The United States Trade in Fish and Fishery Products: Trends, Determinants, and Competitiveness

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Abstract

The United States is the world's top importer and the eleventh-largest exporter of fish and fishery products, with US$4.5 billion. This study provides a comprehensive analysis of the U.S. trade performance, comparative advantage, and competitiveness in exports, as well as the potential of fish and fishery product exports over the last two decades. Estimates of the gravity model via Poisson Pseudo Maximum Likelihood (PPML) revealed that U.S. exports are significantly influenced by the GDP and population of importing countries, as well as by free trade agreements. Conversely, domestic fish production in importing nations tends to substitute for U.S. exports. The market assessment estimates show that the U.S. had a mixed performance in market utilization with its major trading partners. High performance was observed in countries like Lithuania, the Netherlands, Italy, and Thailand, while share was lost in recent years in South Korea, France, and China. The market utilization rate for the U.S. is close to or slightly higher than the market potential for long-term trading partners, such as Canada and Japan. Revealed Comparative Advantage was used to measure the competitiveness, and the U.S. had a consistent competitiveness in the export of frozen fish (HS 0303), fish fillet and other fish meat (HS 0304), dried/salted/in-brine and smoked fish (HS 0305). For other products, the U.S. had a comparative advantage with a few destinations only. The U.S. can expand its exports through enhancing domestic processing capacity, improving trade facilitation with the EU, strengthening maritime infrastructure, and supporting exporters in meeting international standards.

Keywords: Gravity Model, Revealed Comparative Advantage, Seafood Trade, RSCA, Poisson Pseudo-Maximum Likelihood

JEL Classification Codes: F14, Q22, C23

Introduction

Fish and fishery products or seafood commodities are among the most widely traded food commodities. Approximately 37 % of global fish and fishery commodity production by value enters international trade (Natale, Borrello, and Motova 2015). In 2022, fish and fishery products contributed more than 9.1 % of global agricultural trade (excluding forest products) and nearly 1 % of total merchandise trade by value (FAO, 2024). Increased global fish and fishery product trade has been possible because of improved storage, preservation, transportation, logistics, competitive prices, and trade liberalization policies (FAO, 2024). Technological and logistical advancements have created a complex market chain that has enabled cross-country demand for high-end fresh markets traditionally served only by local fishers and farmers (FAO, 2024). Global exports of fish and fishery products were valued at US$136 billion in 2024, and the United States (U.S.) contributed approximately 3.3% of that value. The U.S. exported US$4.5 billion of fish and fishery products in 2024 (UN Comtrade, 2025). Thus, the U.S. was the 11th-largest exporter in 2024. The U.S. is also the largest importer of fish and fishery products in 2024, importing $21.0 billion (UN Comtrade, 2025). This indicates that the U.S. imports significantly more seafood than it exports. Consequently, the U.S.'s 70 % to 85 % seafood consumption is met by imports (NOAA, 2021).

Unfortunately, the COVID-19 pandemic significantly disrupted international trade, including the seafood sector, causing a decline of 6.7 % in 2021 compared to 2019. However, it rebounded in 2022 and 2023. Like other countries, the U.S. was affected but still played an important role in global fish and fishery production and trade. U.S. fish and fishery product imports, adjusted for inflation, increased in value by 133 % from 1995 to 2021 but declined by 19.7 % from 2021 to 2023. These figures indicate the volatility of international trade, especially during major shocks such as the COVID-19 pandemic and the resulting inflation, which raised food security concerns. Despite having extensive natural resources, including coastlines, inland waters, and fisheries infrastructure, the U.S. seafood export sector remains underdeveloped relative to its reliance on imports. Understanding U.S. fish and fishery product export performance is essential, as expanding markets may help reduce the trade deficit, support coastal economies, grow the seafood industry, and improve global food security.

Several methods have been developed to assess the determinants of international trade. According to Ricardian trade theory, a country's export competitiveness plays a key role in shaping trade flows. As such, the literature has widely applied either the Ricardian (classical) model or the revealed comparative advantage (RCA) approach (Yercan and Isikli 2009). The RCA approach, developed by Balassa (1965), is based on trade patterns that reflect relative costs and differences in non-price factors (Zawalinska 2002). However, the Balassa index lacks additivity and is asymmetric, which may result in biased estimates (Vollrath 1991; Dalum, Laursen, and Villumsen 1998; Danna-Buitrago and Stellian 2022). To address these limitations, Dalum, Laursen, and Villumsen (1998) proposed a quasi-logarithmic transformation of the Balassa index, yielding the RSCA index, which ranges from -1 to 1 and allows clearer differentiation between comparative advantage and disadvantage. These indices are especially relevant in the context of U.S. fish and fishery product trade, where a persistent trade deficit and high import dependence suggest potential competitiveness challenges. While gravity models help identify determinants of trade volumes, RCA and its derivatives offer direct measures of export strength, revealing whether the U.S. holds a comparative advantage or disadvantage in specific fishery products. Thus, integrating gravity modeling with competitiveness indicators enables a more comprehensive assessment of U.S. fish and fishery product trade performance in a globalized and volatile market environment.

The gravity model of trade is also a key technique used to assess determinants of trade apart from measuring a country's competitiveness. Tinbergen (1962), inspired by the Newtonian 'force of gravity' function, developed a basic gravity model of trade to explain the trade flow between countries. However, it was criticized for lacking a theoretical framework (Kabir et al., 2017). Later, Anderson (1979), based on Armington's (1969) assumption, applied Cobb–Douglas and CES production functions to the gravity model to provide a stronger theoretical foundation. The basic gravity model examines trade flows based on gross national income of the trading countries and their geographical distance (Kabir et al., 2017). Subsequent work on the gravity model added more regressors, such as trade cost variables (distance, contiguity, language), population, food consumption, primary production, sea access, exchange rate, tariff rates, and trade or regional agreements (Bojnec and Fertő 2011; Taguchi 2013; Tay 2014; Krisztin & Fisher, 2015; Natale, Borrello, and Motova 2015; Aguirre González et al. 2018; Sheikh et al. 2019; Sinaga et al. 2019; Simdi and Unal, 2022; Pal and Sarkar 2023; Pfaffermayr 2023; Zhai 2023; Kuempel et al. 2024; Mai and Wang, 2024; Nga and Xoan 2024; Zeneli, Benga and Hoti 2024; Khmeleva et al. 2025).

This article adds to the literature in several ways. First, it uses multiple methods to focus on U.S. fish and fishery product exports, particularly using post-pandemic data. From a methodological point of view, this paper deviates from the commonly used Ordinary Least Squares (OLS) approach by applying the Poisson Pseudo Maximum Likelihood (PPML) method with country-specific and time fixed effects. In recent years, the PPML estimator has been widely applied in gravity models of international trade (Anderson and Yotov 2016; Simdi and Unal, 2022; Zhai, 2023; Pal and Sarkar, 2023; Alamri et al., 2025; Khmeleva et al., 2025). The advantages of the PPML over OLS are discussed in the methodology section. From a model-specification perspective, it expands on the gravity model by incorporating the Liner Shipping Bilateral Connectivity Index (LSBCI) to observe connectivity and trade costs. Moreover, the model includes seafood production and demand in the importing nation, enhancing the model's accuracy. The rationale for the inclusion of these variables in the augmented gravity model is explained in the methodology section. The paper also identifies and discusses the prospects of the U.S. fish and fishery product sector in the different markets, which have been largely unexplained in previous literature. Therefore, this study's research objectives can be summarized as the following: (i) Identify the major export destinations in recent years for U.S. fish and fishery products trade. (ii) Assess the determinants of exports for the U.S. Fish and fishery products trade using covariates from the gravity model. (iii) Identify which trade partners and product groups exhibit underperformance or unexploited trade potential based on econometric estimations. (iv) Estimate the level of comparative advantage and competitiveness of the U.S. fish and fishery exports.

Data and Research Methodology

Data Source

We have used open-access data from multiple sources: UN Comtrade, UNCTAD, FishStatJ of the Food and Agriculture Organization (FAO), CEPII, and the World Development Indicators (WDI). The UN Comtrade database compiles detailed trade statistics submitted by governments, academic institutions, research organizations, and private enterprises. The database comprises approximately 200 countries and represents over 99% of the world's merchandise trade. We have downloaded fish and fishery product trade flow data from the UN Comtrade. The United Nations

Trade and Development Data Hub, i.e., UNCTAD, provides free access to basic and derived trade indicators. These indicators are developed using common rules, within a harmonized environment, and supported by a clear methodology (UNCTAD, 2024). We have used the Liner Shipping Connectivity Index (LSCI) and its extension, the Liner Shipping Bilateral Connectivity Index (LSBCI), from UNCTAD. LSCI measures a country's integration into global liner shipping networks, and LSBCI focuses on the bilateral integration level between two countries (available quarterly since 2006). A higher value of LSBCI is associated with better connectivity. The LSCI index value is set to 100 for the average across countries in February 2023. The LSBCI index ranges from 0 to 1. FishStatJ is a desktop application containing FAO data on fish and aquaculture production, trade, and consumption from over 200 countries, covering the years 1950 to 2022. The "Global Production by Production Source" dataset provides annual series on both capture fisheries and aquaculture production since 1950, disaggregated by country, species, and region. This study used the combined total of capture and aquaculture production for each country. To evaluate the effects of geographic proximity, diplomatic relations, and regional trade agreements, this study used the CEPII Gravity database (version 202211), which is widely applied in gravity model analyses. The dataset covers bilateral international trade from 1948 to 2021, with each observation representing a specific exporter-importer pair by year. It includes variables such as bilateral distance, cultural ties, and trade agreements. Gross Domestic Product (GDP, used to capture the size of trading economies, was sourced from the World Development Indicators (WDI) database provided by the World Bank. Table 1 summarizes the selected regressors, their data sources, and their characteristics. All regressors were retained based on their contribution to models with the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values.

The list of variables used in the study is shown in Table 1.

Table 1: Variable descriptions and data sources

Variable	Description	Source
Dependent Variable		
U.S. Fish exports	Value of the Fish and Fishery product in U.S. Trade Value (US$).	UN Comtrade
Independent Variable		
GDP of the importing Country	The importing country's Gross Domestic Product at that time (Constant 2015 US$).	World Bank
Population of the importing country	The total population of the importing country at that time.	World Bank
The distance between the capitals of trading economies	Geodesic distance between capital cities (km)	CEPII Gravity Dataset[1]
Total amount fish products imported by the importing country	Value of the Fish and Fishery product in U.S. Trade Value (US$)	UN Comtrade
Fish production in the importing country	Tons in live weight	FAO FishStatJ
1 = Free Trade Agreement between the economies	1 if the importing country has a free trade agreement with the U.S.	Dummies generated from World Bank Global Preferential Trade Agreements Database
1 = The Importing Country is an EU member	1 if the importing country is an EU member, unilateral	CEPII Gravity Dataset
1= The Importing Country is a WTO member	1 if the importing country is a WTO member, unilateral	CEPII Gravity Dataset
Liner Shipping Connectivity Index	A quarterly index compiled by UNCTAD that scores each economy's integration into global container-shipping networks. It combines five components (number of scheduled services, distinct shipping companies, deployed vessel capacity, size of the largest ship, and number of ports called) into a scale where 2023 = 100; higher values indicate better maritime connectivity and thus greater potential for seaborne trade.	UNCTAD Data Hub

[1] Data on GATT, WTO membership, and RTA in CEPII is based on WTO

Analytical Methods

We have used both descriptive and quantitative methods to assess trends in exports and imports, determinants of exports, comparative advantage, and competitiveness in fish and fishery products exported by the United States.

Trends in exports and imports of fish and fisheries products by the United States

To analyze the trends in fish and fishery products trade over time, we have depicted the value of exports and imports over time graphically for all the study years (2001 to 2024). To examine the growth situation, we have estimated the annual compound rate of growth of exports and imports by the U.S.

Gravity model for estimating determinants of U.S. exports

To evaluate the determinants of fish and fishery products exported by the U.S., we have used the gravity model. The dependent variable of the model is the value of exports of the U.S. fish and fishery products to the partner country. The traditional gravity model is shown in equation (3). Thus, based on the literature, this paper has selected the Gross Domestic Product (GDP) per capita of the partner country (j)[2] as the economic size, market potential. We have included the distance between the two economies' capitals and the countries' integration level into global trade to measure the transportation cost (Simdi and Unal 2022; Khmeleva et al 2025). UNCTAD (2024) reports that seaborne trade accounts for over 80 % of international trade by volume, and about 70 % by value. About 66 % of this seaborne trade by value is conducted through regular liner shipping services. Therefore, adding LSBCI to a gravity equation can provide a stronger estimate as a determinant of trade flow as it embeds infrastructure quality, route density,

[2] Only importing country was selected because the U.S. was the sole exporter in our model, so there was no variation in the exporting nation.

competition, ship size, and trans-shipment needs, all key drivers of logistic costs. Wilmsmeier and Martínez-Zarzoso (2009) first documented this effect for LSBCI; Fugazza and Hoffmann (2017) confirmed it by showing that inclusion of LSBCI in the gravity equation drastically reduced the coefficient of distance but significantly boosted the coefficient of determination. Moreover, unlike different distance indicators, it is not time invariant and does not drop out when fixed effect is added to the equation. However, the LSBCI data is limited to 2021. Thus, this study ran three PPML regressions to consider the distance effect. The first is using LSBCI with fixed effects. Second, with a traditional distance variable and LSCI without fixed effects, to have a greater capture of the effect of traditional distance. The third is LSCI with fixed effects to cover a greater period and still provide a partial understanding of the importing country's connectivity and port-related bureaucratic efficiency.

$$Trade_{ijt} = G \cdot \frac{GDP_{it} \cdot GDP_{jt}}{Dist_{ijt}} \tag{3}$$

Equation (4) presents the natural log-linear transformation of the gravity model with added variables. Tay (2014) and Aguirre González et al. (2018) have applied additional regressors mentioned above to explain the trade flow, referred to it as an augmented gravity model. The $\beta_n X_{njt}$ represents the estimations for each regressor added to the model, and ε_{jt} is the error term. n is the number of regressors, and j is the importing country for time t. Thus, alongside traditional variables, this paper has included variables such as free trade agreements (FTAs). FTAs are dummies that are in force based on the Global Preferential Trade Agreements Database, and trade bloc memberships (e.g., EU, WTO) as additional regressors (Anderson and Yotov 2016; Aguirre González et al. 2018; Alamri et al., 2024; Zeneli, Benga, and Hoti 2024). Natale, Borrello, and Motova (2015) used food production and consumption to analyze fish and fishery product trade. Thereby, in this study, we adopted a supply-side perspective by including the total fishery production in the importing country and a demand-side perspective by including the total fish and fishery product demand from the world for the importing country. The list of regressors is shown in Table 1 above.

$$ln\left(US\ fish\ Export_{ijt}\right) = \beta_0 + \beta_n X_{njt} + \varepsilon_{ijt} \quad (4)$$

The log-linear model typically uses pooled OLS or panel effect estimations, causing loss of information due to the removal of zero trade flows, inefficient estimates, and sample selection bias (Shahriar et al. 2019). Hence, several recent studies on the gravity model of trade have increasingly employed the Poisson Pseudo Maximum Likelihood (PPML) estimator introduced by Silva and Tenreyro (2006). Correia, Guimarães, and Zylkin (2020) further highlight the superiority of the PPML estimation method. PPML accommodates zero trade flows by modeling trade in levels rather than logs, using an exponential function of the regressors (Anderson and Yotov 2016; Shahriar et al. 2019). PPML also addresses the limitations of OLS and non-linear least squares, producing consistent estimates under heteroskedasticity and ensuring positive fitted values. Following Correia et al. (2020) and Simdi and Unal (2022), importer and year fixed effects were included to account for unobserved heterogeneity. Standard errors were clustered at the importer level to account for autocorrelation within countries over time.

$$Export_{ij} = exp^{\beta_0 + \beta_n X_{njt} + \varepsilon_{jt}} \quad (5)$$

Analysis of expected trade opportunities and market utilization rate

In this study, we followed Alamri et al. (2024) and Khmeleva et al. (2025) methods to calculate the export potential for the U.S. with its trading partners. First, the expected export between the

U.S. (i) and the importing country (j) during period (t) was predicted using the PPML estimation. Equation (6) was used to calculate the adjusted expected export EX^{*}_{ijt}.

$$EX^{*}_{ijt} = \frac{\hat{E}X_{\mathrm{ijt}} \times (\Sigma_{\mathrm{j}}\, EX_{\mathrm{ijt}} - EX_{\mathrm{ijt}})}{(\Sigma_{\mathrm{j}}\, \hat{E}X_{\mathrm{ijt}} - \hat{E}X_{\mathrm{ijt}})} \tag{6}$$

Equation (7) was then used to estimate the trade potential PC_{ijt} of fish and fishery products between countries during period t as the arithmetic mean of the expected and adjusted exports.

$$PC_{\mathrm{ijt}} = \frac{(\hat{E}X_{\mathrm{ijt}} + EX^{*}_{ijt})}{2} \tag{7}$$

Revealed comparative advantage in export

As outlined above, in this paper, we have used the RSCA to compute the comparative advantage of the United States fish and fishery product exports. The RCA formula is shown in equation (1), and the RSCA index, based on Dalum, Laursen, and Villumsen 1998, was generated through the quasi-logarithmic transformation of the Balassa index, as shown in equation (2).

$$RCA_{US,i} = \frac{\left[\frac{x_{ij}}{Xit}\right]}{\left[\frac{x_{wj}}{X_{wt}}\right]} \tag{1}$$

$$RSCA_{US,\,i} = \frac{RCA_{US,\,i} - 1}{RCA_{US,\,i} + 1} \tag{2}$$

Where, $RCA_{US,i}$ is the RCA index for the export of fish products from the United States to the economy/region i; x_{ij} is the value of export of product j from the U.S. to the economy/region i; x_{wj} is the value of the export of product j from the U.S. to the world. X_{it} is the value of total fish products from the U.S. to the economy/region i; and X_{wt} is the total export value of fish products from the U.S. to the world. For simplicity, we are reporting the top ten export destinations in the last year for the U.S. for the comparative advantage analysis. This is because it allows for a clearer identification of patterns in comparative advantage to the larger export destinations, as these countries represent the most significant shares of U.S. trade. Furthermore, it reduces noise from small trade flows. It also enhances the reliability and economic interpretability of the RSCA results, our findings' reliability, and policy relevance.

Results and Discussion

Trends in U.S. trade in fish and fishery products

Figure 1 shows the trends in the United States' export and import values of fish and fishery products to and from the global market over the period 2001 to 2024. The data reveal a persistent trade deficit in the fish and fishery sector, with imports consistently surpassing exports throughout the entire study period. In 2001, U.S. fish and fishery product exports were valued at approximately US$ 2.84 billion, while imports stood at US$ 7.86 billion. Over the years, both exports and imports showed a general upward trend, albeit with varying growth rates and intermittent fluctuations. Notably, exports experienced a steady increase from 2001 to 2014, peaking at US$ 5.26 billion. However, this growth plateaued afterward, with slight declines in subsequent years, reaching US$ 4.51 billion by 2024. Between 2001 and 2024, the United States' total exports of fish and fishery products increased by 58.8 % with an annual growth rate of 2.35 %.

Imports demonstrated a more pronounced and consistent rise, surging from US$ 7.86 billion in 2001 to a peak of US$ 25.19 billion in 2022. The sharpest annual increase occurred between 2020 and 2021, likely driven by post-pandemic recovery and heightened domestic demand. Since 2022, import values have slightly declined, stabilizing at around US$ 21 billion in 2023 and

2024. Between 2001 and 2024, the United States' total imports of fish and fishery products increased by 167.4 % with an annual growth rate of 4.76 %.

The widening trade gap—evident from the increasing difference between import and export values—signals a growing reliance on foreign fish and fishery products. This structural imbalance in trade emphasizes the need for strategic policy interventions aimed at enhancing domestic competitiveness, diversifying export markets, and reducing dependency on imports. Furthermore, the post-2020 volatility may reflect the impacts of COVID-19, supply chain disruptions, and inflationary pressures on global seafood trade.

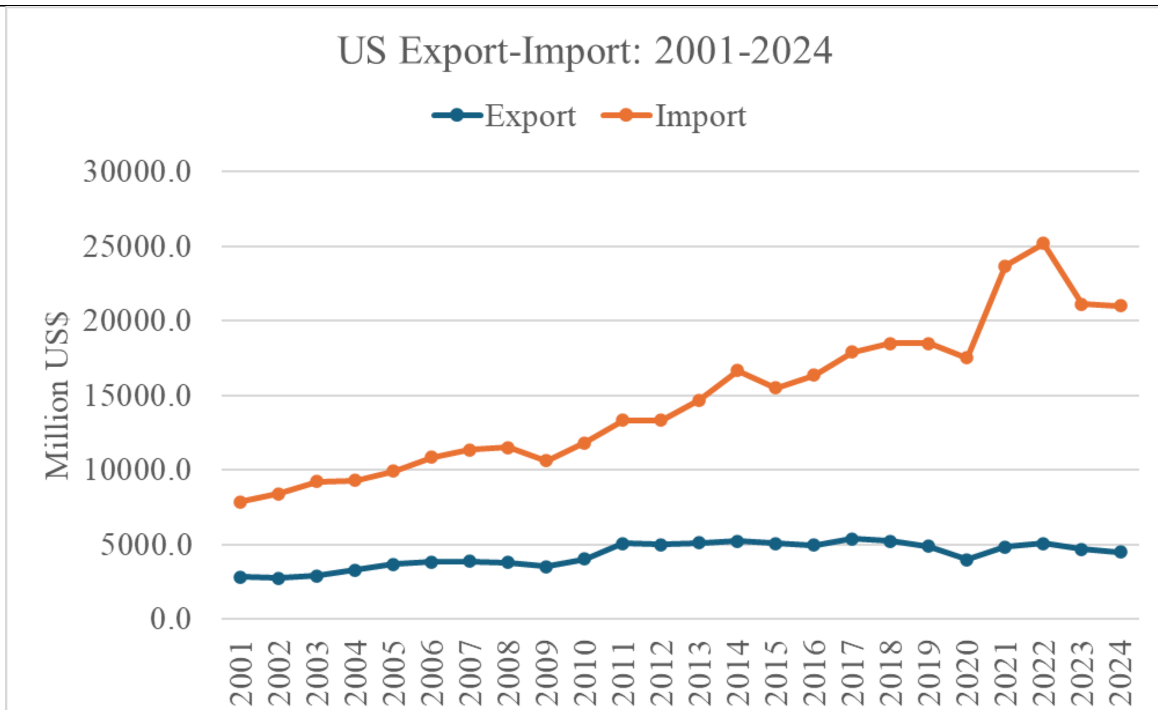

Figure 1: Trends in fish and fishery products trade by the United States, 2001 to 2024.

Determinants of fish and fishery products exports

Table 2 shows the estimates of the gravity model using the PPML method under three different equations. Column (1) incorporates the bilateral Liner Shipping Bilateral Connectivity Index with fixed effects (importer × year). Column 2 incorporates the distance between the capital. Column (2) is regressed without the fixed effect as the distance is time-invariant and is dropped under the fixed effect condition. As the LSBCI is limited to 2021, column (3) estimates the regression with LSCI, which has data up to 2023 and provides post-pandemic estimation.

In line with the theoretical model, the importing country's GDP acts as an important determinant for the U.S.'s fish exports. Under importer fixed and time effect in columns (1) and (3), the GDP size of the importer exhibits a positive and significant value. The coefficient on partner GDP in column (3) is approximately 0.66 ($p < 0.05$), implying that a 1% increase in GDP is associated with a 0.66% rise in U.S. exports, ceteris paribus. As noted earlier, larger, wealthier economies import more, especially high-value food products. The point estimate implies, for example, that as China's income has grown, its demand for premium seafood (like U.S. lobster and shellfish) has risen commensurately (F.A.S. Beijing Staff 2019). The smaller, insignificant coefficient in Model (2) underscores the necessity of accounting for multilateral resistance through fixed effects, consistent with prior gravity model literature (Head & Mayer, 2014). Moreover, under fixed-effects specifications, the GDP effect is measured by within-country income changes over time, and remains positive, reinforcing that income growth in a given country tends to boost its imports from the U.S. (all else equal). Additionally, larger populations in importing countries are also associated with higher U.S. fish and fishery product exports to them, significant at the 1% level in columns (1) and (3). This result indicates a strong aggregate demand effect for food commodities, based on population growth alone. The results indicate that a 10% larger population corresponds to roughly a 21–29% increase in export volume, holding GDP constant. A similar positive and significant finding was found by Nga and Xoan (2023) for Vietnamese canned tuna exports, whereas Sheikh et al. (2019) identified a positive and significant relationship between population and total trade commodities.

As mentioned earlier, international connectivity provides a measure of maritime transport costs more than geographical distance (Wilmsmeier and Martínez-Zarzoso 2009). Nevertheless, column (2) was generated to provide an estimate of how the current equation performs for a traditional gravity model variable. The distance between capital cities was used as it captures the connectivity between the busiest hubs. Estimates show a negative and significant relationship between exports and distance (-0.66, p<1%), implying that a 10% increase in distance decreases the United States' fish and fishery product exports to that country by 6.6%, aligning with the traditional theory. However, the connectivity indexes in columns (1) and (3) suggest that geography is not a significant barrier to U.S. fish and fishery product exports. This is consistent with descriptive findings, as key U.S. destinations include Asian countries such as China, Hong Kong, South Korea, and Thailand. Technological advancements in freezing and processing have facilitated long-distance fish and fishery product trade (FAO 2024). Our fixed-effects results confirm that once we account for importers' inherent characteristics, the simple distance effect is statistically negligible. Nevertheless, the direction of the maritime connectivity index still has implications for the U.S. fish and fishery product exports, especially for the bilateral maritime connectivity based on column (2). The results imply that increased bilateral maritime connectivity substantially enhances trade potential, reinforcing findings from Fugazza and Hoffmann (2017).

The estimations also included importing countries' domestic fish production and total fish imports from other countries to assess any crowding-out effect on the U.S. fish and fishery exports. In the fixed-effects models, there seems to be an indication of the crowding effect as the U.S.'s fish export is negatively but significantly associated with the importing country's domestic fish production, which is consistent with a degree of substitution or self-reliance. However, in column (2), the domestic production is positively associated, albeit statistically insignificant, with partial complementarities in some cases, likely for species differentiation or re-export. Large fish-producing countries often have stronger processing capacity. Consequently, it may have created greater demand for specialized inputs or intermediate fish and fishery products (Natale, Borrello, and Motova 2015; Asche et al. 2022). In model 2, the partner country's fish and fishery product imports from the world are positively and significantly correlated with the fish and fishery products from the U.S. The findings align with Khmeleva et al. (2025) findings of trading partners having a simultaneous increased grain and wheat imports from Russia and the world. However, under the importer fixed effect specification, it loses its significance but still retains the positive association. A potential reason for the loss of significance is that other factors, such as income and population, subsume some of the impacts. In summary, the domestic fish production of the importing country can have a substitution effect, but total increases in fish and fishery product demand will have a complementary effect.

The estimations also stress the importance of trade agreements and institutional memberships in order to boost U.S. exports. As supported by numerous other studies (Anderson and Yotov 2016; Aguirre González et al. 2018; Simdi and Unal 2022), having a free trade agreement can significantly boost the U.S. fish and fishery exports; as evident by the positive and significant coefficient on the FTA dummy (around 0.10 in Model 1 and 0.16 in Model 3). This does not necessarily mean that having an FTA will always increase exports. Simdi and Unal (2022) identified that having FTAs only increased South Korea's iron, steel, copper, and aluminium and related products. Nga and Xoan (2023) did not find any significant impact of FTA on Vietnam's canned tuna exports, due to potential strict regulations on edible imported products. However, in our case, the estimate indicates a positive and significant relationship, indicating the strength of the regulatory framework of the U.S. fishery industry. WTO markets offer beneficial trade frameworks, standards harmonization, or reduced tariff uncertainties (Baier and Bergstrand 2007). However, WTO membership or EU membership for the importing country did not significantly affect fish and fishery product exports in this model, although the negative association with the EU countries indicates a lower export volume to those destinations compared to the rest of the world. A potential reason for lower exports to European Union members is the EU policy of importing seafood from approved countries and from approved establishments, limiting choices (Pinckaers 2018). Thus, from a policy standpoint, this underlines a need for targeted efforts to reduce trade frictions with the EU. For instance, helping U.S. exporters comply with EU certification, addressing specific bans or restrictions, negotiating mutual recognition of standards, and establishing better connectivity with the approved countries to help close this gap. Most of the U.S.'s free trade agreements or regional trade agreements are in the American continents, with a few being in East Asia (Singapore, South Korea, and Australia) and a couple in the Middle East (Israel and Jordan).

Briefly, the PPML with fixed effect specifications estimates that the economy size and friction factors (trade agreements) play a significant role in facilitating the United States fish and fishery product exports. While positive, the connectivity proxy, fish demand, and WTO membership for trading partners do not significantly affect U.S. fish and fishery exports. Meanwhile, the importing country’s domestic production has a substitution effect.

Table 2: Estimations of the U.S. fishery export determinants

Variables	LSBCI with Fixed Effects (2006–2021)	LSBCI and distance without Fixed Effects (2006–2021)	LSCI with Fixed Effects (2006–2023)
ln(GDP) of the importing country	0.53*	0.16	0.66**
	(0.27)	(0.19)	(0.32)
ln(population) of the importing country	2.87***	-0.21	2.10***
	(0.82)	(0.19)	(0.67)
LSBCI index	0.53	1.40***	
	(0.42)	(0.42)	
ln(distance) between the capitals of two trading countries		-0.66***	
		(0.080)	
ln(fish production) in the importing country	-0.35***	0.17	-0.18*
	(0.12)	(0.10)	(0.11)
ln(fish demand) of the importing country from the world	0.11	0.89***	0.30
	(0.23)	(0.13)	(0.25)
1 = If active free trade agreement between the countries	0.12***	0.21	0.16***
	(0.041)	(0.20)	(0.041)
1 = If the importing country is an EU member	-0.0019	-0.89***	-0.065
	(0.18)	(0.24)	(0.058)
1 = If the importing country is a WTO member	0.31	-0.95**	0.0028
	(0.19)	(0.40)	(0.045)
LSCI index value			-0.0010
			(0.00099)
Fixed Effect	Yes	No	Yes
Constant	-45.4***	1.38	-41.1***
	(14.0)	(2.10)	(11.2)
Observations	1,774	1,706	2,031

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Source: Authors' calculation.

Assessment of the potential and expected trade opportunities and market utilization rate

Following the PPML estimations, the next step involved identifying potential trade opportunities and assessing utilization rates, as shown in Table 3. Model 3 of the PPML estimation was used to predict the trade values, as those variables have the longest observation period. Table 3 presents the average export value to each country over three distinct periods (2006-08, 2017-19, and 2021-23). Table 3 additionally reports the trade potential (PC_{ijt}), calculated using Equations 6 and 7. To maintain clarity, the analysis focuses on the top ten U.S. fish and fishery product export destinations over the last three years (2021-23). These countries accounted for 95% of the U.S. fish and fishery product destination by valuation in 2023 and 83% if considering the average of 2021-23. In Table 3, a 100% utilization rate indicates that the market is fully utilized. Utilization rates below 100% suggest untapped potential, with lower values indicating greater room for export expansion. Values above 100% imply that U.S. exports are exceeding predicted levels in a given market.

Calculations indicate Canada, Japan, France, the Netherlands, and South Korea were consistently among the largest destinations for the U.S. fish and fishery products. The U.S. has consistently performed near or slightly better than its potential for Canada, Japan, and South Korea. The U.S.'s export performance with China was mixed, having increased exports and market utilization in 2017-19 (97%) compared to 2006-08 (86%), but then decreased exports in 2021-23 (88%). This market volatility could be linked to trade tensions and pandemic disruptions. Similarly, vitality was observed for Hong Kong as well. On one hand, reduced export value and market utilization were observed for South Korea and France, but they still show strong market utilization. These countries have large economies and established trade ties with the U.S, enabling a strong market utilization. On the other hand, the U.S. fish and fishery products export and market utilization increased significantly in Lithuania, the Netherlands, Italy, and Thailand, especially in recent years, and thus overperformed in market utilization. Data from FishStatJ indicates that in recent years (2019-2022), the U.S. has exported millions worth of frozen Alaska pollock, sockeye, and Pacific salmon, frozen hake, surimi, and salmon roe. Consequently, the U.S. achieved a comparative advantage with them in HS 0303 (Frozen fish excluding fish fillets and other fish meat of heading) and HS 0304 (Fish fillets and other fish meat, whether or not minced, fresh, chilled or frozen). ASMI (2022) reported that Lithuania is a major processing hub in Europe and had 95 fish processing companies across the country in 2018. ASMI (2022) reported that it imports Alaskan pollocks, pink and sockeye salmon for reprocessing towards major European retailers. Salmon roe is redirected towards Eastern Europe. The U.S's export to Thailand also increased to serve Thailand's growing appetite for raw materials for its seafood industry and increased income among its nationals (Ngamprasertkit 2018). The U.S. primarily exported frozen tuna, salmon, and Alaska pollock, and live lobsters and frozen crab meat to Thailand. Thailand also imported a small number of scallops and anchovies from the U.S. Alaskan pollock serves as an important ingredient for Thai surimi. Moreover, Maine lobster, Alaska King crab, Alaska King crab legs, cod, mussel, and salmon are imported into Thailand for high-income individuals, convenience, and restaurant chains to serve its large tourism industry (Ngamprasertkit 2018). Nevertheless, there is significant room for growth in Thailand, especially value-added products, as they import 25% of their crustaceans (crabs, lobsters, rock lobsters, shrimps) from Argentina, salmon from Norway, and tuna from Malaysia. These products are in the export inventory of the U.S. The huge potential in Thailand can also be understood from Table 5, which reflects that the U.S. only recently achieved comparative advantage in HS 0303. This also coincides with the increase in trade utilization in Table 4.

Similar to Lithuania, the Netherlands acts as a gateway for the U.S. to enter the European market. This is reflected based on FishStatJ data, and Pinckaers (2018), that Alaska pollock, Hake, and sockeye salmon dominate the U.S. fish and fishery exports to the Netherlands. Additionally, a significant amount of shell, smoked, dried, salted/in brine shellfish and scallops have been exported to the Netherlands, reflecting a consistent RCA for HS 0305 (Fish, fit for human consumption, dried, salted or in brine; smoked fish) in Table 5. Nevertheless, there is significant potential for the U.S. lobster, squid, oysters, and scallops, and processed seafood in the Netherlands (Pinckaers 2018). Doing so should shift more categories towards comparative advantage for the U.S. over the Netherlands. Unlike other European countries in this study, Italy's import of U.S. fish and fishery products has been driven by domestic consumption rather than reexports. The U.S. has become a notable supplier of specific premium products such as the American lobster (*Homarus americanus*). The U.S.-raised lobsters have been popular in Italy and were the highest valued export from the U.S. to Italy, and are reflected in Table 5, with the U.S. having a consistent comparative advantage in HS 0306 (Crustaceans). Furthermore, data show that Italy has increased its imports of frozen salmon, Hake, and squid rings, shifting the U.S. comparative disadvantage to comparative advantage in recent years. CBI (2021) notes that Eastern European countries import significant amounts of Alaskan pollock and salmon fillets from China. As noted earlier, Alaskan pollock and salmon are not native to China. Lithuania, China, and the Netherlands re-export these from the U.S. Thus, if the U.S. invests in its processing units and actively develops its trade policy, it can capture US$140 million in Eastern Europe. This US$ 140 million is the value of pollocks and salmon fillets that Eastern Europe imported from China in 2019. Southern European countries import approximately 82% of their fish and fishery products from developing nations and have a high per capita consumption ranging from 30 to 40 kg (CBI, 2021). These trends highlight a substantial market opportunity for the U.S., particularly for high-value crustaceans, mollusks, and tuna species native to U.S. waters. The per capita fish and fishery product consumption is much lower in Northwestern Europe than in Southern Europe. However, in value terms, Northwestern European countries exhibit strong demand for pollock, cod, and Atlantic bonito tuna. They imported approximately $1.4 billion worth of processed pollock, pangasius, and cod products from China in 2019, along with $1.2 billion of preserved skipjack and Atlantic bonito tuna (CBI, 2021). Accordingly, the U.S. should provide technical assistance to its fish and fishery product industry to support compliance with EU regulations, strengthen institutional engagement, and enhance sectoral competitiveness. These measures are essential to increase export volumes and expand market share in the European Union.

Table 4 offers insights into countries with the sharpest shifts in trade utilization, identifying significant market contractions and expansions between 2006-08 and 2021-23. Among the analyzed countries, the United States' fish and fishery product exports exhibited the most severe reduction in utilization in Gabon, followed by Egypt, Bulgaria, Gambia, and Kuwait. Conversely, substantial increases in trade utilization were observed in Pakistan, where the U.S. heavily overperformed and saw an increase in market utilization by 364%. The increased export is primarily driven by Alaskan pollock and fish body oil. However, there was no consistent pattern of the U.S. fish and fishery products to these countries, and the effect seems temporal. These findings corroborate Alamri et al.'s (2024) findings that evaluating trade potential through expected exports based on structural characteristics provides more actionable insights than comparisons of absolute trade volumes alone.

Table 3: Mean actual exports, potential trade opportunities, and utilization rates for the top 10 fish and fishery products destinations for the U.S. (2021-23)

Export Destination	Actual Exports (US$ millions)	Potential (Expected) Exports (US$ millions)	Trade Utilization (%)
	Average of 2006-08		
Canada	735.18	746.38	99%
China	504.63	586.64	86%
Hong Kong	49.42	101.35	49%
France	150.08	134.32	112%
Italy	73.32	75.91	97%
Japan	825.19	739.87	111%
Lithuania	20.85	38.44	54%
Netherlands	150.66	198.17	76%
South Korea	342.38	315.35	108%
Thailand	45.86	52.63	87%
	Average of 2017-19		
Canada	1006.19	1048.85	96%
China	1053.91	1092.93	97%
Hong Kong	190.70	156.54	122%
France	156.02	146.11	107%
Italy	73.34	77.97	94%
Japan	786.74	754.93	104%
Lithuania	51.45	40.86	129%
Netherlands	293.64	236.00	125%
South Korea	485.11	458.49	107%
Thailand	89.89	79.16	114%
	Average of 2021-23		
Canada	1170.28	1099.01	107%
China	884.16	1001.03	88%
Hong Kong	146.57	143.39	103%
France	126.69	141.19	89%
Italy	82.96	70.14	118%
Japan	675.97	612.20	111%
Lithuania	78.74	36.87	216%
Netherlands	366.66	254.04	144%
South Korea	424.57	407.98	105%
Thailand	86.87	66.41	130%

Source: Authors' calculation.

Table 4: Countries Showing the Five Greatest Gains and Losses in U.S. Fish-Export Utilisation Rates, 2006-08 vs. 2021-23

Export Destination	Average (2006-08)	Average (2021-23)	Change
Gabon	595%	9%	-586%
Egypt	428%	7%	-421%
Bulgaria	334%	28%	-307%
Gambia	310%	8%	-302%
Kuwait	318%	28%	-291%
Pakistan	84%	447%	364%
Namibia	15%	257%	242%
Qatar	80%	282%	202%
Antigua and Barbuda	28%	212%	184%
Congo	5%	169%	164%

Source: Authors' calculation.

Revealed comparative advantage in exports

This study initially assessed the RSCA for U.S. fish and fishery product exports to the top ten destinations from 2022 to 2024. During this period, the U.S. exported fish and fishery products worth $14.3 billion globally. The top ten export destinations were Canada, China, Japan, South Korea, the Netherlands, Hong Kong, France, Lithuania, Thailand, and Italy. These countries accounted for 83% of total U.S. fish and fishery product exports during 2022–2024. Table 5 shows the nature and trends of U.S. fish product export competitiveness to its major importers. The first column indicates the economies where the U.S. experienced revealed comparative advantage (RCA) in nearly all analyzed years. For example, the U.S. had an RSCA greater than 0 in at least 21 of the 24 analyzed years with Canada for fish products under HS codes 03031, 0302, 0303, and 0305. Similarly, the second column shows the economies with which the U.S. had a consistent comparative disadvantage (RCD) for the period analyzed. For example, the U.S. had RSCA of less than 0, with Japan for HS 0301, HS 0302, and HS 0305, for all the years, except for one or two years when RSCA values may have been positive. Columns 3 and 4 show the change in the competitiveness trend. For example, for HS 0303, the U.S. had a comparative disadvantage with Italy from 2001 to 2005. From 2006 onwards, it shifted to a comparative advantage. Thus, Italy was placed in Column 3. Similarly, the U.S. had positive RSCA with China and Hong Kong for HS 0308 from 2012[3] to 2016 and 2019, respectively, but RSCA values turned negative in subsequent years. Column 5 shows a mixed trend where the export competitiveness to that economy displayed RCA and RCD for several years, without a consistent directional pattern. For example, the U.S. exports to Thailand for HS 0302 had a positive RSCA from 200 to 2003, and again from 2009 to 2013. For the rest of the years, the RSCA indicated fluctuating competitiveness.

A good way to understand the U.S.'s fish and fishery competitiveness is to understand the nature of the U.S. fish and fishery commodity exports. As such, data were downloaded from FishStatJ trade statistics to identify the top exporting commodities of the U.S. in recent years (shown in Figure 1). Data indicated that most exported fish and fishery products are frozen or fish meat (Alaskan pollock and fillets, Pacific salmon, cod, squid, and yellowfin sole), generating a consistent comparative advantage for the U.S. with several countries in the HS 0303 and HS 0304 categories. The U.S. also exported several thousand metric tons of salmon and other fish roe, including caviar substitute, increasing its competitiveness in the HS 0305. As for other categories, the U.S. has a relatively more niche market, which limits their comparative advantage to a destination-specific, for example, American lobster to Canada and Italy, fresh or chilled Atlantic and Danube salmon to Canada, and Anchovies to Thailand.

[3] HS 0308 data started from 2012 onwards

Overall, the trends indicated that the U.S. demonstrated two different markets. It has a comparative advantage in exporting premium species (scallops, crab, squid, lobster, sockeye salmon) to developed markets. or white fish (Alaska pollocks, cod, hakes) for processing. Natale, Borrelo, and Motova (2015) found that seafood is in high demand in countries that have either well-established seafood preferences or a cheap processing industry. Other literature corroborates the trend, as Shister, Fry, and Melton (2022) mentioned that the U.S. and Canada harvest the same biological species because they share a border with well-integrated logistical hubs. Together with Canada, the U.S. accounts for roughly half of global lobster output (Pereira and Josupeit 2017). Shister, Fry, and Melton (2022) further explained that, due to state-level regulatory requirements, Massachusetts often exported its lobster harvest to Maine or Canada for processing. Given Canada's processing capacity advantage, many lower-quality live lobsters are sold to Canada, bolstering U.S. export competitiveness. Moreover, USDA (2015) states that Pacific salmon and Alaska pollock were among the top U.S. fish exports, particularly to China, Thailand, and the European Union (EU). Asche et al. (2022) reported that a significant portion of U.S. fish exports to China were reprocessed and re-exported by Chinese firms, enhancing U.S. competitiveness in frozen fish and fillet markets. Beyond re-exporting, economic growth in China has increased Chinese demand for premium crustaceans such as geoducks, lobsters, and king crabs. This is reflected in rising imports from multiple countries, suggesting a growing preference and more inelastic demand for these products (F.A.S. Beijing Staff 2019; Harkell 2022). Therefore, these RSCA trajectories are consistent with observed trade flows, such as strong U.S. exports of Alaska pollock and salmon to Asia, and high-value lobster to East Asia and the EU (NOAA Fisheries 2021).

Table 5: Nature and trends in Revealed Symmetric Comparative Advantage (RSCA) in exporting fish products by the U.S. to major export destinations, 2001-2024

HS Codes	Consistent RCA, RSCA > 0.0 for almost every year from 2001-2024	Consistent RCD, RSCA < 0.0 for almost every year from 2001-2024	RCD → RCA (RSCA>0 in almost all years except for the recent years)	RCA → RCD (RSCA<0 in almost all years except for recent years)	RCA←→ RCD RSCA has no consistent patterns
HS 0301	Canada	China, Japan, South Korea, the Netherlands, Hong Kong, France, Lithuania, Thailand, and Italy			
HS 0302	Canada	Japan, South Korea, the Netherlands, Hong Kong, France, Lithuania, and Italy			China, Thailand
HS 0303	Canada, China, Japan, France, and South Korea		Italy and Lithuania	Hong Kong	Netherlands and Thailand
HS 0304	Lithuania, the Netherlands, and South Korea	Canada and Hong Kong	Thailand	China and Japan	France and Italy
HS 0305	Canada, China, the Netherlands, Hong Kong, France, Lithuania, Thailand, and Italy	Japan		South Korea	
HS 0306	Italy	China, Japan, Lithuania, the Netherlands, and South Korea			Canada, Hong Kong, and France.
HS 0307	Hong Kong, France	Canada, Italy, Japan, Lithuania, South Korea, and Thailand			China and the Netherlands
HS 0308	Japan	Canada, Lithuania, France, Italy, the Netherlands, South Korea, and Thailand		China, Hong Kong,	

Source: Authors' own calculation

Conclusions and Policy Implications

This study provides a comprehensive analysis of the United States' trade performance, comparative advantage, and competitiveness in exports, and potential in fish and fishery product exports. The results reveal several key insights with significant policy implications. Despite moderate export growth, the sector continues to face a persistent and widening trade deficit, with imports growing at nearly double the rate of exports. This imbalance reflects increasing reliance on foreign seafood and underscores the structural weaknesses of the U.S. fishery export sector. Gravity model estimations highlight that the economic size and population of importing countries are key determinants of U.S. export flows. Countries with higher GDP and larger populations import significantly more, suggesting that targeting economically advanced and populous markets can enhance export volumes. Trade agreements also play a crucial role—U.S. exports are positively influenced by the presence of FTAs, while maritime connectivity further facilitates trade, particularly to distant markets in Asia. Conversely, greater geographical distance and higher domestic fish production in importing countries exert a negative influence, indicating a potential substitution effect and the importance of processing capabilities in partner countries.

Market potential assessments reveal that several key destinations, including Thailand, Italy, and the Netherlands, remain underutilized despite growing demand. Although the U.S. has demonstrated a comparative advantage in exporting frozen fish, fillets, and premium species like lobsters and crabs, these advantages are often limited to specific products and markets. The revealed comparative advantage (RSCA) analysis shows strong U.S. competitiveness in certain commodity-market pairs—such as HS 0303 and HS 0304—but also highlights fluctuating or mixed trends with countries like Japan and Thailand. The U.S. frequently exports products that are either reprocessed abroad or cater to niche high-value segments, such as Alaskan pollock, Pacific salmon, squid, and lobster. This export structure presents both strengths and vulnerabilities.

From a policy perspective, enhancing domestic processing capacity is critical to capturing more value within the U.S. supply chain and reducing dependence on re-exporting countries like China and Canada. Improving trade facilitation through expanded FTAs, regulatory harmonization, and institutional support for certification can reduce trade frictions, especially in the European Union. Infrastructure investments in port facilities and shipping connectivity are equally important to support long-distance trade. Supporting exporters in complying with import standards and promoting U.S. products as safe, traceable, and sustainably sourced could improve market penetration, particularly in high-value, regulation-intensive markets. Additionally, real-time monitoring of trade trends, flexible market strategies, and diversified export portfolios are needed to navigate shocks like the COVID-19 pandemic and shifting geopolitical dynamics. By strategically leveraging its comparative advantages, improving competitiveness through value addition, and addressing trade barriers, the U.S. can expand its fish and fishery product exports and strengthen its position in the global seafood market.

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