Fair Enough? Food Security and the International Seafood Trade

Frank Asche*,
Department of Industrial Economics, Universitetet i Stavanger, 4036 Stavanger, Norway. Email: frank.asche@uis.no. Tlf. (+47) 51832286.
Marc F. Bellemare,
Department of Applied Economics, University of Minnesota, 1994 Buford Avenue
St. Paul, MN 55108, USA. Email: marc.bellemare@gmail.com
Cathy Roheim,
Department of Agricultural Economics and Rural Sociology, University of Idaho, 875 Perimeter Drive, Moscow, ID 83844-2334, USA. Email: croheim@uidaho.edu.
Martin D. Smith,
Nicholas School of the Environment Duke University Box 90328 Durham, NC 27708, USA. Email: marsmith@duke.edu.
Sigbjørn Tveteras,
Norwegian School of Hospitality Management, University of Stavanger, 4036 Stavanger, Norway. Email: sigbjorn.tveteras@uis.no.
*Corresponding author

Abstract

Does international trade make all parties better off? Although the theory of comparative advantage concludes that trade leaves no country worse off in the aggregate, international trade does generate winners and losers within a given country. For that reason, there is cause to be concerned about the food security of individuals in food-exporting developing countries. To shed light on whether developing countries lose out in terms of food security when they export to developed countries, we study the international trade of fish and seafood between developing and developed countries. Seafood contributed at least 15% of average animal protein consumption to 2.9 billion people worldwide, and fisheries and aquaculture directly employed 43.5 million people in 2006, with 520 million people indirectly deriving their livelihoods from seafood-related industries. Thus, there is much to be learned from the international trade of seafood. Specifically, we look at and discuss the evolution of trade flows – values, quantities, and prices – between developing and developed countries. The picture that emerges suggests that the quantity of seafood exported from developing countries to developed countries is close to the quantity of seafood imported by developing countries from developed countries. What takes place is a quality exchange: developing countries export high-quality seafood in exchange for lower-quality seafood. This result is consistent with Bennett's Law, which states that as people become wealthier, they substitute away from low-quality foods toward higher-quality foods, and it suggests that the international trade of seafood does not pose a threat to food security.

Keywords: Fish and Seafood, Food Security, International Trade

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1. Introduction

Does international trade make all parties better off? That question has preoccupied economists since well before David Ricardo published his *Principles of Political Economy and Taxation* in 1817, which outlined a theory of comparative advantage still taught to economics students the world over. According to that theory, trade leaves no country worse off if countries choose to specialize in producing and exporting the goods for which they have the lowest opportunity cost out of all the goods they can produce. In other words, trade is not a zero-sum game, and in most cases trade makes both countries better off.

Although the theory of comparative advantage concludes that trade leaves no country worse off in the aggregate, international trade can generate winners and losers within a given country. It is perhaps for this reason that many people question the theory of comparative advantage and believe that international trade makes certain countries worse off. That belief is especially prevalent when the trade being discussed is that between developing and developed countries, or when the goods being traded are food commodities. Opinions are even stronger when the subject is food exports from developing to developed countries, prompting arguments in favor of food sovereignty (Pinstrup-Andersen, 2002).

Indeed, the Declaration of Nyéléni, which was adopted at the 2007 Forum for Food Sovereignty, states that

> Food sovereignty … puts those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations. … It offers a strategy to resist and dismantle the current corporate trade and food regime, and directions for food, farming, pastoral and fisheries systems determined by local producers. … Food sovereignty promotes transparent trade that guarantees just income to all peoples and the rights of consumers to control their food and nutrition. It ensures that the rights to use and manage our lands, territories, waters, seeds, livestock and biodiversity are in the hands of those of us who produce food (Forum for Food Sovereignty, 2007).

Food sovereignty advocates therefore argue that food security – adequate nutrition for individuals, no matter the provenance of the food commodities consumed – is not enough. Rather, one of their goals is a greater role for local foods, which necessarily means a smaller role for the international trade of food.

Does the international trade of food really threaten food security? In this paper, we look at this question by studying the international trade flows of fish and seafood between developing and developed countries.[1] Because seafood plays an important nutritional role and provides a livelihood for many people worldwide, and since seafood trade has a substantially higher value than any other food commodity (Smith et al., 2010), studying international trade flows of seafood can provide helpful insights about the relationship between international trade and food security. Seafood contributed at least 15% of average animal protein consumption to 2.9 billion people worldwide in 2006, and fisheries and aquaculture directly employed 43.5 million people, with 520 million people indirectly deriving their livelihoods from seafood-related industries (FAO, 2012). Not only is seafood is an important source of protein, it is also a highly traded good, which makes it a key source of income for many individuals, households, and firms across many countries. In fact, seafood is among the most traded of all food commodities, exceeding the combined trade value of sugar, maize, coffee, rice and cocoa, as shown in figure 1. For reference, figure 1 also shows that the trade of seafood is more important than that of pork and poultry combined, which are the two most important sources of animal protein globally. In 2009, 39% of the global seafood production was traded internationally, and as much as 78% of fish and seafood products are estimated to be exposed to international trade competition (Tveteras et al., 2012).

As with food in general, there is disagreement about whether the benefits of exporting seafood outweigh the costs for developing countries. One reason for that disagreement is that the lens used to

[1] In the interest of brevity, we use the term "seafood" to refer to both marine and freshwater fish and other seafood products throughout this paper.

investigate this issue differs radically among studies (Béné et al., 2009). In particular, the focus of the studies that argue in favor of trade tends to be aggregate flows measured in monetary value (Valdimarsson and James, 2001; Bostock et al., 2004; Thorpe, 2004; Kurien 2005). The studies that argue against trade tend to be micro-oriented and to focus on socio-economic variables for specific sub-population (Sauper, 2004; Ruddle 2008), with Béné et al. (2009) as a partial exception, looking at trade for a subset of African countries. By distinguishing among values, prices and quantities, we contribute a different insight to this debate.

The impact of seafood trade on food security creates further controversies because it is perceived to move large volumes of fish of high nutritional value from poor (i.e., developing) to rich (i.e., developed) countries. Indeed, in 2010, developing countries accounted for only 23% of the value of global imports of seafood while they accounted for 50% of the value of global exports of seafood. We refer to this concern as the *seafood trade deficit* throughout this paper. On the one hand, from a food security perspective, this could be interpreted as a substantial problem, as it might mean that poor countries are deprived of sorely needed proteins (Swartz et al., 2010). On the other hand, this could be interpreted as contributing to poverty alleviation due to the increased earnings and purchasing power resulting from export growth. Béné et al. (2009) provide an overview of the literature on these different perspectives on seafood trade. Thus, while the increase in trade flows is indisputable, the effect on poverty reduction, via economic growth, of those trade flows is contentious (Ravallion, 2004; Edward, 2006). Moreover, there are growing concerns that economic growth might have adverse effects on income distribution and equity (Basu, 2006; Goldberg and Pavcnik, 2007).

Our contribution is to use data on the prices and quantities of traded seafood to shed light on channels through which the seafood trade could contribute to or undermine food security. The Food and Agriculture Organization (FAO) of the United Nations seafood trade data allow us to distinguish between developing and developed countries' exports and imports. Based on these data, we can calculate unit prices for the actual trade flows, as well as the imputed value of the quantities that are obtained or given up by trade. Looking at prices and quantities in addition to total value shows a more nuanced picture of the actual effects of seafood trade; it shows gains and losses from different – but highly policy-relevant – perspectives.

The remainder of this paper is organized as follows. Section 2 provides background on the production and trade of seafood worldwide. In section 3, we discuss the trade data. Section 4 characterizes the total values as well as the prices and quantities of the international trade flows of seafood, and discusses the seafood trade deficit between developing and developed countries. To more comprehensively explore variations in income and seafood consumption across nations, a stochastic frontier model is estimated. In section 5, we offer policy recommendations and directions for future research.

2. The Production and Trade of Seafood Worldwide

The international trade of seafood has grown rapidly over the last few decades, enabled by a corresponding increase in the global supply of seafood. The availability of seafood has more than doubled over the last 40 years as the total supply of seafood increased from 65.3 million metric tons in 1970 to 148.9 million metric tons in 2011 (FAO, 2012). Seafood supply originates from two main production technologies, namely capture fisheries and aquaculture. Until the 1970s, aquaculture was relatively unimportant as a source of seafood supply. Since then, however, there has been a virtual explosion in the use of aquaculture as a seafood production technology. Figure 2 shows the relative shift in production from wild fisheries to aquaculture as well as total seafood production. In 1970, fish farming was limited, with a harvested quantity of about 3.5 million metric tons representing 5.1% of the total seafood supply. In 2011, farmed fish made up 40.6% of the total seafood supply with a production of 60.4 million metric tons. Capture fisheries production, however, has fluctuated between 90 and 100 million metric tons in annual landings, with no obvious trend since the 1980s. Consequently, the only reason why global seafood supply has continued to increase since 1990 is increased aquaculture production. Aquaculture growth has been sufficient not only to maintain but also to slightly increase the global per capita consumption of seafood (FAO, 2012).

Aquaculture is a technology that has its origins in ancient Egypt and China, and is mentioned by Pliny the Elder as having been practiced in Rome in the first century BCE (Parker, 2011). In the early 1970s, a significant change took place as better control over the production process enabled a number of new technologies and production practices to develop. The salmon industry, in particular, was a pioneer in developing modern industrialized fish farming, but these techniques were quickly adapted and developed for other marine and freshwater species worldwide (Asche, 2008). These changes dramatically improved the competitiveness of aquacultural products, both for subsistence and as sources of income. Product development and marketing made possible by a more stable supply further enhanced the competitiveness of aquaculture. The combined effect of productivity and market growth has made aquaculture the world's fastest growing animal-based food sector of the last decades (FAO 2006). Fisheries supply, on the other hand, is not expected to increase very much, as the majority of fish stocks are either fully exploited or over-exploited (FAO, 2012). The world may thus be fairly close to extracting as much seafood as possible from ocean capture fisheries.

The increasing importance of aquaculture in global seafood supply helps explain the export-orientation of the seafood industry. As in other food-related value chains (Barrett et al., 2012; Bellemare, 2012) the combination of (i) the significant investments needed to start up aquaculture production and (ii) limited domestic markets for aquaculture products (due for example to purchasing power constraints in developing countries, but also because of the size of domestic population and other factors) provide incentives for the industry to adopt a global outlook on marketing of seafood products. Likewise, fisheries have gradually become more capital-intensive worldwide, providing a similar incentive scheme for this industry.

Technological innovations have facilitated the international orientation of the seafood industry (Anderson et al., 2010). Transportation and logistics have improved significantly. Substantial reductions in transportation costs by surface and air has promoted the international trade of fresh seafood. Lower transportation costs have also given new producers access to the global market. Improved logistics have also created economies of scale and scope on all levels of the supply chain, particularly in the retail sector where supermarkets have replaced fishmongers and markets in a number of places. Progress in storage and preservation has continued, allowing a wider range of seafood products to be traded. Freezing technology has improved to such an extent in recent years that many product forms can be frozen twice, allowing products to be processed in locations with competitive advantages in processing fish rather than in locations close to where the fish is caught. Lastly, the improved control in the harvesting process in fisheries and throughout the production process in aquaculture has enabled producers to better target the needs of the modern consumer and to further innovate in the supply chains.

While technological changes have been critical, institutional changes have also facilitated global seafood trade. The imposition of 200-mile exclusive economic zones (EEZs) by coastal nations, in particular, created strong incentives to increase the trade of seafood. Countries with large distant-water fishing fleets, such as Spain and Japan, were negatively affected, as other coastal nations expanded their own domestic fleets to exploit the fisheries within their 200-mile EEZs. As a result, distant-water fishing countries that relied on harvesting within 200 miles of other countries had to turn to increased imports to maintain domestic consumption.

These various factors tend to reinforce each other, even though the strength of each differs by market and species. Increased trade has profoundly affected seafood markets; an increasing number of markets have gone from regional to global and as more species from widely different places have become substitutes (Asche et al., 2001). Moreover, a growing share of producers have access to the global market as global transportation systems improve and can take advantage of new market opportunities, increasing trade competition in export as well as import markets. For those consumers who have the ability to pay, these trends increase the available supply of seafood in the short run. Hence, the share of the imports of developed countries – the European Union, Japan, and the US in particular – remains high. Economic growth in many developing countries also increases demand (Delgado et al., 2003). As a result, there is a declining import share for developed countries despite growth in total values of seafood exports from developing to developed countries.

3. Data

The data we use in this paper are available from the FAO. They are aggregated seafood trade data obtained from the Fishstat J software (FAO, 2013), and they are separated into exports from and imports to both developing and developed countries for the period 1976-2009. Tables A1 and A2 in Appendix A list the developing and developed countries included based on the FAO's own classification. The FAO systematically collects these data from its member countries, and it began doing so in 1976. We exclude the product categories "aquatic plants", "inedible", and "sponges, corals, shells" from the FAO seafood trade statistics, and focus on the trade in seafood products.

The export and import values V_X and V_M are in nominal terms and are denoted in US dollars (USD), and the corresponding quantity weights (i.e., trade volume) q_X and q_M are measured in metric tons. The value data are converted to real terms (i.e., adjusted for inflation) using the US consumer price index.

Given the value and quantity data, one can also recover the unit prices of exports and imports p_X and p_M by dividing value by quantity, such that

$$p_X = \frac{V_X}{q_X}, \text{ since } V_X \equiv p_X q_X, \text{ and} \quad (1)$$

$$p_M = \frac{V_M}{q_M}, \text{ since } V_M \equiv p_M q_M, \quad (2)$$

The second relationship in each of equations 1 and 2 is an accounting identity. In what follows, we show these variables – V_X, V_M, p_X p_M, q_X, and q_M – separately for developing and developed countries. We denote developing countries with the subscript 0 and developed countries with the subscript 1. Thus, the variables we use are V_{0X}, V_{0M}, p_{0X} p_{0M}, q_{0X}, and q_{0M} for developing countries and V_{1X}, V_{1M}, p_{1X} p_{1M}, q_{1X}, and q_{1M} for developed countries. Table 1 shows descriptive statistics for the twelve variables. The upper half of table 1 covers developing countries' exports and imports and the bottom half developed countries' seafood trade.

4. Empirical Results

4.1. Export and Import Values

We first show export and import values, which clearly reveal the growth in seafood trade. Figure 3 shows the real value of the global seafood exports for developing and developed countries, with 2009 as the base year. The international trade of seafood, as measured in total real value exported $V_X = V_{0X} + V_{1X}$, has grown substantially over the past four decades. In 1976 the total traded value was 23.7 billion USD. This increased to 82.7 billion USD in 2009, which is more than a threefold increase. The developing countries' share of seafood exports rose steadily from 36.5% in 1976 to 49.8% in 1994, after which it has remained stable at around 50%. Exports from developing countries have thus grown faster than the total increase in exports until the mid-1990s, and they have had a similar growth rate as those of developed countries after the mid-1990s.

Figure 4 shows $V_M = V_{0M} + V_{1M}$, the global seafood imports for developing and developed countries. Here, the story is different. The growth in the *total* real value of seafood imports is very similar to that of the total value of seafood exports, since seafood exports from somewhere necessarily end up as imports elsewhere, i.e., $V_X \equiv V_M$.[2] However, there is a striking difference in import value shares between developing and developed countries. In 1976, developing countries imported only 12.2% of the total value of seafood imports. While that share steadily increased throughout the period 1976-2009, it was no more than 22.1% of the total value of seafood imports in 2009. This asymmetry in export and import shares between developing and developed countries is at the core of the perception that exporting seafood is detrimental for the food security of developing countries. In what follows, we show that focusing solely on values can be misleading and lead to the wrong conclusions.

4.2. Quantities

Figure 5 shows the quantities q_{0X} and q_{1X} of seafood exported by developing and developed countries. Except for the fact that the growth in exported quantities is sharper than the growth in exported values, figure 5 paints a picture similar to figure 3. For developing countries, the exported quantity of seafood increased until the mid-1990s, at which point it tapered off around 50%. The growth in trade measured by quantity was fourfold, starting at 7.9 million metric tons in 1976 and increasing to 32.1 million metric tons in 2009. But recall that the corresponding value only increased threefold, which suggests that the unit value of traded seafood – in other words, the real price – has been declining over time.

[2] There are some deviations in all the actual data, as the registration date for export data is not the same as for imports as the export and import data are reported by different countries.

Figure 6 shows the quantities q_{0M} and q_{1M} of seafood imported by developing and developed countries. An important difference here is that the asymmetry we observe between the seafood exports and imports of developed and developing countries is much less pronounced than in value terms. First, the import share for developing countries rose steadily from 24.7.6% in 1976 to 41.5 in 2009. While developing countries make up only 22.1% of the imports in 2009 when measured in value, they made up 41.5% of the imports measured in quantity. In other words, the seafood trade deficit for developing countries is much smaller when measured in quantity than in dollar value. However, this simple comparison does not account for the possibility that some seafood net export values may be spent on importing other foods.

4.3. Prices

The data shown in figures 3 to 6 suggest that, in aggregate terms, developing countries export relatively high-valued and import lower-valued seafood. The reason for the difference in value between seafood exports and imports among developing countries is apparent when we compute prices. The four unit prices, export and import prices for developed and developing countries, respectively, are shown in Figure 7.

All four prices p_{0X}, p_{0M}, p_{1X}, and p_{1M} exhibit downward trends; the unit values of seafood have been declining worldwide over the past 40 years. This pattern reflects the Law of Demand. As the supply of seafood increases and one moves along the seafood demand curve, there is a corresponding decrease in consumer marginal willingness to pay for seafood, which translates into a decrease in market price. Indeed, the ability to sell farmed fish at ever more competitive prices is recognized as the driving factor in making aquaculture the world's fastest growing food production technology in recent decades (Asche, 2008; FAO, 2006). Moreover, the high degree of substitutability between wild and farmed seafood also ensure that reductions in production costs spill over to wild fish (Asche et al., 1999; Valderrama and

Anderson, 2010). Of course, demand has not been constant in the past four decades. Nevertheless, supply appears to have grown fast enough to reduce real prices despite demand growth.

Besides exhibiting a downward trend, the four prices series exhibit similar fluctuations over time: all prices peak in the late 1970s, and all experienced the same decline. This pattern reflects the fact that the seafood market has become increasingly integrated (Tveteras et al. 2012). It also shows that seafood trade flows are exposed to the same shocks, irrespective of geography.

Our most important observation is that the import price level is much lower in developing compared to developed countries. The average export prices from developing and developed countries are relatively similar, i.e., there are no substantial differences when it comes to export prices between developing and developed countries. This suggests that, in aggregate, developing and developed countries have similar endowments of seafood resources. Import prices, however, are very different: developed countries clearly pay the much higher import prices, and developing countries pay lower prices. In other words, wealthy developed countries have a preference for high-value seafood, and poorer developing countries import cheap protein.

So what may be occurring is as follows. Both seafood and food quality are normal goods, i.e., a good whose quantity demanded increases as income increases, and consumers in developed countries exhibit a higher willingness to pay for high-quality food, including seafood. Indeed, previous studies have found that seafood demand in most cases is income elastic (Delgado et al., 2003; Asche et al., 2007). Given that the market for seafood is well integrated, and because efficiency dictates that goods and services should gravitate toward those who value them the most, this also means that developed countries import high-quality seafood from developing countries. Since consumers in developing countries have been getting better off over the past few decades (Kenny, 2012), their demand for seafood has been increasing. Indeed, a well-known empirical regularity, Bennett's Law, states that as incomes increase, people substitute away from coarse grains (e.g., cassava) toward finer grains (e.g., rice), and that at higher incomes still, people substitute way from grains and cereals toward meat and protein (Bennett, 1941). Figure 9 illustrates this by showing a positive relationship between seafood consumption and GDP per capita. Apparent per capita edible seafood consumption (2003-2005 average kg/yr in live weight equivalent) includes all fisheries and aquaculture products used for human consumption (FAO 2009). Apparent consumption is calculated for each nation by adding total seafood production to total imports, and subtracting total exports. Per capita consumption divides apparent consumption by population. The scatter plot in Figure 9 depicts gross domestic product per capita (averaged for 2003-2005 in USD) and per capita seafood consumption by country (both on a logarithmic scale). Clearly, per capita income and per capita seafood consumption are correlated (ρ = 0.506, p-value = 0.000, n=198).

To explain more variation in the relationship between income and seafood consumption, we also estimate a stochastic frontier model (Kumbhakar and Lovell 2000) for the relationship between seafood consumption and income. Deviations from this efficient frontier are explained by natural advantages (proxied by production), trade (exports and imports), and governance. We assume an iid error structure (v) and a half-normal deviation from the frontier (u). The frontier represents the highest expected seafood consumption possibility given different countries' income levels. At the outset, it is essential to note that this exercise is able to explore cross-sectional correlations but should not be interpreted causally. It may be that correlation results are indeed picking up causation, but we do not have the ability to identify causal impacts with the data that we have.

Production, imports, and exports are from the same data source used to calculate apparent consumption (FAO 2009). The World Bank Index is a measure of governance at the country level. The index averages four indicators of governance (rule of law, control of corruption, governmental effectiveness, and regulatory quality) (Kaufman, Kraay, Mastruzzi, 2009; Smith et al. 2010). Some observations were dropped in the analysis due to missing data for governance variables.

Results of the stochastic frontier model are in Table 2. All coefficients are significant at the 1% level, including the test for model significance χ^2 =13.42 (p=0.0002). We use corrected Akaike Information Criterion for model selection to explain deviations from the frontier. The results indicate that after conditioning on other factors, wealthier countries on average consume more seafood (equation 3). Negative coefficients in equation 4 indicate that a country is closer to the frontier with a higher value of the covariate. Thus, on average, countries consume more seafood with high seafood production, low net exports (high imports or low exports), and, critically, strong governance. Holding trade flows and other variables constant, countries with weak governance have lower seafood consumption per capita. The solid red line depicts the estimated frontier of seafood consumption with the dotted red lines representing the 95% confidence interval of the frontier.

In Figure 10, we show the same scatter plot as Figure 9 but filter the data to only countries with at least 500,000 metric tons of seafood production per year. Despite filtering, the pattern in Figure 10 is similar to that of Figure 9. Darkened points with labels illustrate the regression results for three hypothetical levels of per capita income. If the correlations identified in Table 2 represent causal channels, countries could theoretically improve governance, produce more seafood (including aquaculture production), or choose to consume more of their production and export less in order to move closer to the frontier. We assume natural advantages in capture fisheries are fixed and would offer limited opportunities for expanding production. Because exporting less seafood reduces the benefits from participating in the global seafood trade, improving governance and expanding aquaculture then would appear to be the only viable options for efficient seafood consumption..

4.4. Compensating for the Seafood Trade Deficit

The fact that developing countries export high-value and import low-value seafood implies that the trade deficit is much smaller when measured in quantity than in value. There is still a net quantity outflow from developing to developed countries (i.e., $q_{0X}-q_{0M}$), which peaked at 3.5 million metric tons in 2003 and remained high at 2.3 million metric tons in 2009. While this outflow is problematic if one only considers food security from a production perspective, it needs not be problematic if countries receive sufficient compensation that enables them to import other foods.

An important question is then how large is the compensation that developing countries receive in exchange for their seafood exports? The simplest answer, of course, is that they receive the revenue from exports net of their expenditures on seafood imports. But this does not take the quantity exchange into account. Thus, a better measure is the unit value of the net quantity outflow from developing countries. This can be computed as the net export value divided by the net export quantity, or $p_{comp} = \frac{V_{0X}-V_{0M}}{q_{0X}-q_{0M}}$. These two variables are shown in Figure 8 together with the actual export price, p_{0X}.

Given that exports are increasing, as shown in figure 3, it is not surprising that the net export value is also increasing. In 2009 the net export value was equal to 25.1 billion USD compared with 15.9 billion USD in 1990. The unit value compensation for every kilogram of seafood net exported is more interesting. In 2009 it was 7.83 USD/kg, somewhat down from the peak of 9.80 USD/kg in 2007. However, this compensation is more than twice the actual export price in most years. Hence, the developing countries are well paid for the seafood quantities they export.

5. Conclusions

The results of the preceding sections show that even though the total value – that is, price times quantity – of seafood exported by developing countries to developed countries has increased, this need not have ill effects on food security in developing countries. The pattern of exporting higher valued seafood and importing lower valued seafood largely confirms Bennett's Law in that people substitute away from cheaper food with higher incomes. In other words, developing countries exporting high-value seafood to developed countries and importing lower-valued seafood from developing countries, illustrates how the market system works in reallocating the most valuable resources to those with the highest ability to pay.

Food sovereignty remains an issue, because there is a seafood trade deficit for developing countries. While it is more apparent when measured in value than in volumes, in either regard one may believe this to be a negative effect of trade. Whether it actually is depends on one's point of view. The seafood trade deficit can be viewed negatively if one believes that all reductions in availability for a specific food source are a negative outcome. However, if one accepts that some types of food can substitute for other types of food, increasing developing nations' incomes allows for purchases of more food thus making them better off.[3] The data analyzed in this paper do not allow us to draw conclusions about whether developing countries as a group actually use the income from seafood exports to (i) replace the lost quantities of seafood with other foods, (ii) use the proceeds for other useful purposes like funding infrastructure or education, or (iii) whether they are appropriated by a powerful elite. However, the data clearly show that the developing countries as a group are well compensated for the quantities of seafood that they export give up, and the increased income is more than sufficient to replace the food that is given up at prevailing market prices. As such, a trade deficit in seafood should not necessarily contribute to decreased food security.

[3] Cheaper seafood does not mean that the nutritional value of the seafood imported by developing countries is lower. This is especially so if we take into account that much of the seafood imports of developing countries are composed of pelagic species high in omega-3 fatty acids. For example, chub mackerel, herring, and jack mackerel are commonly imported by sub-Saharan African countries.

Yet, that developing countries as a group are well compensated for their seafood exports does not mean that everyone within these countries will be better off. From the time of David Ricardo, economists have understood that while society in general is better off with trade, there are winners and losers within each trading country. As such, our results do not in any way remove the possibility that the poorest people in developing countries are made worse off by seafood trade. Our results only show that the countries are being given the means to improve societal welfare, although gains from the international trade of seafood from developing to developed countries could be misappropriated (Barrientos et al., 2011).

Our final point is theoretical in nature and relates to the necessary conditions for free trade to ensure welfare improvement. Detailed models of resource extraction with poorly managed natural resources show that trade liberalization leading to increase traded provides a short-run benefit to the resource exporter at a long-run cost due to resource overexploitation (Brander and Taylor, 1998). Whether the benefits of trade outweigh the costs then becomes an empirical question. In this sense, seafood illustrates a trade-governance dilemma, as aggregate governance indicators tend to indicate significant scope for improved governance for seafood net exporters (Smith et al., 2010).

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Appendix A

Table A1. Developing countries included in seafood statistics

		Developing countries		
Algeria	Congo, Republic of	Honduras	Mozambique	Sierra Leone
Angola	Cook Islands	India	Myanmar	Singapore
Antigua and Barbuda	Costa Rica	Indonesia	Namibia	Solomon Islands
Argentina	Cuba	Iran (Islamic Rep. of)	Nepal	Somalia
Aruba	Cyprus	Iraq	Netherlands Antilles	Sri Lanka
Bahamas	Côte d'Ivoire	Jamaica	New Caledonia	St. Pierre and Miquelon
Bahrain	Djibouti	Jordan	Nicaragua	Sudan
Bangladesh	Dominica	Kenya	Niger	Suriname
Barbados	Dominican Republic	Kiribati	Nigeria	Swaziland
Belize	Ecuador	Korea, Dem. People's Rep	Northern Mariana Is.	Syrian Arab Republic
Benin	Egypt	Korea, Republic of	Oman	Taiwan Province of China
Bermuda	El Salvador	Kuwait	Pakistan	Tanzania, United Rep. of
Bhutan	Equatorial Guinea	Lao People's Dem. Rep.	Palau	Thailand
Bolivia (Plurinat.State)	Eritrea	Lebanon	Palestine, Occupied Tr.	Timor-Leste
Botswana	Ethiopia	Lesotho	Panama	Togo
Brazil	Ethiopia PDR	Liberia	Papua New Guinea	Tonga
Brunei Darussalam	Falkland Is.(Malvinas)	Libya	Paraguay	Trinidad and Tobago
Burkina Faso	Fiji, Republic of	Madagascar	Peru	Tunisia
Burundi	French Guiana	Malawi	Philippines	Turkey
Cambodia	French Polynesia	Malaysia	Qatar	Turks and Caicos Is.
Cameroon	Gabon	Maldives	Rwanda	Tuvalu
Cape Verde	Gambia	Mali	Réunion	Uganda
Cayman Islands	Ghana	Marshall Islands	Saint Helena	United Arab Emirates
Central African Republic	Greenland	Martinique	Saint Kitts and Nevis	Uruguay
Chad	Grenada	Mauritania	Saint Lucia	Vanuatu
Chile	Guadeloupe	Mauritius	Saint Vincent/Grenadines	Venezuela, Boliv Rep of
China	Guam	Mayotte	Samoa	Viet Nam
China, Hong Kong SAR	Guatemala	Mexico	Sao Tome and Principe	Yemen
China, Macao SAR	Guinea	Micronesia, Fed.States of	Saudi Arabia	Zambia
Colombia	Guinea-Bissau	Mongolia	Senegal	Zimbabwe
Comoros	Guyana	Montserrat	Seychelles	
Congo, Dem. Rep. of the	Haiti	Morocco		

Table A1. Developed countries included in seafood statistics

Developed countries	
Albania	Lithuania
Armenia	Luxembourg
Australia	Macedonia, Fmr Yug Rp of
Austria	Malta
Azerbaijan	Moldova, Republic of
Belarus	Montenegro
Belgium	Netherlands
Bosnia and Herzegovina	New Zealand
Bulgaria	Norway
Canada	Poland
Croatia	Portugal
Czech Republic	Romania
Czechoslovakia	Russian Federation
Denmark	Serbia
Estonia	Serbia and Montenegro
Faroe Islands	Slovakia
Finland	Slovenia
France	South Africa
Georgia	Spain
Germany	Sweden
Greece	Switzerland
Hungary	Tajikistan
Iceland	Turkmenistan
Ireland	Ukraine
Israel	Un. Sov. Soc. Rep.
Italy	United Kingdom
Japan	United States of America
Kazakhstan	Uzbekistan
Kyrgyzstan	Yugoslavia SFR
Latvia	

Table 1. Descriptive statistics

Variables	Unit	Observations	Mean	Std. Dev.	Min	Max
	Developing Countries					
q_{0X}	Metric ton	34	6.766	4.059	1.504	13.886
V_{0X}	Bill USD	34	19.424	12.993	2.523	47.159
p_{0X}	USD per kg	34	2.698	0.470	1.639	3.404
q_{0M}	Metric ton	34	4.889	3.244	1.283	11.877
V_{0M}	Bill USD	34	7.192	5.751	.937	21.270
p_{0M}	USD per kg	34	1.334	0.284	0.721	1.881
	Developed Countries					
q_{1X}	Metric ton	34	8.521	3.016	3.399	13.168
V_{1X}	Bill USD	34	21.599	12.720	4.386	49.184
p_{1X}	USD per kg	34	2.328	0.671	1.210	3.838
q_{1M}	Metric ton	34	10.228	4.214	3.970	16.476
V_{1M}	Mill USD	34	36.987	21.424	6.763	81.188
p_{1M}	USD per kg	34	3.330	0.807	1.704	4.947

Table 2. Stochastic Frontier Model Results. The dependent variable is the natural log of seafood consumption per capita.

	Coefficient	SE	Z-statistic
Frontier Estimation			
Constant	2.06	0.36	5.70
ln(Per Capita Income)	0.14	0.04	3.66
Deviations from the Frontier			
Constant	1.14	0.29	3.97
ln(Per Capita Production)	-1.09	0.17	-6.57
ln(Per Capita Net Exports)	0.22	0.07	3.05
World Bank Governance Index	-0.67	0.26	-2.54
n 186			

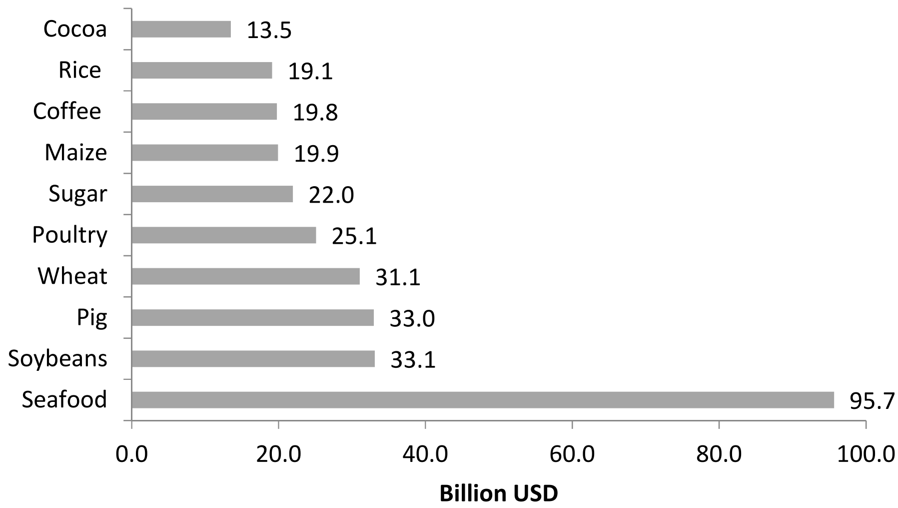

Figure 1. Export Value of Selected Food Commodities in 2009 (Source: FAO, 2013)

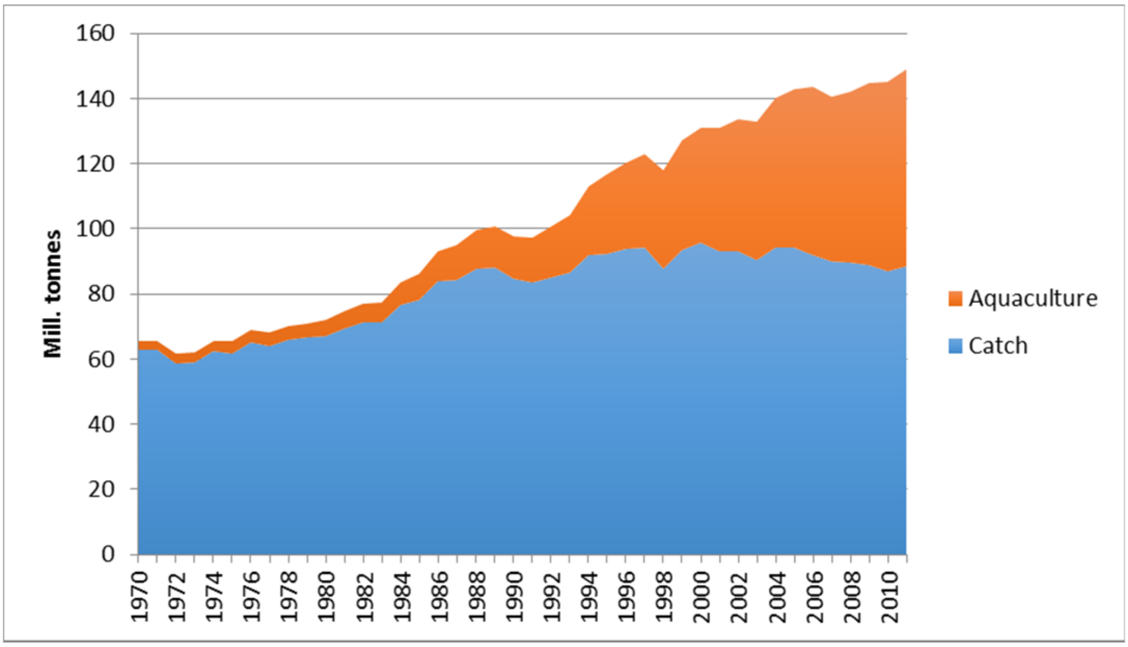

Figure 2. The Global Production of Seafood by Production Technology, 1970-2011 (Source: FAO, 2013)

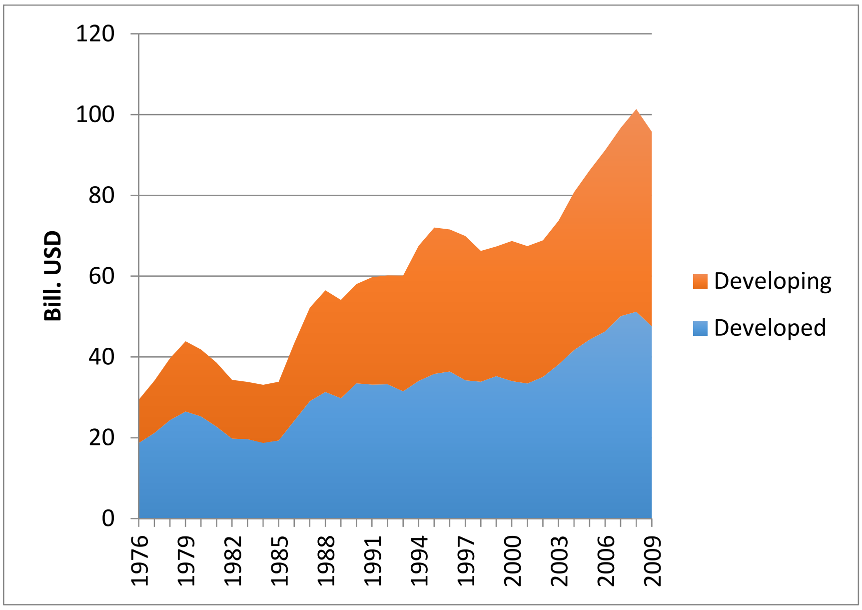

Figure 3. Global Seafood Exports in Real Terms, 2009=1 (Source: FAO, 2013)

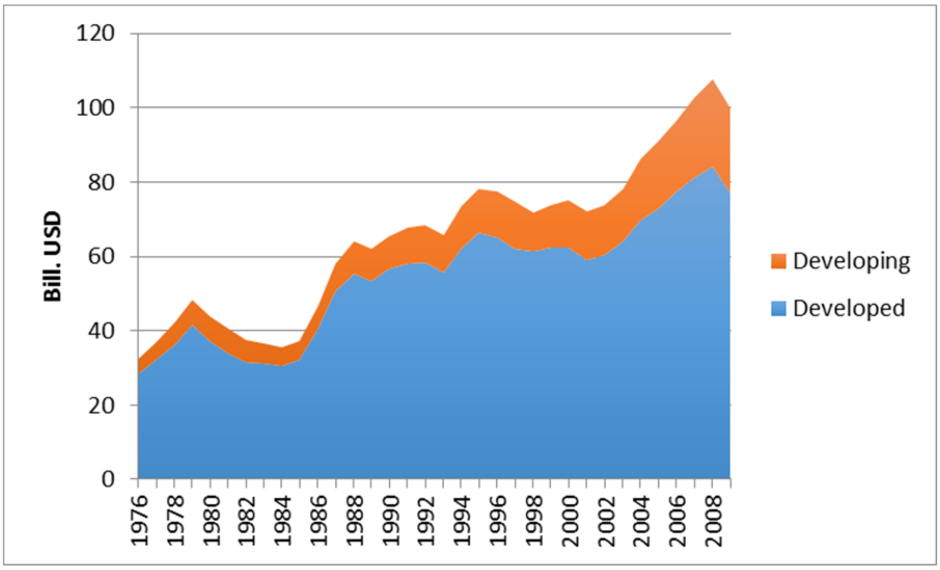

Figure 4. Global Seafood Imports in Real Terms, 2009=1 (Source: FAO, 2013)

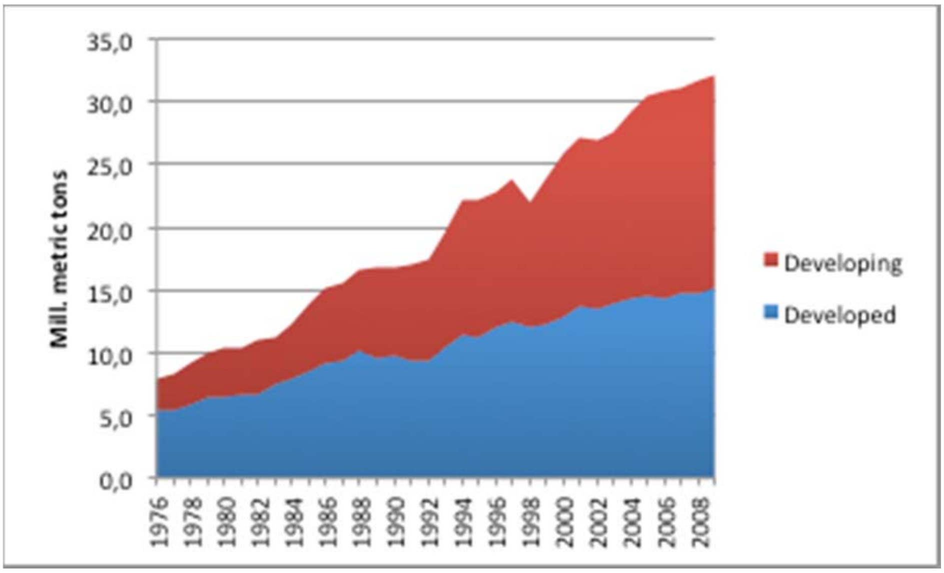

Figure 5. Global Seafood Exports (Source: FAO, 2013)

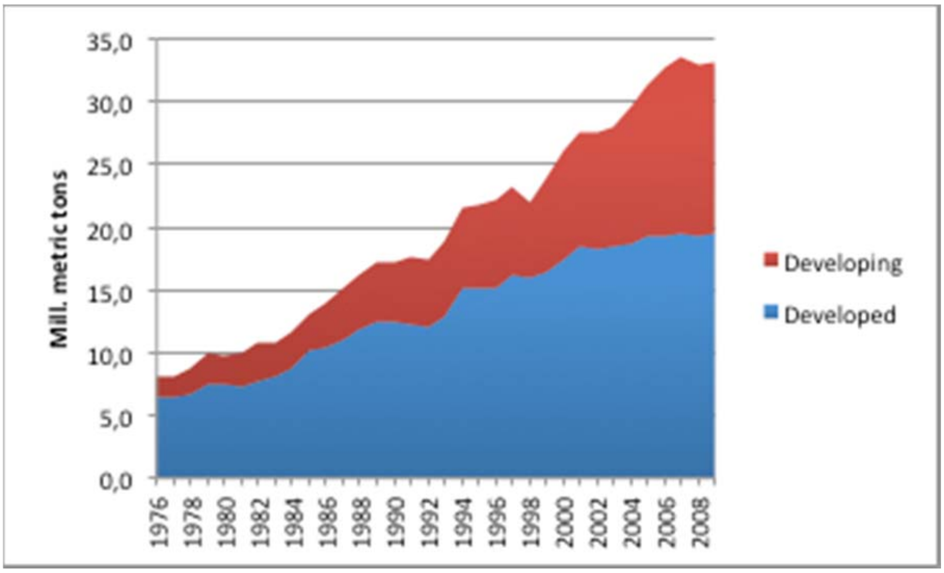

Figure 6. Global Seafood Imports (Source: FAO, 2013)

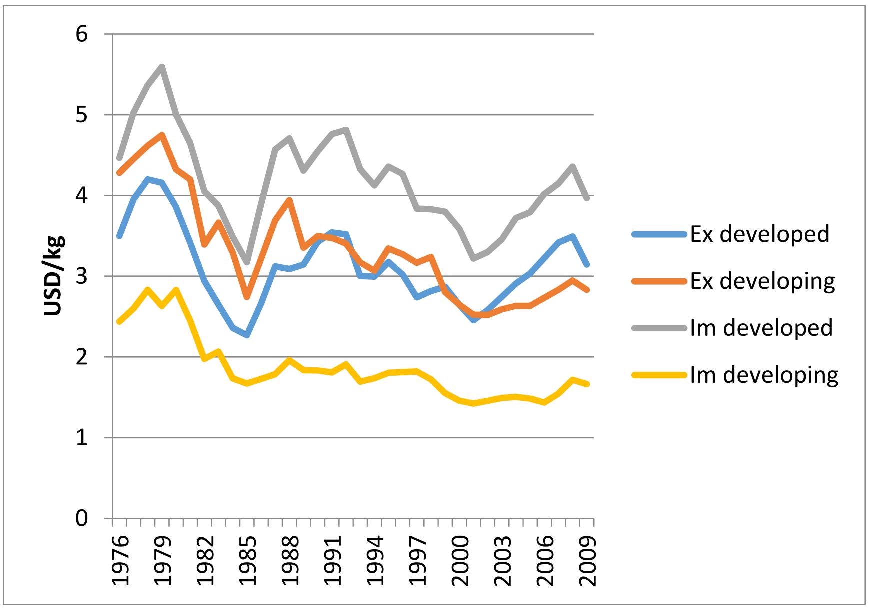

Figure 7. Real Unit Prices, 2009=1.

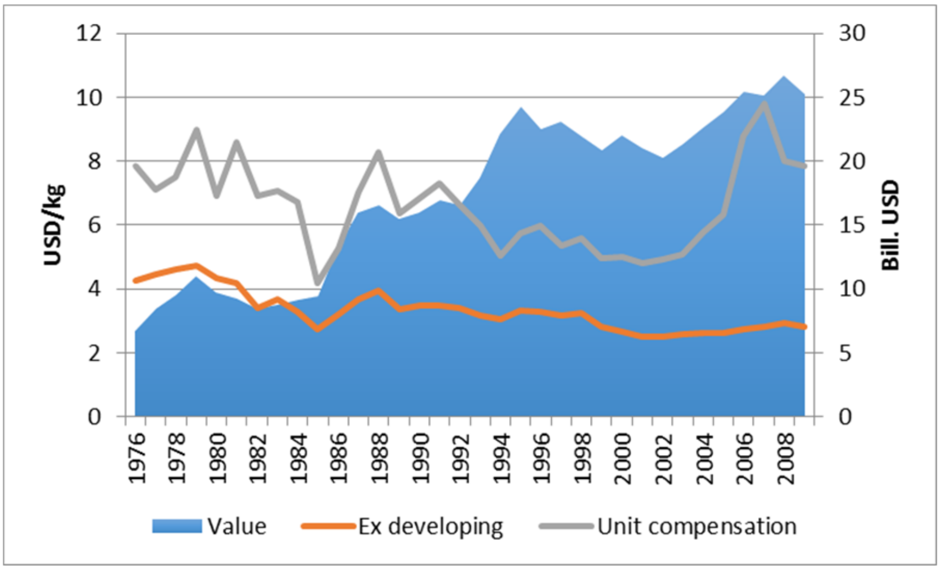

Figure 8. Real Export Price from Developing Countries, Net Export Surplus Value and Real Unit Compensation for Net Quantity Exported, 2009=1.

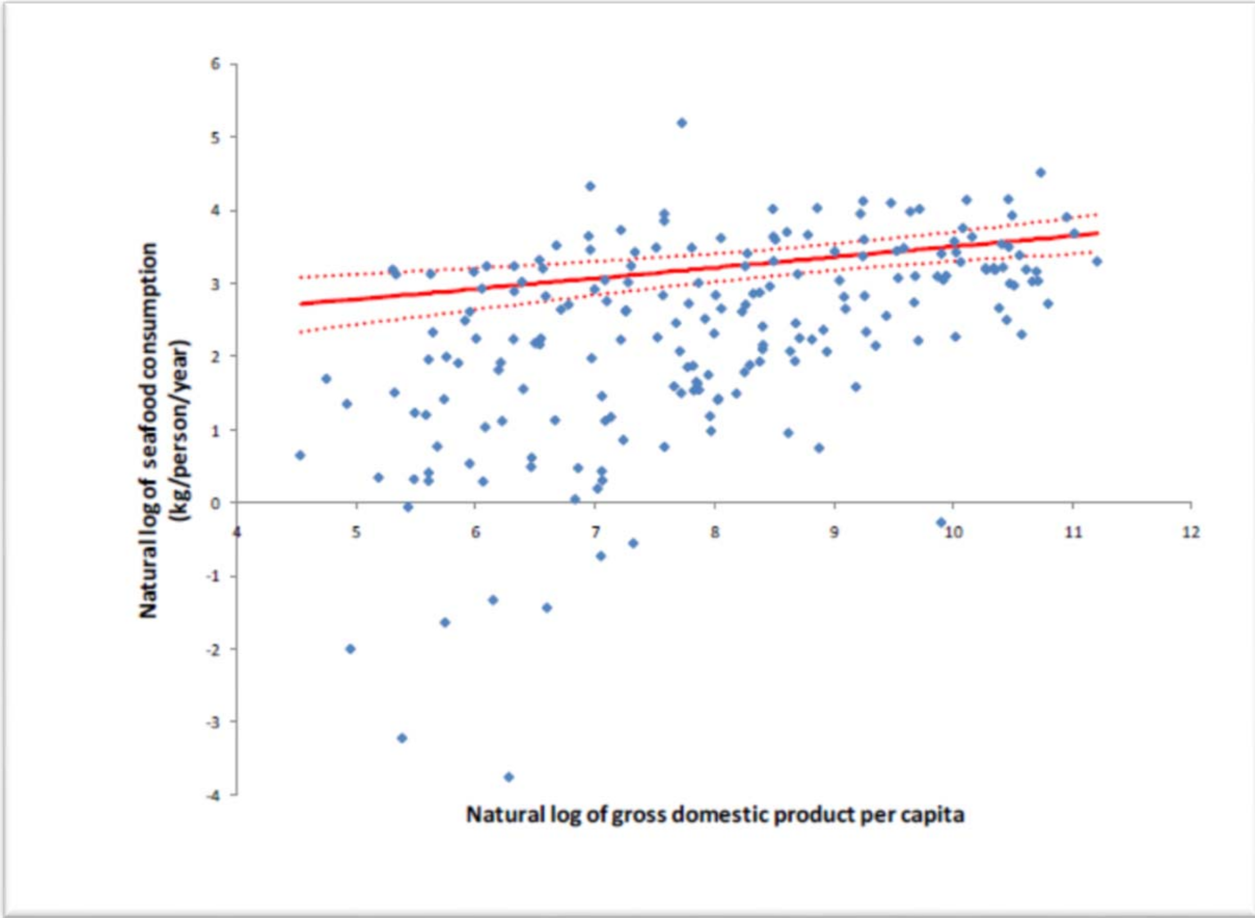

Figure 9. The Relationship between Income and Seafood Consumption.

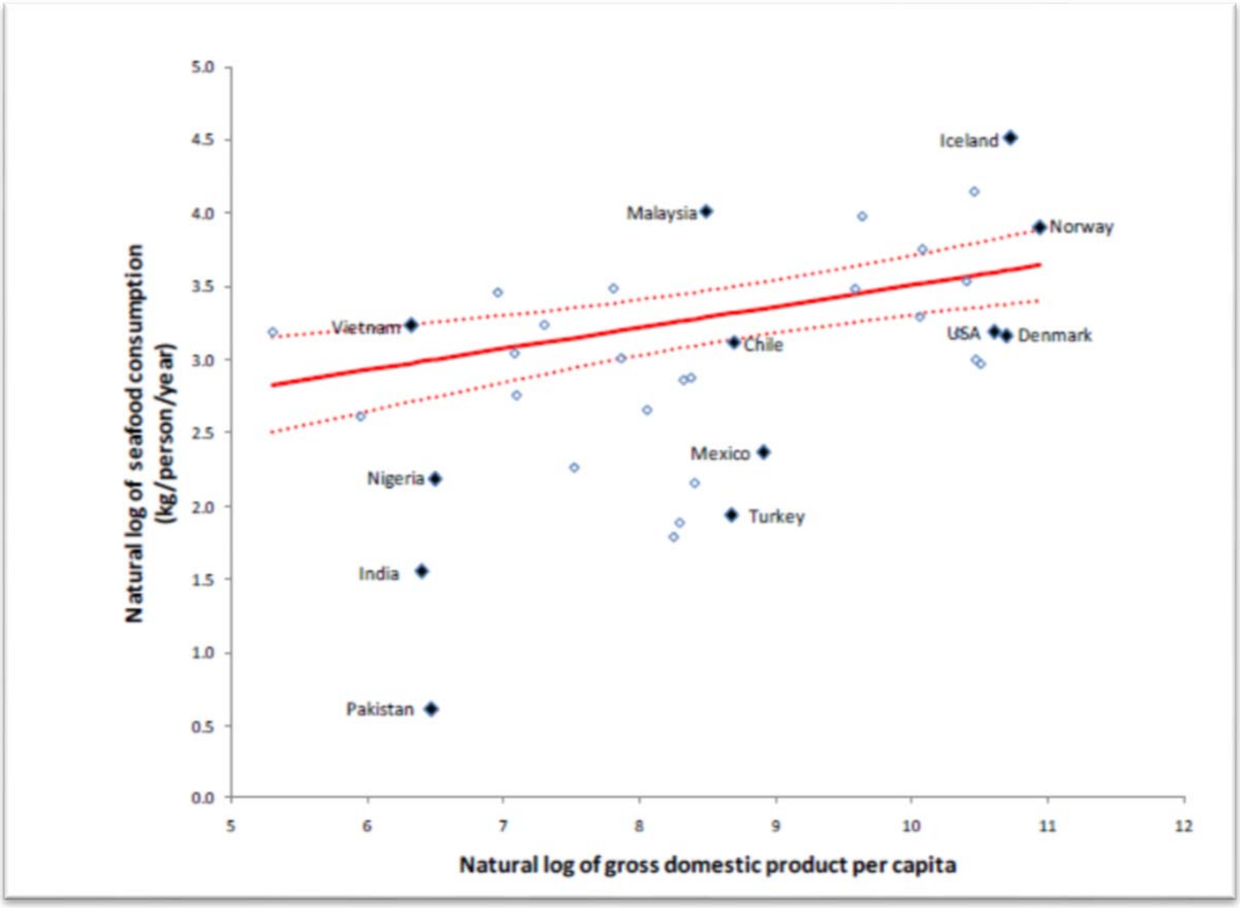

Figure 10. The Relationship between Income and Seafood Consumption for Selected Countries.