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Review

Fish and fishery products trade in Brazil, 2005 to 2015: A review of available data and trends

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ABSTRACT: Along the last ten years fish and fishery product trade in Brazil has been on a downward trajectory turning a profit of US$ 98.6 million in 2005 into a loss of US$ 1.25 billion by 2014. On the other hand, the country is a leading producer of grains and has the third largest animal feed industry in the world, which has added 5.5 million hectares of freshwater reservoirs and 3.5 million km^2 of an exclusive marine economic zone in the same period, a sizable potential for development of the aquaculture industry. This study aims at unveiling strategies for the reduction of the deficit in the Brazilian seafood trade balance, based on critical analysis of the quantitative and qualitative characteristics of imported fishery products. The fish and fishery product trade in Brazil, from 2005 to 2015, was studied considering import and export data mined from the Brazilian Ministry of Development, Industry and Commerce databases through the Aliceweb system, and clustered as follows: processing; product species; origin; conservation; and group. The main imported products were gutted fresh fish, highest price (salmon); salted dried fish, higher price (cod); frozen fish fillets, lowest price (fish and hake). The replacement of fish imports by domestic production is not enough to enable consumers to identify the equivalence between products (technical, qualitative or organoleptic). Developing strategies for the production of fish and fishery products at competitive prices and quantities that meet consumer demand is an immediate need, and the development of the aquaculture industry a rational strategy.
Keywords: seafood, demand analysis, price analysis, market preferences, aquaculture economics

Introduction

The Brazilian trade balance recorded in 2014 a considerable deficit for the first time in the last 14 years – $ 3.959 billion – with sizable contribution of fish and fishery products (MDIC, 2015). Therefore, understanding the fish import profile as a basis for recommending parameters and challenges for its substitution may help mitigate these circumstances.

Brazilian water resources comprise approximately 5.5 million hectares of freshwater, artificial reservoirs, in addition to an 8,500 km coastline, and an exclusive marine economic zone of approximately 3.5 million km^2, the 15th largest area in the world (IBGE, 2011; Ostrensky et al., 2008; Sidonio et al., 2012). The country is also a leading producer of grains and harbors the world's third largest animal feed industry. Brazil's territory is a subcontinent encompassing both tropical and subtropical climate zones, which significantly favor aquaculture production (FAO, 2012; IFIF, 2013; Sindirações, 2014). Nevertheless, because the aquaculture industry still lacks clear regulations on licensing, certification and financing, seafood landings in Brazil essentially count on capture fishery (Sidonio et al., 2012). However, freshwater capture fishery in north Brazil, the most productive area, is hampered by poor logistics, inadequate conservation and distribution infrastructures (IBAMA, 2007), and marine fisheries are characterized by very low yields resulting from consistently low natural productivity in the exclusive marine economic zone, exploited by an obsolete fishing fleet (Bricaud et al., 2012; Chassot et al., 2010; Gasalla, 2007).

Twelve million Brazilian families ascended from the C to the B economic class between 2003 and 2009, thereby increasing home food consumption, both quantitatively and qualitatively. Food consumption away from home increased 27 % and spending on prime beef increased 4 %, while consumption of poultry products decreased 12 % (FECOMERCIOSP, 2012; IBGE, 2012). *Per capita* seafood consumption thus increased from 6.66 to 9.75 kg between 2005 and 2010, the largest all-time increase, resulting in an increased deficit in the fish trade balance of approximately $ 750 million in 2010 (MPA, 2011). This study aims at unveiling the Brazilian seafood trade balance, based on critical analysis of the quantitative and qualitative characteristics of imported fishery products, suggesting strategies designed to reduce the deficit.

Data mining

Import and export data were mined from the Brazilian Ministry of Development, Industry and Commerce (MDIC) databases through the Aliceweb system (http://aliceweb2.mdic.gov.br/), MDIC's website for all methods of acquisition, registration and accessibility of data. All categories of imported and exported fish and fishery products were represented by the interval between 03021100 and 03075910 of the Mercosur Common Nomenclature code (MCN), downloaded for the

period 2005-2015. Data were clustered into specific processing methods (fillet, whole piece, powders, and organs), product species (hake, tuna, cod, etc.), origin (marine or freshwater), conservation (cold, frozen, salted and smoked), and group (mollusks, fish, and shellfish). Data were also grouped and quantified by value, weight (quantity), and percentage relative to the total.

Total aquaculture production in Brazil in 2013 was estimated at 475,000 tons: 392,000 tons of fish, 64,000 tons of shrimp, and 19 tons of mollusks (IBGE, 2014). Although proved unreliable and overestimated (Sonoda et al., 2015), data on Brazilian aquaculture show steady but insufficient growth to meet the increasing consumer demand for seafood though, intermittent fluctuation aside, imports of fish and fishery products in due course have narrowed the gap (Figure 1).

Seafood trade in Brazil happens in pulses. The end of subsidies to the Brazilian fisheries industry back in 1986 ignited the growth of seafood imports (Abdallah and Bacha, 1999). Oscillations in the country's fish trade balance in subsequent periods occurred as a result of shifting economic policies on inflation control and exchange rate instability (Baer, 2007). Relevant historical landmarks are: in 1988 the "Plano Cruzado" (Cruzado Plan) set up indiscriminate price freezing; in 1990 the "Plano Collor" (Collor Plan) reduced imports and trade barriers; in 1994 – the "Plano Real" (Real Plan) put an end to hyperinflation and currency devaluation; in 1999 the extraordinary devaluation of monetary value resulting from the international economic crash favored exports, especially of farmed shrimp; from 2003 to 2014 the recovery in the exchange rate, resulting from the stability of the Brazilian economy, favored imports; in 2009 the newly appointed Ministry of Fisheries and Aquaculture took on responsibility for the national fisheries statistics, and landing data showed marked disruptions from the norm (Sonoda et al., 2015); the current, sharp currency depreciation resulting from the internal economic crisis may now set up a new scenario for Brazil's fisheries and aquaculture, but only time will tell if that was a positive or negative landmark.

Brazilian trading in fish and fishery products has established a trend that went from a profit of + US$ 98 million in 2005 to losses reaching – US$ 1.25 billion by 2014. However, exports amounting to US$ 200 million in 2015 (Figure 2) may set off a considerable shift in this trade pattern, a probable reflex of the devaluation of the exchange rate, always expressed in US$, resulting from Brazil's recent economic crisis (IPEA, 2016). Social awareness about healthier foods has increased consumption of seafood in recent years, and for the first time, world production of fish (66×10^6 MT) has exceeded the production of beef (63×10^6 MT) (Larsen and Roney, 2013). The increasing Brazilian domestic demand for seafood has been met mainly by imports, increasing by 8 % in 2014 alone, more than half of international purchases (assessed by weight) coming from Chile, China and Vietnam.

Meeting seafood demand with imports reflects, among other implications, a lack of both legal definition of domestic production together with a lack of policies and strategies to develop the sector. As a result, data from the Brazilian Institute of Geography and Statistics (IBGE) shows that at least 70 different native fish species and their hybrids are farmed in Brazil, even though no legal benchmarks have ever been established for the husbandry and use of hybrid fish in farming systems (Hashimoto et al., 2011; Hashimoto et al., 2013; Hashimoto et al., 2014). Under such a scenario, setting quality standards at competitive prices for Brazilian aquaculture products is virtually impossible.

How storage and processing methods affect the fishery products trade

There is not a single study on preferences of Brazilian seafood consumption by type of storage and processing of aquaculture products. Therefore, an analysis of preference by storage and processing methods has been performed using only imported products as reference.

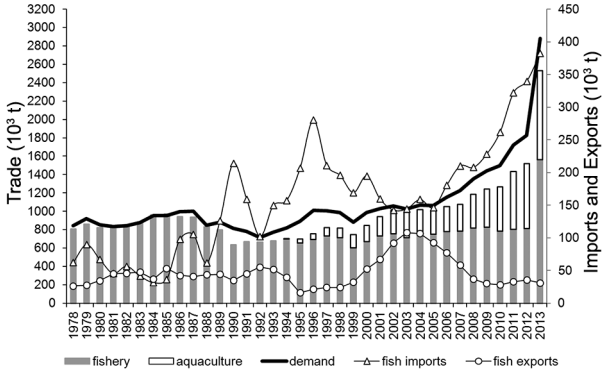

Figure 1 – Quantity of Brazil's fishing, imports, exports and demand for fish and fishery products from 1978 to 2014; Graph from data mined at: Aliceweb; IBAMA, 2003, 2004, 2007a, 2007b and MPA, 2010, 2011, 2013, 2014.

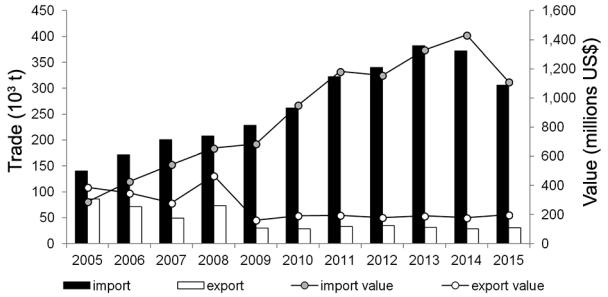

Figure 2 – Quantity and value of Brazil's imports and exports of fish and fishery products from 2005 to 2015; Graph from data mined at: Aliceweb.

The largest share of imported fish by storage was frozen, with 71 %; unidentified conservation products and refrigerated represented 22 %; the group "others" (mostly salted) accounted for circa 7 %, and smoked products represented only 0.05 %. With regard to processing method, approximately 43 % of imported fishery products (weight) were sold whole, 5 % as flitches and darnes, and 52 % as fillet, while fish residues and organs accounted for less than 0.02 %. However, between 2008 and 2009, when the price of fish fillet ranged from US$ 1 to US$ 2 kg^{-1} and was more expensive than gutted fish, imports were lower. When prices were even, there was a faster increase in fish fillet imports (Figures 3 and 4). The increased consumption of fish fillet coincided with changes in eating habits as a result of greater participation of women in the labor force, the increased number of single-living individuals, both male and female, and the need for practicality and fast-cooking food (Estima et al., 2014; Mitterer-Daltoe et al., 2013; Ortega et al., 2014).

The information on different processing forms of fish and their potential markets could become a very valuable commodity, given that in certain instances a by-product may become the major product. Despite low quantities (in weight), the average price of viscera were higher in comparison to other processed food items and products. A number of markets may pay as much as US$ 29.82 kg^{-1} for products such as fish eggs, semen, fish livers, and also black toothfish cheeks. However, this market share has not grown expressively in recent (last five) years in Brazil.

The development of novel market shares may become an alternative for the marketing of Brazilian fishery by-products – heads, tails and swim bladders, for instance – as spices overseas. In 2015, for instance, the country exported a total of 505,182 kg of fishery by-products to Asian markets, mainly swim bladders at an average price of US$ 38.76 kg^{-1}, total proceeds of US$ 19,581,914.00. Therefore, the usage of low-valued products in the domestic market to access overseas profitable markets could be a strategy for reducing the deficit in the Brazilian trade balance.

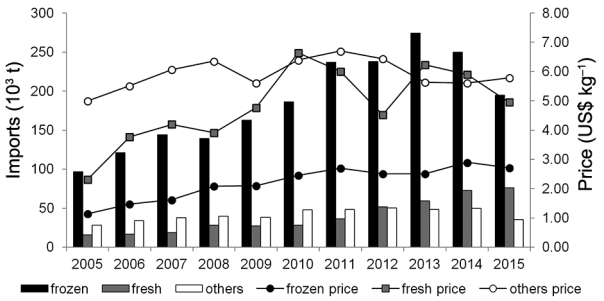

Figure 3 – Quantity and price of Brazil's imports of fish and fishery products by conservation method from 2005 to 2015; Graph from data mined at: Aliceweb.

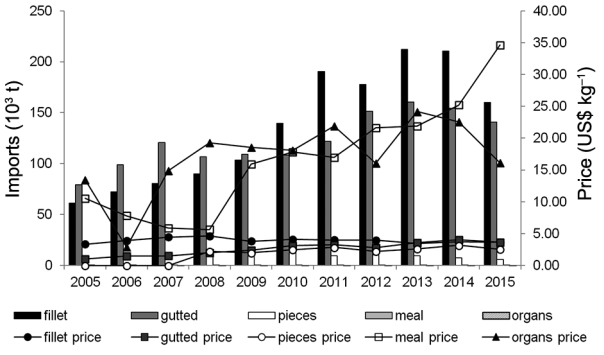

Figure 4 – Quantity and price of Brazil's imports of fish and fishery products by processing method from 2005 to 2015; Graph from data mined at: Aliceweb.

Role of imported fishery products in the Brazilian seafood market

It is important to assess the quantity and price of the main species produced by the Brazilian fishery and aquaculture sector (Table 1) before performing a comparative analysis of the main imported species, especially because statistical figures relating to the Brazilian fishery and aquaculture sector are erratic and scarce. Nevertheless, recorded data clearly demonstrate the rather low fishing potential of Brazil's exclusive marine economic zone, especially taking into consideration the large size of the exploitable area (3,539,919 km^2) and the fact that Brazilian mariculture is essentially sustained by mollusks and shrimp farming, marine fish farming being

Table 1 – Main marine and freshwater species produced by Brazil's fishery and aquaculture industries, respectively in 2011 and 2013. Data mined at: MPA (2011) and IBGE (2014).

Fisheries[1]			
Main marine species	Volume	Main freshwater species	Volume
	t		t
Sardinella brasiliensis	75,122.5	*Prochilodus lineatus*	28,643.0
Micropogonias furnieri	43,369.7	*Brachyplatistoma vaillanti*	24,789.3
Katsuwonus pelamis	30,563.3	*Semaprochilodus* sp.	16,556.8
Cynoscion acoupa	21,074.2	*Brachyplathystoma flavicans*	14,486.1
Mugil brasiliensis	18,045.9	*Plagioscion* sp.	13,150.3
Xiphopenaeus kroyeri	15,417.8	*Piaractus mesopotamicus*	11,123.0
Total marine	482,335.7	Total freshwater	249,600.2
Aquaculture[2]			
Main marine species	Volume	Main freshwater species	Volume
	t		t
Litopenaeus vannamei	64,668.8	Tilápia	169,306.0
Molluscs[3]	19,359.7	*Colossoma macropomum*	88,718.5
		Hybrids[4]	60,463.3
		Carp	18,836.8
		Catfish hybrids[5]	15,714.7
		Piaractus sp.	13,652.9
Total marine	84,212.3	Total freshwater	392,492.5

[1]MPA, 2011; [2]IBGE, 2014; [3]*Crassostrea gigas*; *Nodipecten nodosus*; *Mytilus edulis*; [4]Different hybrids between *Piaractus* sp. and *Colossoma* sp.; [5]Different hybrids between *Pseudoblatystoma* sp. and *Leiarius* sp.

virtually nil. In such a scenario, opportunities to develop marine aquaculture business in Brazil are limitless and competition-free, pointing to an urgent need to develop, or test and adapt, new technologies to foster the business.

When the main imported fish groups in weight and proceeds (Figures 5 and 6) are considered, it could be reasoned that fish imports are driven by consumers' preference for fish that cannot be farmed or trawled in Brazil, such as cod, salmon and hake. Many species of salmon and cod (*Gadus morhua*), chiefly salted codfish, for a long time have been the main aquatic organisms imported by Brazil (Figure 5), closely linked to the boom in Asian cuisine, especially Japanese, and the traditions of Portuguese cuisine, which dates back to colonial times, respectively.

The rainbow trout, *Onchorhynchus mykiss*, was introduced in Brazil in the early nineteen-fifties (Lazarotto and Caramaschi, 2009) for the purposes of stocking and setting up the fauna and farming in altitude streams. However, rainbow trout can be farmed only in a few of the country's high-altitude, micro regions of South and Southeast Brazil where the water temperature is below the species' maximum threshold. This geographical limitation is reflected in an annual production of a mere 0.9 tons (IBGE, 2014). Nonetheless, consumer preference for salmonid fish and products is considerably strong.

From 2005 to 2015, imports of salmon increased 6.8 times, in spite of an 18 % reduction in 2010 after a crash in the Chilean salmon industry, whose production levels declined from 650,000 to 400,000 MT as a result of infestation with infectious salmon anemia (ISA) of farmed stocks (Barton and Floysand, 2010; Estima et al., 2014). In the same period, salmonid trout (as defined by Salán et al., 2006) imports grew by 350 %, rising from 1,249 to 5,619.5 MT, an indication of the capture of a share of the salmon market in Brazil by the salmonid trout industry. It is thus safe to infer that aspect, appearance, "looks", take on real importance in the selection of fish and fishery products by consumers, who seem to be more interested in differentiated product rather than its origin or even the species of fish being marketed. "Salmonification" may yield more intensely colored fishery products than the natural coloration of salmon flitches, darnes or fillets, and this is a technique that could easily be adopted by Brazilian fish farmers (Salán et al., 2006). Actually, a number of players in the private sector are already eyeing this promising market. Walmart Brazil, for instance, has retained an agreement with an aquaculture cooperative and Santa Cruz State University, Ilhéus, BA, with the aim of developing a "salmonification" technique and omega-3 enrichment of tilapia fillets (Walmart Brasil, 2012).

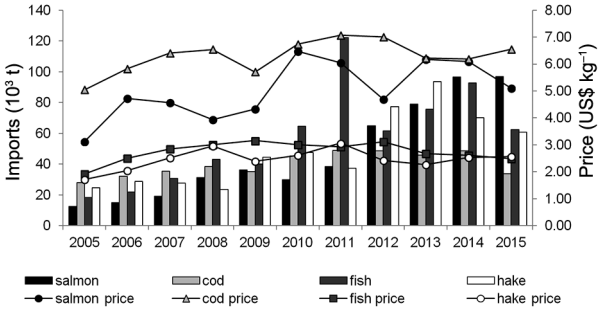

Figure 5 – Quantity and price of Brazil's main imports of fish and fishery products from 2005 to 2015; Graph from data mined at: Aliceweb.

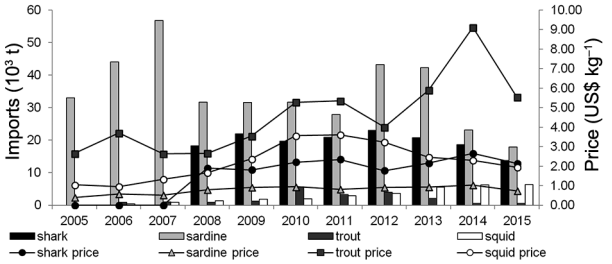

Figure 6 – Quantity and price of Brazil's imports of the main fishes from 2005 to 2015; Graph from data mined at: Aliceweb.

Brazil is the world's largest consumer of salted codfish, priced between $ 10.00 and $12.00 kg^{-1} (Jankavski, 2013), and imports of this product grew nearly 26 % in the studied period. Polar cod and other lower-priced ($ 4.00 to 6.00 kg^{-1}) species of the Genus *Gadus* sp. also share this market. Imports of the category "fish" without specific species rose steadily starting in 2010, reaching a peak in 2011 with a sizable increase in the imports of *Pangassius* sp. (Figure 7).

From 2009 to 2015, Argentina, China and Vietnam were the biggest exporters of chilled and frozen fish fillet to Brazil, 78 and 89 % of total, respectively. Imports of frozen fillet from Vietnam increased 1,944 % in weight and 2,026 % in value, reaching 67,108 MT and $ 134,016 in 2014. There is evidence that imports of pangassius catfish accounted for this growth, an increase from 4 to 40 % of total frozen fillet imports from Vietnam during this period. This scenario was the probable cause of the reduction of the participation of Argentina during

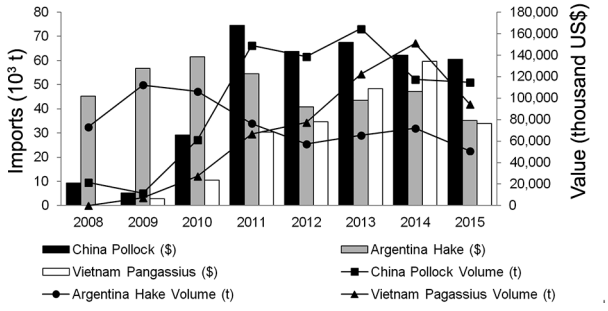

Figure 7 – Quantity and price of Brazil's imports of the category "fish" from China, Argentina and Vietnam from 2008 to 2015; Graph from data mined at: Aliceweb.

the period, from 55% down to 19% (Figure 7). The significant decrease in imports from Vietnam in 2015 more likely resulted from the holdup in pangassius imports in Sept 2014, when a noncompliance, restrictive note on sanitary regulations was issued by Brazilian regulatory agencies on Vietnamese pangassius. Restrictions were suspended in June, 2015, but no data on pangassius imports have been released since then (Seafood Brazil, 2014; Seafood Brazil, 2015).

Hake was the main fish imported in 2013 (93.5×10^3 MT), but as a rule imports of hake stand behind imports of salmon and "fish". The hake category represents a group of several species, such as Argentine hake (*Merluccius hubbsi*), European hake (*Merluccius merluccius*), pink hake (*Macruronus megellanicusque*), Alaskan hake (*Theragra chalcogramma*), and the Patagonian toothfish, or simply toothfish (*Dissostichus eleginoides*). It is therefore no easy task to identify the organoleptic characteristics that explain the preference of Brazilian consumers for this fish. However, the average price for this food item in 2012 was US$ 2.43 kg^{-1}, clear cut evidence of a larger demand for low-priced fishery products, a rather important market share and niche, which meets the demands of a very large social income class in Brazil. An exception would be the Patagonian toothfish, also known as deep-sea cod, which presents a specific market price nearing US$ 24 kg^{-1}, but currently occupies a trading niche and share of low significance of only 9 MT in 2011.

Shark imports reachd a plateau at 20,000 MT per year, a market share value of $ 48 million. Apparently the reasons why this product accounts for a considerable market share are its low price (about US$ 2.00 kg^{-1}) and easy conservation (frozen).

Imports of sardines and sardinella were almost exclusively restricted to the pickling and canning industry (IBAMA, 2011). Because of low supply, Brazil's government granted a tax reduction on imports of fresh sardines starting in 2001 (MDIC, 2001; MDIC, 2003; MDIC, 2004), a strategy which has resulted in a steady growth in import tonnage. The price range practised by foreign markets has reduced the competitiveness of Brazilian sardines and sardinella products, thereby discouraging the country's producers.

According to Brazil's Program of Competitive Substitution of Imports (Brazil PSCI), increased imports of mackerel (*Scomber scombrus*, *Scomber australasicus*, *Scomber japonicus*) averaged 9 % between 2003 and 2006, main suppliers being Norway, the UK, and Japan. However, the largest Brazilian supplier in the period was actually Argentina, capturing a market share of approximately 84 %, the remaining smaller shares going to Morocco, Ecuador, Chile, Norway, United States, Taiwan, Spain, and Panama. Although significant, tonnage trading of mackerel was not sizable in weight, peaking at 8.5 MT in 2011 when prices averaged $ 1.35 kg^{-1} (Figure 6), it is worth remarking that this scenario was underscored by the increase in mackerel imports which helped filling up the market gap in hake.

The fishery product trade and seafood prices

Imported products were divided into two average price categories: above and below US$ 3.50 kg^{-1} (Figure 8), cod and salmon, in particular, standing above that value. Products priced above US$ 3.50 kg^{-1} accounted for 28 to 35 % of total imports during the studied period. However, imports of the most expensive products totaled 146,000 MT in 2014, while imports of the cheapest products amounted to 254,000 MT, that is, 60 % of imported product.

Products priced below US$ 3.50 kg^{-1} included hake, sardines, mackerel and shark. This group also comprises several species already produced or which could be substituted by other species produced and/or catched in Brazil, such as "curimbata" (*Prochilodus* sp.), croaker (Sciaenidae), "piaus" (Anostomidae), "pacu" (*Piaractus mesopotamicus*), flounder (unspecified), catfish (both marine and freshwater, unspecified), and a few other species more likely to be marketed at affordable prices. This is even more true in the case of tilapia (*Oreochromis* spp.), carp (*Cyprinus carpio*), and sunfish Characins (pacu, tambaqui *Colossoma macropomum*, pirapitinga *P. brachypomus*, and their reciprocal "hybrids"), all proved as part of well managed and economically feasible agribusiness chains (Ayroza et al., 2011; Barros and Martins, 2012; Garcia et al., 2013; Hernandez et al., 2014; Scorvo Filho et al., 2007; Scorvo Filho et al., 2010). It is thus evident that fish and fishery products priced below US$ 3.50 kg^{-1} share a pool of species and significant volume of imports which, notwithstanding, might be replaced by national production.

Over the past five years, three main categories represented 60 % to 70 % of total imports. Between 2005 and 2015, salted cod lost some relative importance, whilst fresh salmon and frozen fillet increased their relative importance. Both salmon and cod are priced above $ 3.50 kg^{-1} and, together, share 30 % of the total market in terms of weight and 45 % of market proceeds. On the other hand, the market share of frozen fillet, which is in the product group priced below $ 3.50 kg^{-1}, is nearly 35 % of marketed weight and 20 % of market proceeds (Figure 9).

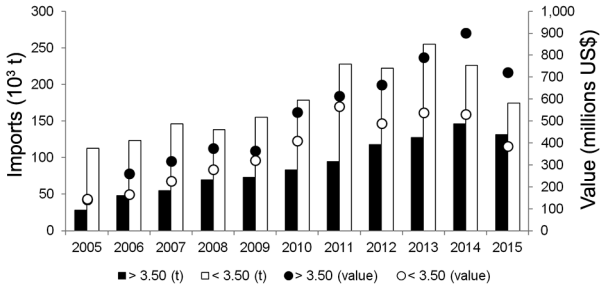

Figure 8 – Quantity and value of imported fish in two price ranges from 2005 to 2015; Graph from data mined at: Aliceweb.

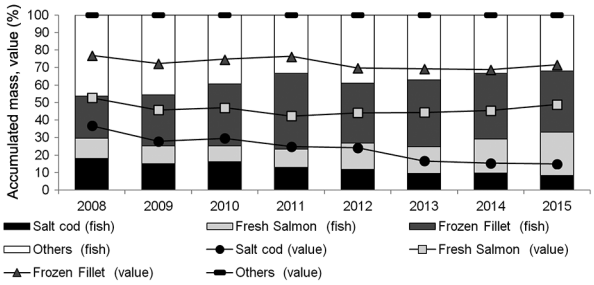

Figure 9 – Accumulated percentage of mass and value of four main categories of imported fish from 2008 to 2015; Graph from data mined at: Aliceweb.

Final Remarks

The marketing of fish and fishery products in Brazil is continuously challenged to reduce the trade deficit. This scenario requires developing products to meet and match three main market niches: (i) fresh, gutted, high priced fish (especially salmon), whose imports increased in the last 4 years; (ii) salted, dried, high priced fish (cod), whose imports show a very modest increase over the past 7 years, but still represent a sizable total; (iii) frozen fish fillet, lowest priced product ("fish" and hake), whose total numbers, weight and proceeds are the most relevant. It also requires fostering exports of products, especially viscera and processing by-products, unsuited to the population's feeding habits and Brazilian cuisine, but appreciated overseas. The replacement of fish imports by domestic production is not enough to enable consumers to identify technical, qualitative or organoleptic equivalence between products. Developing strategies for the production of fish and fishery products at competitive prices and quantities which meet consumer demand is an immediate need, and the development of the aquaculture industry a rational strategy.

Finally, it is opportune to point out that this review comes to light at the same time as the United Stated Department of Agriculture [USDA] publishes a historical data set on the economics of the fishery product trade in the United States of America (http://www.ers.usda.gov/data-products/aquaculture-data.aspx), which ignites concerns in the Brazilian fishery and aquaculture companies, since Brazil is emerging as a large seafood importer, and is thus becoming a target for exporters, and has been simply written off as a seafood supplier, especially to the American market, the world's leading seafood importer, a fact that has not gone unnoticed by market experts and analysts.

It is not (yet) safe to say that an economic war is imminent, but a serious economic struggle is on the rise. Hence, this analysis will certainly prove useful for Brazilian and overseas readers alike, especially since, for the time being, no other source of information on the economics and trading of seafood in Brazil is at hand.

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