Seafood Import Monitoring Program (SIMP) to combat IUU fishing and seafood fraud by requiring chain-of-custody documentation of 13 species when imported to the U.S. This will exclude IUU seafood from the U.S. market. If the U.S. has market power due to large imports, it will also give exporters incentives to improve management to comply with the SIMP. However, if the U.S. has no market power, the effect of the SIMP will be a change in trade patterns and the costs associated with the SIMP will be carried by U.S. consumers in the form of higher prices and lower seafood consumption. In this paper, a residual supply approach is used to investigate whether the U.S. has buyer power for three species included in the SIMP: shrimp, crab, and tuna. The standard residual supply framework is augmented to account for exchange rates. The results indicate that the U.S. has buyer power for most products. Hence, the SIMP will give incentives to improve the management practices in the investigated supply chains.

Key words: SIMP; residual supply; IUU fishing; international trade

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1. Introduction

The United States (U.S.) is the world's largest seafood importer by value and recognized as a global leader in promoting sustainable seafood production (FAO, 2020; NOAA, 2020). Moreover, despite significant domestic production, seafood imports to the U.S. have grown over 50% since 1980 (NOAA, 2020).[1] A challenge with these imports is that a significant share may come from fisheries and aquaculture producers with problematic environmental production practices, such as Illegal, Unregulated, and Unreported (IUU) fishing, seafood fraud (also related to aquaculture), and excessive use of antibiotics in aquaculture (Roheim and Sutinen, 2006; Cabello et al., 2013; Lampert, 2017; Willette and Cheng, 2018; NOAA, 2018a). IUU fishing is an environmental challenge as it leads to depleted fish stocks and unsustainable fisheries (Roheim and Sutinen, 2006). Seafood fraud can facilitate overfishing as fish from unsustainable fisheries are marketed as sustainable (Kroetz et al., 2020) and can also be a food safety risk. Excessive antibiotics use, if traces remain in the seafood a food safety risk, may cause environmental externalities at the source. Seafood is over-represented as a carrier of the food-born disease (Uchida et al., 2017: Love et al., 2021).

[1] NOAA (2020) estimates that over 80% of the seafood consumed in the U.S. is imported. Gephart et al. (2019) estimate that this figure is lower, but still, that over 60% of the seafood consumed is imported.

In an attempt to combat IUU fishing and seafood fraud, a Seafood Import Monitoring Program (SIMP) has been instigated. A pilot for the program took effect on January 1, 2018, initially for eleven species and was extended with two more from April 1, 2019, and will be extended to all the other seafood imports if the program is successful (NOAA, 2018c).[2] The thirteen high-risk species in relation to IUU fishing that made up over 40% of U.S. imports by value in 2016 (NOAA, 2018b; USITC, 2018).[3] The SIMP requires that a complete production record of the seafood imported to the U.S. is traced and provided, demonstrating that the fish is legally caught or produced and that it is from sustainably managed fisheries or aquaculture (NOAA, 2018a). Seafood imports without the required files will not be released by the Customs and Border Protection (CBP) (Havice, 2017), constituting an import ban in practice. However, it is also worthwhile to note that while the pilot program has been instigated, there are so far very limited enforcement and guidelines with respect to the

[2] According to the World Trade Organization, the U.S. cannot restrict the import of products due to concerns with the production process if the domestic producers are not held to the same requirement. The pilot species were therefore reduced to 11 and did not include abalone and shrimp. From December 31, 2018, the pilot extended to these two species, and restrictions on the aquaculture management of abalone and shrimp have been released by NOAA in 2019 (NOAA, 2018c; NOAA, 2019a).

[3] Priority species in the SIMP are: Abalone, Atlantic Cod, Blue Crab (Atlantic), Dolphinfish (Mahi Mahi), Grouper, King Crab (red), Pacific Cod, Red Snapper, Sea Cucumber, Sharks, Shrimp, Swordfish and Tunas (Albacore, Bigeye, Skipjack, Yellowfin, and Bluefin).

required documentation, so beyond paperwork, it has had a very limited impact so far (Connelly, 2019).

This study focuses on the potential for the SIMP to achieve its objectives for the three most important species by import value in the SIMP: shrimp, crab, and tuna. Shrimp is the most consumed seafood species in the U.S., making up to 27.5% of American seafood consumption in 2017 (Shamshak et al., 2019; Love et al., 2020), and shrimp farming is one of the fastest-growing industry in aquaculture (Kobayashi et al., 2015; Garlock et al., 2020). While there are significant landings of domestic shrimp in the U.S., the market is dominated by imported shrimp, primarily from aquaculture in developing countries (Asche et al., 2012; Smith et al., 2017). However, the shrimp aquaculture industry often operates in countries with poor governance systems, with significant negative impacts on the environment as well as food safety concerns such as excessive use of antibiotics (Broughton and Walker, 2010; Cabello et al., 2013; Kroetz et al., 2020). Tuna and crab are primarily sourced from fisheries and imported from regions with weak fishery management systems (NOAA, 2020). For instance, king crab is one of the most important crab species in the SIMP by the import value, and nearly 90% of the king crab imported to the U.S. are from Russia (USITC, 2019), where IUU fishing is a real concern as the actual crab export levels are reported to be two to four times higher than the official harvest levels (WWF, 2014).[4] Global tuna fisheries also face significant challenges due to the high levels of IUU fishing (WWF, 2007). As much as 70% of the tuna products have been reported to be from IUU fishing in Pacific tuna fisheries (Souter et al., 2016).[5]

Whether the SIMP will provide incentives to reduce IUU fishing and improve the production practices in aquaculture depends on the extent to which the U.S. as an importer has oligopsony power relative to the exporting countries. If the U.S. has no buyer power, seafood from IUU fisheries will just be exported to the other countries, and producers will have no incentives to incur costs to comply with the SIMP. For products that fulfill the U.S. requirements and are imported to the U.S., the cost associated with SIMP will be fully borne by the U.S. importers and ultimately the U.S. consumers. As a result, the increasing price of these products in the U.S. will reduce seafood imports and domestic consumption. On the other hand, if the U.S. has buyer power, the implementation of SIMP will give countries whose management systems do not conform to the sustainable

[4] Blue crab is also a target species in the SIMP. Here, the buyer power of the U.S. in the blue crab market will not be tested since the majority of blue crab products are fresh and domestically produced. Only few products of blue crab crabmeat are imported (USITC, 2018).

[5] It is worthwhile to note that it is not necessarily the illegal part of IUU that is the challenge here. McCluney et al. (2019) provide a good discussion of tuna management in the Pacific.

requirements incentives to improve their management systems. If this is the case, the SIMP has the potential to reduce IUU fishing or improve the aquaculture production practices, and the costs in compliance with the SIMP will be shared between exporters and U.S. consumers as determined by the relevant supply and demand elasticities. Hence, it is of interest to investigate whether the U.S. has buyer power for the species included in the SIMP pilot as this is a necessary although not sufficient condition for the SIMP initiative to actually reduce IUU fishing and improve aquaculture production practice.[6] The U.S. is a particularly important importing country for many of the seafood species included in the SIMP, making it more likely that the U.S. has the market power for these species.

To estimate the potential buyer power of the U.S., residual supply equations are estimated for the main exporters of the three seafood species. The origin of this model is the residual demand model of Baker and Bresnahan (1988). Durham and Sexton (1992) adopted this model to a buying power setting by specifying a residual supply curve. In an international trade setting, somewhat different factors influence the degree of competition. Goldberg and Knetter (1999) derive a residual demand model for import demand

[6] To be sufficient, the benefits of exporting to the U.S. must outweigh the cost of the introducing the SIMP.

and note that exchange rate variation is particularly useful for model identification. This paper adopts the residual supply model of Durham and Sexton (1992) in an international trade setting similarly as Goldberg and Knetter (1999) adopted the Baker and Breshnahan (1988) residual demand model to this setting.

The following of this paper is structured as: In the following section, the residual supply method will be introduced by a start from a graph description. Then data analysis to estimate the buyer power of the U.S. on different seafood species by countries is given. Next, the results of the estimation on the U.S. buyer power of the interested species using the residual supply model is described. Finally, concluding remarks are offered.

2. Method

A graphical representation of a residual supply equation is a useful starting point for the analysis. The residual supply curve that faces an importing country depicts how a country influences the input price through the quantity it purchases. To derive the residual supply, one has to take into account the total supply from the relevant source and the derived demand of all the other importers of the product. This is illustrated in Figure 1. The left panel shows the total market supply, S, and the derived demand from all the other countries importing the product in question, D_{other}. The residual supply $S_{residual}$ curve shown in the right panel is then given by the difference between the market supply and the other countries' derived demand, which will determine the elasticity of the residual supply curve. In a competitive market, the price is completely determined by the other countries' derived demand, and the residual supply curve will be flat and there is no scope to exploit oligopsony power. In this case, an import restriction will not have any effect on the price of the exporter. If the supply curve is an upward-sloping one, it implies that the country of interest has some oligopsony power.[7] Given at the price P*, for instance, if the country will maximize its profits or to obtain a maximum rent transfer, the country can act as a monopsonist on the marginal expenditure (ME) curve. When the residual supply curve and the market supply curve coincide, i.e., have the same slope, the country will be a monopsonist as there will be no other countries importing the product.

[7] Note that this does not necessarily imply that individual importers in the importing country have oligopsony power. It is changes in aggregate imports that influence the exporter's price. As a result, this can be exploited by introducing trade measures that serve to 'coordinate' the importers in reducing the quantity imported. Trade measures as a coordination mechanism was discussed by Steen and Salvanes (1999).

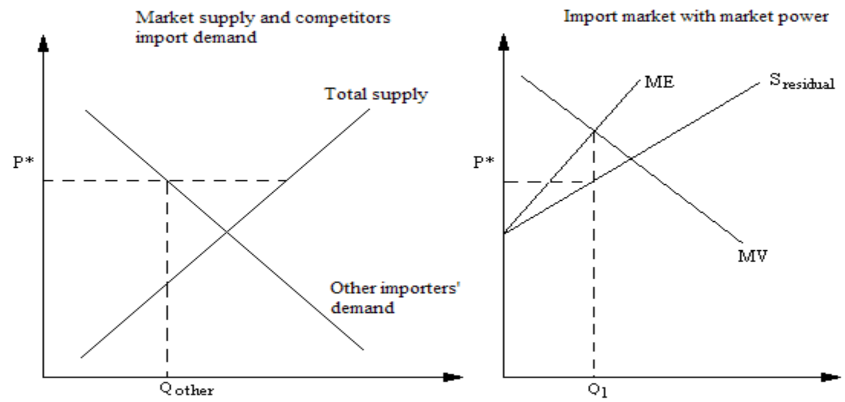

Figure 1. Market supply and residual supply of intermediate good *M*

To test for the oligopsony power, a residual supply schedule provides a single equation that can be easily estimated when given a functional form. This provides a different approach to test for oligopsony power than the specifications of Schroeter (1988) and Morrison Paul (2001), who specified the markup equation together with a full cost function specification similar to the approach of Appelbaum (1982). Schroeter et al. (2000) used the model of Bresnahan (1982) and Lau (1982). The fact that a residual supply schedule can be estimated as a single linear equation in its parameters in many cases will make it an easier specification to use in the empirical work. The specification is independent of the assumptions about market structures in other markets, and any behavior on the buyer side from a competitive situation to a monopsony can be identified. Moreover, the inputs can be differentiated, which is an important feature in international trade as many products are differentiated by origin. Finally, estimating the residual supply curve does not require the conduct parameters to be estimated, and one accordingly avoids the issues addressed by Corts (1999).

The inverse supply function for an exporter (or intermediate good *M*) facing the importing country of interest, *im*, the country of interest, is

$$w^{im} = W^{im}(Q^{im}, w^2, \dots, w^n, V^s) \quad (1)$$

where w^{im} and Q^{im} are the interested importing country's import price in the exporter's currency and quantity, $w^2, \dots w^n$ is a vector of import prices to other countries of the good in the exporters' currencies, and V^s is a vector of exogenous variables entering the supply equation, typically the supplier's input prices in the exporter's currency. Correspondingly, we can formulate the inverse supply facing each of the other importers of good *M*, $i = 2, \dots, N$, as

$$w^i = W^i(Q^i, w^j, w^{im}, V^s) \quad (2)$$

Goldberg and Knetter (1999) provide a discussion on how the export industry's first order conditions can be derived for a specific firm. A similar procedure is used here. As the object of interest is the import demand of a country, one can, by assuming the appropriate aggregation conditions are fulfilled, just pose the importer's problem. For every exporter, import demand for the good can be found by solving the profit-maximizing problem:

$$\max_{Q_i^{im}} \pi_i^{im} = epf\left(Q^{im}, \mathrm{z}\right) - w^{im}Q^{im} - erz \qquad (3)$$

where e is the exchange rate, p is the importer's sales price of the good in domestic currency, $f(\cdot)$ is the production function, which is related to the import quantity (Q^{im}) and the quantities of other input factors (e.g. marketing costs) (denoted as z vector) over the time period we investigated.[8] Here, r is the prices of inputs in the domestic currency. The first-order conditions imply that the marginal revenue product (*MRP*) is set equal to the perceived marginal expenditure (*ME*). The *MRP* shows the additional value that the importing country attaches to a marginal increase in import of the product, and it is found by taking the derivative of the first term on the right-hand side of equation (3) with respect to the imported quantity, Q^{im}. Likewise, the *ME* shows the additional outlay following a marginal increase in imports, and it is found by taking the derivative of the second term on the right-hand side. Since *ME* depends on the importing country's conjectures concerning the response from other importers, it is perceived, rather than actual, as the marginal expenditure. By solving the equation (3), the first-order condition can be written as:

[8] We assume that the state of technology is fixed in this continuous production function in our analysis.

$$w^{im} = eMRP^{im} - Q^{im} \sum_{j} (\frac{\partial W^{im}}{\partial w^{j}})(\frac{\partial w^{j}}{\partial Q^{im}}) \qquad (4)$$

The degree of market power is determined by the last parenthesis $\frac{\partial w^j}{\partial Q^{im}}$, which is often denoted by a conduct parameter λ^{im}. The conduct parameter λ^{im} shows the conjectures about the impacts on the other countries' import prices of increased demand from the country of interest. A similar expression can be found for all the other countries that import the good:

$$w^{i} = e^{i}MRP^{i}(p^{i}, r^{i}) - Q^{i} \sum_{j} (\frac{\partial w^{i}}{\partial w^{j}})(\frac{\partial w^{j}}{\partial Q^{i}}) \qquad (5)$$

for $i = 1,\ldots,N$. Solving the equations defined by (2) and (4), one obtains the import prices in the competing importing countries as functions of the supply and demand shifters, and the imported quantity. Using the vectors notation, this is given as:

$$w^{i} = E^{I}(Q^{im}, V^{s}, eR, eP, \lambda^{I}) \qquad (6)$$

where E^I is the equilibrium quantity for all markets except for the market of interest, P is the importer's sales price of the good in domestic currency in equilibrium, and R is the price of inputs in the domestic currency in equilibrium. All right-hand side variables but Q^{im} are exogenous. Equation (3-6) can, therefore, be denoted as a partially reduced form.

By substituting equation (6) into (1), one obtains the residual supply relationship facing the country of interest as follows:

$$w^{im} = W^{im}(Q^{im}, E^{I}(Q^{im}, V^{s}, eR, eP, \lambda^{I}), V^{s}) \qquad (7)$$

Substituting out the redundancies, this gives the residual supply curve facing the country of interest as the formula below:

$$w^{im} = S^{res,im}(Q^{im}, V^{s}, eR, eP, \lambda^{I}) \qquad (8)$$

Here, the residual supply curve is a function of the demanded quantity of the import goods, the supply shifters V^s, and the demand shifters for the other countries buying the goods, which are divided into their sales price *eP* and the price for their input factors *eR*. The output price, other input factor prices, and the exchange rate for the importing country are not included in this equation and will serve as the instruments for the endogenous quantity Q^{im}.

The key parameter of interest is the inverse residual supply elasticity, or the residual supply flexibility, which is expressed as:

$$\kappa = \frac{\partial lnS}{\partial lnQ^{im}} \qquad (9)$$

This elasticity κ will be zero if the demanded quantity of the importing country does not influence the import price and the importing country does not have any market power. The significance level of this elasticity indicates if the importing country has buyer power or not. The elasticity increases in magnitude as the market power of the importing country increases.

As the model is formulated at the country level one can, of course, provide criteria that give consistent aggregation as in Appelbaum (1982), or one can interpret the estimated parameters as an average indicator of the industry as in Goldberg and Knetter (1999). Golberg and Knetter (1999) are typical representatives of the Pricing-To-Market literature, where exporting and importing countries are the unit of analysis. In general, when using the aggregated data, little focus is given to whether the aggregation criterion is met. What matters in relation to the trade policy is that trade measures can be interpreted as coordinated actions by the importing firms in a country. This also applies in the case of the trade regulations on the import, as these are typically levied on all exporters from a given country. We will not elaborate further on this issue here, but only note that the models can be used on aggregated data to test whether groups of firms have market power if one is willing to assume that an aggregation criterion holds or to make interpretations based on the aggregated data directly.

As noted by Goldberg and Knetter (1999), in general, there are substantially greater variations on the exchange rates than in factor prices and other cost variables, which is also true for the variables influencing revenue. With functional forms like a double log, where it is reasonable to separate the exchange rates from the prices, the exchange rates may provide a very good indicator for changes in the marginal costs or the import demand even if the data of input price is not available. It is also reasonable to treat the exporter as a revenue maximizer, basically by modeling the supply as a trade allocation.[9] If so, all the supply variables can be obtained from the exporting country's trade statistics.

3. Model specification and data

The residual supply equation to be estimated is given as:

$$lnP_t = \beta_0 + \beta_1 lnQ_t + \beta_2 lnS_t + \beta_3 lnD_t + \varepsilon_t \qquad (10)$$

where P_t is the import price to the U.S. in the exporting country's currency, and Q_t is the quantity of goods imported. S_t is a vector of exogenous supply shifters in the exporting country, including the wage rate, the fuel price, and the total production of this species in the exporting country, with the prices in the local currency. The vector D_t contains exogenous demand shifters for alternative countries/markets to the U.S. The demand shifters are represented by the wage rates in the alternative countries and the exchange rates between the exporting country and the alternative

[9] See e.g. Dixit and Norman (1980) for a discussion of the use of revenue functions to model trade allocation.

markets.[10] The import quantity is endogenous if the residual supply schedule is not horizontal. The U.S. import demand equation provides the instruments. These are the U.S. retail price, U.S. production, exchange rates between the U.S. and the exporting country, the wage rate of the U.S. in addition to the lagged dependent variables.

The data covers the period from 2006 to 2016 and is limited by the availability of the U.S. retail scanner data to obtain the U.S. retail price. Quarterly import quantity and value for the seafood products are obtained from the U.S. International Trade Commission (USITC), where the data is organized by product form using the Harmonized Tariff Schedule (HTS) 10-digit codes (USITC, 2018). The retail price of each seafood species is obtained from the Nielsen scanner data panel (Nielsen, 2018).[11] The diesel price is collected from the U.S. Energy Information Administration (EIA) (EIA, 2018). FAO FishStatJ (Fisheries and aquaculture software, 2016) provides the production statistics in the exporting countries. The wage rates of all the countries are downloaded from the World Bank (World Bank, 2018), and the exchange rates are

[10] We have also estimated the equations with interest rates as a measure of user cost of capital. These results are not reported as in all cases these parameters were statistically insignificant, and dropping the variable did mot influence the interpretation of the results.

[11] We took the weighted average price for each seafood by quarters based on a monthly data available from Nielsen scanner panel dataset.

obtained from the Federal Reserve Bank of St. Louis (FRED, 2018). Finally, the alternative markets are found based on the import shares from the United Nations Comtrade Database (UN Comtrade, 2018).

For each of the species to be investigated, we chose the product forms and export countries that make up the main share of the imports as this is the source where the U.S, is most likely to be able to exercise buyer power. A summary of the data used in relation to total imports is provided in the appendix. Frozen shrimp is the largest imported shrimp category both in value and quantity to the U.S., making up more than 70% of the total shrimp imports. The main categories of the frozen shrimp are peeled shrimp and shell-on shrimps in different weights, which almost take equal import shares. Asche et al. (2012) found that the U.S. shrimp market is highly integrated, and the relative prices are constant. Hence, the frozen shell-on shrimp and the frozen peeled shrimp are aggregated into one category. Thailand, Ecuador, Indonesia, and India are the largest shrimp suppliers to the U.S., and these countries together supply almost two-thirds of the frozen shrimp imported. The alternative markets of these four main exporting countries vary by country. For Thai shrimp, Japan, Canada, United Kingdom, South Korea are considered alternative markets. For Ecuadorian shrimp, the largest alternative markets are Vietnam, EU, China, and South Korea. For Indonesian shrimp, alternative markets are Japan, EU, Vietnam, and China, and for Indian shrimp, alternative markets are Japan, Vietnam, and the EU.

Frozen crab is clearly the most important by an import share of more than 90% (USITC, 2018). Russia is the only exporting country of interest in this study as almost 90% of the king crabs imported to the U.S. are from Russia. South Korea is the largest alternative market of the U.S. for the king crab from Russia, with the Netherlands, Japan, and Norway as other important alternative markets.

More than 90% of the tuna imported to the U.S. are prepared. Four prepared tuna products are aggregated into our tuna import variable.[12] The exporting countries are Thailand, Ecuador, and Vietnam. For Thai tuna, alternative markets are Australia, Japan, Egypt, and Canada. For Ecuadorian tuna, it is Spain, Venezuela, the Netherlands, and Columbia, and for Vietnamese tuna, it is Germany, Thailand, and Japan. Since Ecuador uses U.S. dollars as the currency, only the wage rates of the alternative countries are used as the demand shifters.

4. Empirical results

[12] The majority of tuna products include those with HTS code 1604143091, 1604143099, 1604144000 and 1604143059.

Table 1 and Table 2 show respectively the results for the U.S. imports for shrimp, king crab, and tuna. All equations are reported with robust standard errors. The estimated equations perform well econometrically. Except for tuna from Ecuador where the R^2 is only 0.474, all equations have good explanatory power. Moreover, in all equations, Hansen's J-test cannot be rejected for any of the equations, indicating that the instruments are valid. In all the equations, at least one of the supply shifters and one of the demand shifters are statistically significant. Initially, all models were estimated with a set of seasonal dummies. These were dropped if an F-test indicated that they were statistically significant. In Tables 1 and 2, it is indicated if seasonal dummies are present or not, but for brevity, the individual parameter estimates are not reported.

As can be seen in the first row (import quantity) of Table 1 and Table 2, the residual supply elasticities indicate that there is a statistically significant elasticity for most of the countries, indicating that the U.S. has buyer power for these products. The results reported in Table 1 show that the U.S. has a high degree of buyer power for shrimp imports from Thailand, Indonesia, and India. However, the elasticity is not statistically significant for Ecuador. For the three countries where the elasticity is statistically significant, the magnitude is also relatively large. This implies that the SIMP is likely to provide significant incentives to improve production practices in those countries. At first glance, it may seem somewhat surprising that the only country where the U.S. does not have market power is the closest country geographically and located in the Americas. However, most of Ecuador's exports go to China, and in most years the EU also takes more Ecuadorian shrimp than the U.S. as the country export primarily head-on shrimp, a quality that most Asian producers cannot supply. Hence, Ecuador has good alternative markets to the U.S. market.

Table 2 reports the estimated equations for king crab and tuna. The residual supply elasticity of Russian king crab is statistically significant with a relatively high magnitude (0.944), indicating that the U.S. has a substantial buyer power on the king crab imported from Russia. This indicates that SIMP can provide a strong incentive for Russian king crabbers to improve management practices to get compliance with the SIMP. For tuna, the U.S. is found to have significant buyer power for Thailand and Vietnam. However, the estimates of tuna imported from Ecuador are not significant, indicating that the U.S. does not have buying power for tuna from Ecuador. This is largely for similar reasons as for shrimp, as Ecuador serves other markets partly due to the controversies and requirements surrounding dolphin-safe tuna (Roheim and Sutinen, 2006)

Table 1. Residual supply model estimates for frozen shrimp imported to the U.S.

Variables	Frozen shrimp			
	Thailand	Ecuador	Indonesia	India
Import quantities	0.636*** (0.0952)	0.0522 (0.0448)	0.736*** (0.254)	0.679*** (0.166)
Fuel price	0.197*** (0.0571)	0.250 (0.152)	0.423** (0.211)	0.608** (0.251)
Fish catch	0.108 (0.143)	1.207*** (0.255)		0.0228* (0.0134)
Wage	0.00938 (0.0543)		4.097*** (0.816)	1.723** (0.837)
Exchange rate_1	0.756 (0.667)		0.373 (0.739)	4.903*** (1.398)
Exchange rate_2	1.010 (1.646)		-0.0131*** (0.00493)	-16.04*** (5.752)
Exchange rate_3	2.988** (1.498)		0.546 (6.431)	0.00545 (0.00465)
Exchange rate_4	0.148 (0.501)		-0.817 (0.701)	
Wage_MktA1	-0.486 (1.077)	-1.231*** (0.176)	-7.244*** (2.221)	-2.406*** (0.719)
Wage_MktA2	0.870 (1.188)	-2.718 (2.657)	-2.338 (3.607)	-0.364 (0.348)
Wage_MktA3	0.867 (1.242)	0.548 (0.335)	0.696 (0.631)	-2.209 (1.565)
Wage_MktA4	2.638*** (1.017)	0.0108 (0.187)	-2.896 (2.299)	
Constant	-28.10 (20.62)	30.25 (24.10)	57.95 (49.62)	29.47 (18.47)
Seasonality	YES	YES	NO	YES
Hansen J (p-value)	0.546	0.177	0.430	0.076
R^2	0.968	0.946	0.803	0.970
Observations	42	42	42	42

*, **, *** indicates that the corresponding coefficients are significant at the level of 10%, 5%, and 1%.

Table 2. Residual supply model estimates for king crab and prepared tuna imported to the U.S.

Variables	King crab		Tuna	
	Russia	Thailand	Ecuador	Vietnam
Import quantities	0.944***	0.912***	-0.379	0.847***
	(0.0925)	(0.100)	(0.547)	(0.228)
Fuel price	0.779***	0.352***	0.344**	0.393***
	(0.230)	(0.0694)	(0.166)	(0.100)
Fish catch	0.188	-0.0658	0.535*	0.420
	(0.133)	(0.0615)	(0.292)	(0.274)
Wage	-0.151	0.0642*	-0.371	1.051**
	(0.550)	(0.0356)	(0.307)	(0.471)
Exchange rate_1	-7.402***	8.06e-05		-0.000784
	(2.264)	(0.000120)		(0.00153)
Exchange rate_2	0.00427**	-0.553		-0.0580
	(0.00213)	(0.789)		(0.479)
Exchange rate_3	4.318***	-0.0261		-1.576**
	(1.092)	(0.124)		(0.644)
Exchange rate_4	0.729	-1.31e-05		
	(0.465)	(9.38e-06)		
Wage_MktA1	5.977***	-3.886***	-3.435	-5.866
	(0.633)	(1.172)	(2.426)	(4.204)
Wage_MktA2	-3.449**	-1.093***	-0.0726	0.0795
	(1.653)	(0.419)	(0.310)	(0.0581)
Wage_MktA3	-7.822***	0.758***	-1.611	2.492**
	(1.402)	(0.274)	(2.335)	(1.027)
Wage_MktA4	2.380***	-3.164***	-0.878*	
	(0.718)	(0.405)	(0.459)	
Constant	22.66	60.83***	68.84	10.57
	(17.00)	(7.969)	(51.41)	(28.81)
Seasonality	NO	NO	YES	NO
Hansen J (p-value)	0.076	0.102	0.565	0.067
R^2	0.940	0.968	0.474	0.924
Observations	43	42	42	42

*, **, *** indicates that the corresponding coefficients are significant at the level of 10%, 5%, and 1%.

5. Discussion and conclusions

Measures influencing the market access are increasingly used to influence seafood production due to sustainability concerns (Brécard et al., 2009; Ankemah-Yeboah et al., 2016: 2020; Bronnmann and Asche, 2017; Roheim et al., 2018; Sogn-Grundvåg et al., 2019). While the most common tools are associated with private measures such as ecolabels, there is an increasing interest in using trade measures against exporting countries with unacceptable production practices. As the largest seafood importing country, the U.S. plays an important role in the global seafood market. The U.S. already has import measures in place for two seafood species, dolphin-safe tuna and excluding turtle bycatch shrimp (Asche et al. 2016; NOAA, 2018d). To address the increasing concerns over the fishery practices related to IUU fishing, seafood fraud, and poor production practices in aquaculture, a pilot for a more comprehensive program was implemented in 2018, requiring some seafood species to provide tracing information as well as documentation of the production process when they enter the U.S. market (NOAA, 2018e).

Whether the imposed trade measures will actually influence exporters' production behavior depends on the extent of the U.S. market power relative to various exporters. If the buyer country (the U.S. in our case) has a high degree of market power, the exporters will have limited access to alternative markets and the trade measures will provide strong incentives for exporters to improve fishery management to comply with the SIMP. The incidence will lead to a sharing of the management costs between producers and U.S. consumers. On the other hand, if the U.S. does not have buyer power, non-compliant producers will just redirect their exports elsewhere and U.S. consumers will have to cover all SIMP costs for compliant producers. In this paper, a residual supply model is developed for an international trade setting to investigate the degree of oligopsony power of the U.S. as an importing market for shrimp, tuna, and king crab for the largest exporting countries to the U.S.

The empirical results indicate a high degree of buyer power of the U.S. for shrimp from Thailand, Indonesia, and India, for king crab from Russia, and for tuna from Thailand and Vietnam. Hence, the SIMP will give strong incentives to reduce IUU fishing in these countries. Somewhat surprisingly, the degree of buyer power of the U.S. for Ecuador is not significant, highlighting that product form/quality may be more important than distance and trade costs for the disaggregated product (Baldwin and Harrigan, 2011; Tveterås, 2015; Straume et al.,2020ab). As a consequence, the SIMP is not likely to provide any incentives for producers in Ecuador to change their practices. In sum, these results are promising for the potential efficiency of the SIMP to lead to positive changes on the water, even though its impact varies with species and countries. However, it is still worthwhile to note that the U.S. having market power is only a necessary condition. Whether the incentives of compliance are strong enough to cover the corresponding costs is an open question.

SIMP measures are a significant change in trade practice as they prescribe general conditions for many seafood species to be imported to the U.S. market, and leave no room for trade itself to help improving production practices.[13] This may pose a challenge particularly to developing countries with limited capacity to manage their seafood production in a way required by SIMP, and these will then also be excluded from the U.S. market. Hence, it is likely that there is an implicit north-south bias in the implementation of SIMP.[14] The measures may also lead to a reallocation of trade patterns if there are countries that currently do not export significant quantities of seafood to the U.S. which can comply with the SIMP at a lower or no cost.[15]

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[13] SIMP requires a consistent filing system for all priority species import to include the header records, permit number, product data, and vessel specific catch information (NOAA, 2019). However, the production practices vary by seafood species.

[14] NOAA modified the rules to implement SIMP for aggregated harvests from small vessels and small-scale aquaculture to help reduce the compliance costs (NOAA, 2019). However, this is likely to miss data and lead to a lack of efficiency for the SIMP implementation in developing countries.

[15] The literature on anti-dumping measures in the seafood market indicates that this may be a real challenge, as is shown for salmon and shrimp (Asche et al.,

In a global market, the number of alternative markets will have impacts on the effectiveness of any trade measure.[16] This will limit the effect of any unilateral action by any country, and this will also be the case for the U.S. SIMP. However, the seafood market is not only global, but developed countries are taking a very high share (>70%) of the imports (Asche et al., 2015; Anderson et al., 2018). These countries are largely the ones that share the U.S. concerns over IUU fishing. Hence, coordinating the U.S. efforts with the EU, in particular, would increase the efficiency of trade measures to combat IUU fishing. The EU has used trade policy to combat IUU fishing for about a decade using a traffic-light based card system (Leroy et al., 2016). However, this is less discriminating than the U.S. system in that it is targeting national management and not specific species.

2016). However, there are also important differences in that the anti-dumping cases targeted at a limited number of named countries, while the SIMP is comprehensive.

[16] Import data of the U.S. and EU show inconsistent restrictions on the import seafood species. Exporting seafood to the EU may not be included in the SIMP, and vice versa (NOAA, 2019). It is thus not surprising to notice that EU has detected many unsustainable fisheries management system since it went into effect, while there are no IUU vessels reported since the SIMP implementation.

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Appendix

The total 2016 U.S. imports of the HTS product codes used in this paper are reported in Table A1 together with the imports from the countries used in the analysis and their share of imports. The development over time is shown in Fig. A.1-A.3.

Table A1. Import value (in million dollars) of investigated seafood products in 2016

King crab	Russia	$263 M
	% share in total imports	92.88%
	Total king crab imports	**$283 M**
Frozen shrimp	India	$1546 M
	% share in total imports	26.34%
	Indonesia	$1135 M
	% share in total imports	19.33%
	Thailand	$852 M
	% share in total imports	14.52%
	Ecuador	$600 M
	% share in total imports	10.21%
	Total shrimp imports	**$5872 M**
Prepared tuna	Thailand	$1076 M
	% share in total imports	42.84%
	Ecuador	$259 M
	% share in total imports	10.32%
	Vietnam	$243 M
	% share in total imports	9.69%
	Total tuna imports	**$2511 M**

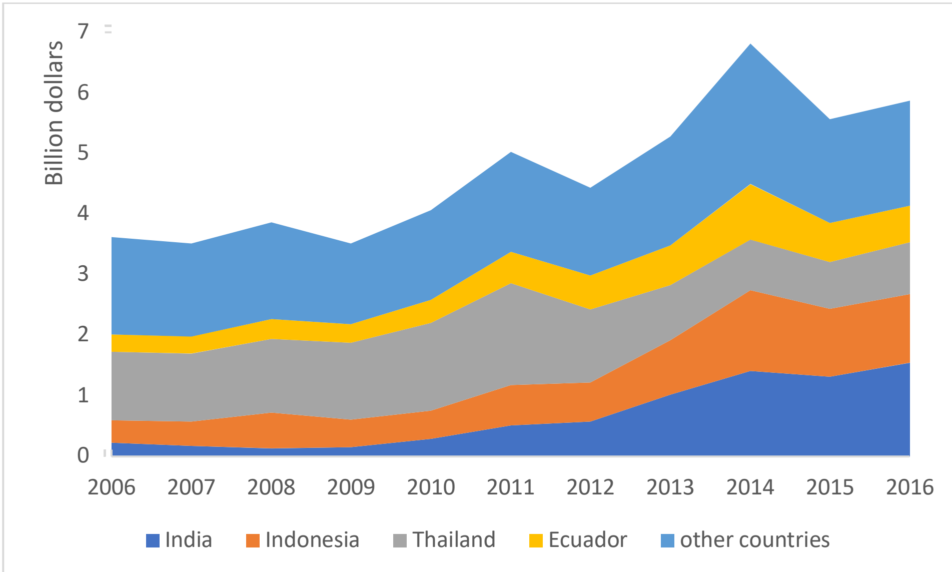

Fig. A.1. Import values of frozen shrimp from different countries (2016=1)

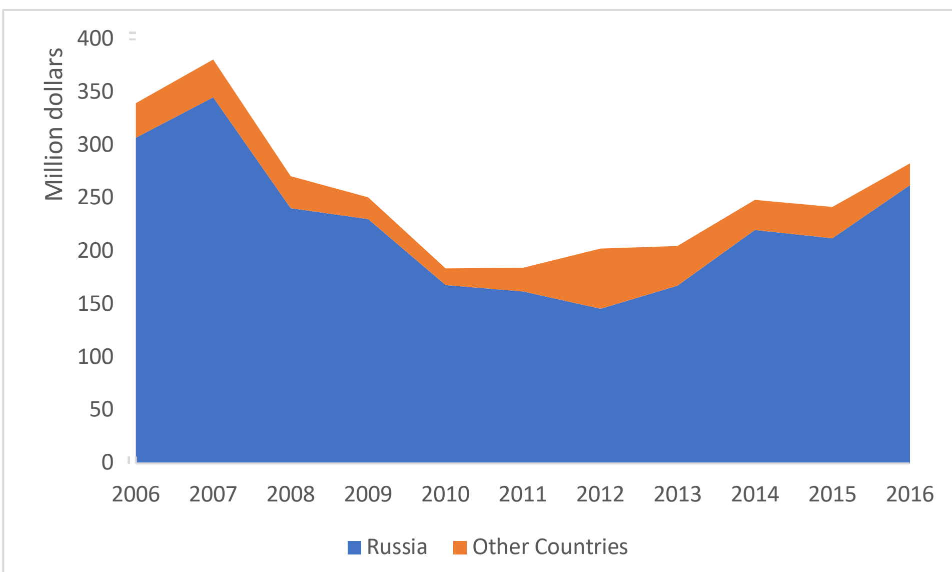

Fig. A.2. Import value of king crab and crabmeat from different countries (2016=1)

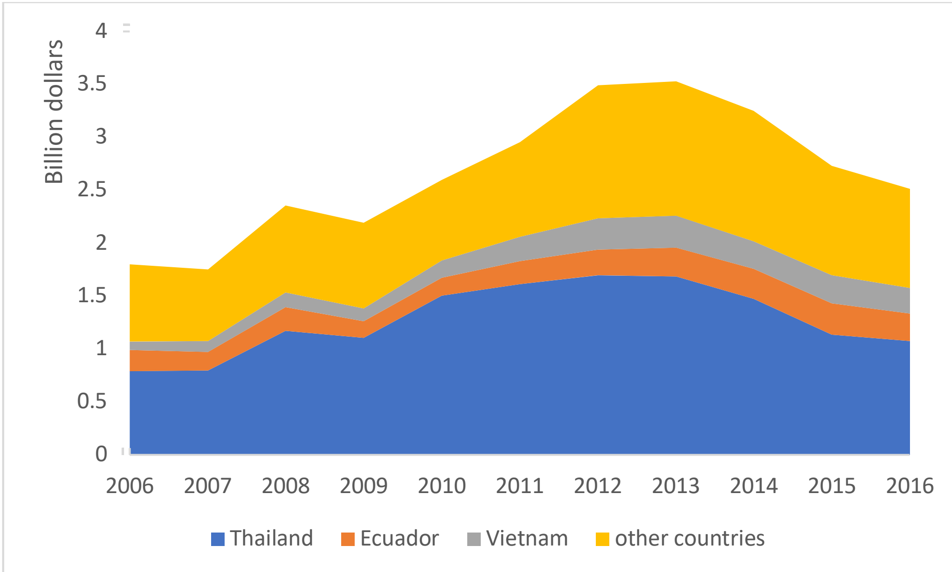

Fig. A.3. Import value of the prepared tuna (HTS code 1604143059, 1604143091, 1604143099, and 1604144000) from different countries (2016=1)