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Performance on Sanitary and Environmental Indicators and the Demand for Exports of Fishery Products: Case Study of the Shrimps and Prawns from Mozambique

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Abstract

The trade of fishery products is increasing, raising the concerns regarding their sanitary and environmental conditions. In fact, recent foodborne incidences involving fishery products induced importers' countries to adopt stringent border inspections and risk analysis. Using Mozambican exports to its main destinations as a case study, this study test whether the sanitary and environmental indicators are determinant for the demand of shrimps and prawns exported, based on the export demand model. The regression indicates that sanitary and environmental issues (represented by the cases detected at the importer's borders) are significantly and negatively correlated with the demand of shrimps and prawns.

Key Words: Mozambique; Sanitary and Environmental Measures; Frozen Shrimps and Prawns; Export Demand Model

1. Introduction

The international trade of fishery products is increasing, and with it, the concerns regarding the sanitary and environmental conditions of these products (De Waal 2003; Ababouch 2006). In fact, over the past decades, several foodborne diseases incidences originated from inadequate sanitary and environmental factors were reported worldwide, mainly in developed countries. Such impressive detected cases are explained by the improved hazards detection methods (De Waal 2003; FAO and WHO 2005; Ababouch 2006) and by the developed countries' dependence on fishery originated from developing countries (De Waal 2003; Ababouch 2006).

The figures on the border detection cases reveals that all species of fishery can be vehicles of illnesses to human, especially those caused by pathogens (*Salmonella* spp, *Vibrio parahaemolyticus*,

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Staphylococcus aureus, *Escherichia coli, Vibrio cholera*), parasites (Nematodes, Cestodes, Trematodes), toxins (Paralytic shellfish poisoning, Neurotoxic shellfish poisoning, Diarrhetic shellfish poisoning, Amnesic shellfish poisoning and Ciguatera fish poisoning), decomposition (Histamine, Putrecine, Cadaverine), environmental contaminants and pesticides (Mercury, Cadmium, Lead), drugs (Banned or prohibited), additives (Sulphites, Nitrates, Cyclamate) or by strange objects in foods (Plastic or Metal fragments) (Ababouch 2006).

To reduce the probability of occurrence of foodborne diseases, importing countries are reorganizing their food safety systems, increasing the number of border mandatory inspections, and enforcing stringent risk analysis (FAO and WHO 2005; Korinek *et al*. 2008). They are also exchanging and spreading information on the safety of food and feed, and especially of seafood (Korinek *et al*. 2008). This suggests that sanitary and environmental factors are determinants of the trade in food products.

Mozambique is a sea-dependent developing country, where seafood products and fishing activities play a crucial role. The recent development strategies point that agro-food industries shall be restructured to induce economic growth and promote job creation. To meet these targets, both production and exports shall be expanded, and the strengths and weaknesses at the supply and demand sides should be assessed.

The selection of the case study is explained by the importance of shrimps and prawns at the domestic level. Indeed, shrimps and prawns generate valuable exchange earnings in Mozambique, which are increasing at an annual average of 8.654％. The commercial fishing industry–also, highly dependent on shrimps and prawns–provide employment, and has potentiality of being expanded by doubling or tripling its actual size.

Mozambican small share in the world market, however, imply that the market forces and the demand side are important. Therefore, this paper assesses how the performances on sanitary and environmental indicators are correlated with the demand for exports of fishery products, specially the frozen shrimps and prawns. The sanitary and environmental conditions are represented by the *border detection cases*, as reported by the importer's food and feed safety authorities. Concretely, *border detection cases* comprise a set of notifications reported as hazards to health or to the environment, including to animals and plants.

After this "Introduction", the paper follows by presenting the world trade figures of shrimps and prawns, as well as the sanitary factors that influences its tradability (Section 2). Then, the focus turns to the case study, by describing the export direction for shrimps and prawns and the sanitary and environmental conditions that affects the exports of these products in Mozambique (Section 3). The methodology, data and sources are reported in the Section 4, while the regression's results and discussion appears in the Section 5. The conclusions and policy implications appears in the Section 6.

2. Shrimps and Prawns in the International Trade

2.1 Shrimps and Prawns: World Trade Figures

Shrimps and prawns comprehend large number of species of the sub-order *Decapoda Natantia*, all of them used for human consumption (Holthuis 1980). Although they are among the most valued fishery products, specially the *Panaeidae* family (FAO 2010), some species are not yet exploited commercially (Holthuis 1980). They are found and harvested in any latitude, but the most traded in the world are the warm-water shrimps, caught in the inter-tropical waters. Recent data indicates that a significant amount of shrimps and prawns comes from aquaculture farms, influenced by the reduction in marine and inland captures (FAO 2010).

The world's shrimps and prawns trade and production figures are presented in the Figure 1. By production, Asia and Americas share the first and second positions. As for 2006–09, Asia production reached 3,332,937 tons (52.33%) while Americas reached 2,499,539 tons (39.25%). In exports, Asia and Americas are leading, having exported 3,462,130 tons (51.56 %) and 1,912,753 tons (28.49 %),

Figure 1 Shrimps and Prawns Trade and Production, Quantity (Tons)

	Trade Flow	1976–80	1981–85	1986–90	1991–95	1996–00	2001–05	2006–09
Africa	Export	69,553.0	98,830.0	130,618.0	158,501.0	176,780.0	216,045.0	228,717.0
	Import	86.0	168.0	9,205.0	19,235.0	16,488.0	33,343.0	87,439.0
	Production	60,601.0	90,526.0	129,309.0	146,581.0	188,104.0	211,942.0	148,143.0
Americas	Export	429,287.0	659,130.0	870,098.0	1,193,821.0	1,451,898.0	1,965,067.0	1,912,753.0
	Import	518,331.0	687,577.0	1,068,223.0	1,358,115.0	1,602,407.0	2,098,396.0	1,896,260.0
	Production	884,805.0	1,120,642.0	1,501,316.0	1,771,906.0	1,993,383.0	2,535,802.0	2,499,539.0
Asia	Export	727,996.0	848,414.0	2,036,453.0	2,797,515.0	2,813,384.0	3,739,248.0	3,462,130.0
	Import	797,349.0	999,913.0	1,710,958.0	1,906,930.0	1,805,318.0	2,091,597.0	1,591,546.0
	Production	717,957.0	839,581.0	1,710,289.0	2,669,498.0	2,799,925.0	3,260,291.0	3,332,937.0
Europe	Export	166,715.0	261,517.0	480,069.0	568,398.0	833,639.0	1,183,130.0	1,081,649.0
	Import	331,834.0	541,840.0	1,093,275.0	1,618,890.0	1,919,146.0	2,960,615.0	2,915,116.0
	Production	238,192.0	246,758.0	367,355.0	418,688.0	464,624.0	524,686.0	365,583.0
Oceania	Export	46,805.0	72,190.0	69,154.0	61,708.0	77,583.0	66,110.0	29,109.0
	Import	6,248.0	17,842.0	29,302.0	40,795.0	52,806.0	95,791.0	92,629.0
	Production	42,898.0	68,476.0	62,758.0	56,252.0	66,138.0	54,297.0	22,686.0
World	Export	1,440,356.0	1,940,081.0	3,586,392.0	4,779,943.0	5,353,284.0	7,169,600.0	6,714,358.0
	Import	1,653,848.0	2,247,340.0	3,910,963.0	4,943,965.0	5,396,165.0	7,279,742.0	6,582,990.0
	Production	1,944,453.0	2,365,983.0	3,771,027.0	5,062,925.0	5,512,174.0	6,587,018.0	6,368,888.0

Data Source: FAO FISHSTAT

respectively. For imports, Europe, Americas and Asia were in the top three, having imported 2,915,116 tons (44.28%), 1,896,260 tons (28.81%) and 1,591,546 tons (24.18%), respectively. By countries (and markets), the main shrimps and prawns importers are the EU, Japan and the USA (FAO 2010).

2.2 Sanitary and Environmental Issues and the Trade in Shrimps and Prawns

Many countries–concretely the major importers–are detecting several irregularities, brought to them by fresh, cooked, boiled or frozen shrimps and prawns, despite the implementation of the HACCP (Hazard Analysis and Critical Control Points). Apparently, the implementation of the HACCP, whose goal is to generate safe food, remains a challenge at the exporters' side.

The Figure 2 reports cases of crustaceans–crabs, lobsters, crayfish, and shrimps and prawns–rejected at the EU and Japanese borders due to sanitary and environmental reasons. Once rejected, the products were redirected to others markets, returned to their origin or destructed at the importer's borders. The figure on the *border detection cases* shows that unauthorized food additives, prohibited or abnormal levels of chemical products, and pathogenic micro-organisms are the main concerns reported, both for the EU and for Japan.

The general principles and requirements of food law and the procedures in matters of food safety required by the EU are described in the European Parliament and Council Regulation (EC) No. 178/2002 of 28 January 2002. According to it, if a third-country firm is approved by a competent authority it is included in a positive list and can export. This requirement induces exporting firms and plants to be inspected periodically by the EU technical teams.

The EU's marketing standards for fishery products appears in the Council Regulation (EC) No. 2406/96 of 26 November 1996. This regulation describes the sizes and freshness standards of fishery products accepted in that market. Third-countries exporting firms must be in capacity to run periodic tests to control for *Staphylococcus Aureus,* and *Escherichia Coli*, as well as to carry out tests in all the surfaces that touches fishery products. Additionally, exporting firms shall, regularly, check the sanitary conditions to its personnel and equipments.

The requirement for exporting seafood products to Japan appears in the Food Sanitation Act (Act No. 233 of December 24, 1947), enacted to prevent sanitary hazards resulting from foods and drinks (JETRO 2006). The act is enforced by a Food Safety Commission, which gather the Ministries of Agriculture, Forestry and Fisheries and of Health, Labor and Welfare. Due to its high dependency on imported seafood, Japan is particularly vulnerable to unsafe imported products.

As for shrimps and prawns, Japan requires two checking points, one at the exporting countries and the other at the Japanese borders. However, is not uncommon checking the products during their retail and distribution stages (GAO 2008). Despite the exporter's sanitary and environmental control measures, the Figure 2 shows that Japan continues to report significant figures of imported hazards detected at the borders.

Figure 2 Notifications at the Importer's Border due to Sanitary and Environmental Reasons (1980–85 — 2011–12)

Crustaceans, World

Hazard Category	Importer	1980–85	1986–90	1991–95	1996–00	2001–05	2006–10	2011–12	Total
Sanitary Reasons									
Allergens	EU						1		1
	Japan							1	1
	Sub-Total						**1**	**1**	**2**
Biotoxins	EU	1			2	6	1		10
	Japan						5	2	7
	Sub-Total	**1**			**2**	**6**	**6**	**2**	**17**
Food additives	EU				1	140	166	30	337
	Japan						211	34	245
	Sub-Total				**1**	**140**	**377**	**64**	**582**
Organoleptic aspects	EU				1	9	12	10	32
	Japan								
	Sub-Total				**1**	**9**	**12**	**10**	**32**
Pathogenic micro-organisms	EU	2	1	1	93	186	42	15	340
	Japan						35	28	63
	Sub-Total	**2**	**1**	**1**	**93**	**186**	**77**	**43**	**403**
Residues of veterinary products	EU					313	257	30	600
	Japan						5	4	9
	Sub-Total					**313**	**262**	**34**	**609**
Environmental Reasons									
Chemical contaminants	EU						1		1
	Japan						236	143	379
	Sub-Total						**237**	**143**	**380**
Foreign bodies	EU						1		1
	Japan						1	2	3
	Sub-Total						**2**	**2**	**4**

Heavy metals	EU		1			35	104	5	145
	Japan						5	2	7
	Sub–Total		**1**			**35**	**109**	**7**	**152**
Industrial contaminants	EU						5	4	9
	Japan								
	Sub–Total						**5**	**4**	**9**
Radiation	EU					1	1	2	4
	Japan								
	Sub–Total					**1**	**1**	**2**	**4**
Others (Related to Sanitary and Environmental Reasons)									
Labelling absent, incomplete or incorrect	EU					6	2		8
	Japan								
	Sub–Total					**6**	**2**		**8**
Non-pathogenic micro-organisms	EU	2			5	28	2		37
	Japan						3	1	4
	Sub–Total	**2**			**5**	**28**	**5**	**1**	**41**
Not determined	EU						1		1
	Japan						13	7	20
	Sub–Total						**14**	**7**	**21**
Packaging defective or incorrect	EU					1	3	1	5
	Japan								
	Sub–Total					**1**	**3**	**1**	**5**
Poor or insufficient controls	EU				2	2	36	37	77
	Japan								
	Sub–Total				**2**	**2**	**36**	**37**	**77**
TOTAL		5	2	1	104	727	1,149	358	

Note: 2012: up to 31 October 2012

Data Sources: EU RASFF (EU–Rapid Alert System for Food and Feed) and Japanese Ministry of Health, Welfare and Labour (Imported Foods Inspection Services)

In Figure 2, the increased number of unauthorized food additives detected is explained by the increasing trade of processed foods and by the tendency of using preservers'. The figures on the abnormal level of chemical products are explained by the trend of altering the water's chemical characteristics to enhance its safety, to avoid contamination at the production, processing and transportation phases. The huge numbers of pathogenic micro-organisms detected constitute evidences that processed crustaceans can be vehicle of diseases, justifying, thus, the increased number of banishments, withdrawal or the incinerations of the fishery products at the borders (Tauxe *et al.* 1994; FAO and WHO 2005).

All these reasons, together, disclose the vulnerability of the developing and tropical countries as fishery exporters: they are the main exporters. Their bad sanitary and environmental conditions, plus the usage of unsafe water sources tend to favor cyclical and recurrent appearance of health and environmental problems. In fact, the majority of exports rejected at the EU and Japanese borders are originated from developing countries of Southeast Asia (including China), Latin America and Sub-Saharan Africa.

3. Case Study: Shrimps and Prawns from Mozambique

3.1 Shrimps and Prawns Production

Mozambican shrimps and prawns production is composed by captured and aquacultured products. Captures are carried out by the commercial and artisanal actors. The aquaculture production is strongly concentrated in the commercial sector, in marine waters. The Figure 3 provides figures on the 2006–2011 shrimps and prawns production.

In the Figure 3, the overall trend indicates a slight decreasing of commercial captures and

Figure 3 Shrimps and Prawns Production in Mozambique 2006–2011 (Tons)

	2006	2007	2008	2009	2010	2011
Captures Production						
Commercial	7,393	7,046	5,395	5,339	5,654	4,620
Artisanal	1,367	838	2,087	2,508	4,320	1,825
Sub–Total Captures	**8,760**	**7,884**	**7,482**	**7,847**	**9,974**	**6,445**
Aquaculture Production						
Marine	995	693	602	374	667	506
Sub–Total Aquaculture	**995**	**693**	**602**	**374**	**667**	**506**
TOTAL	**9,755**	**8,577**	**8,084**	**8,221**	**10,641**	**6,951**

Data Source: Ministry of Fisheries–Mozambique

aquaculture production, while the artisanal captures are increasing modestly. Taking 2006 as the year-base, the 2011's production decreased 28.74% , negatively affected by marine aquaculture (49.15%) and by the decreases in commercial captures (37.51%).

3.2 Exporting to Higher Standard Consumers

The most important destinations of the Mozambican exports of shrimps and prawns are the EU, Japan and South Africa. In the EU, Mozambican shrimp's exports are destined to Mediterranean countries, notably to Spain, Portugal and Italy. The EU alone has been responding for more than 70% of the quantities exported and more than 75% of the values, being the remaining shared by the others markets, notably by Japan and South Africa.

Figure 4 Top 10 Crustaceans Producers, Processing and Exporter's in 2008, in Quantity (Tones)

	Company	Shareholders	Activity Region	Activity (Crustaceans)	Share (%)	Main Destinations
1	Pescamar	Mozambique and Spain	Captures, Sofala bank	Shrimps, lobster	24.039	EU
2	Krustamoz	Mozambique and Spain	Captures, Sofala bank	Shrimps, lobster	17.934	EU, Japan, South Africa
3	Efripel Lda	Mozambique and Japan (a)	Captures, Sofala bank	Shrimps, lobster, crab	8.872	EU, Japan
4	Gambeira, Lda	Mozambique	Captures, Sofala bank	Shrimps, lobster, crab	7.736	EU, South Africa
5	Indicus Pesca	Mozambique	Captures, Sofala bank	Shrimps, lobster, crab	7.214	EU, South Africa
6	Pescabom, Lda	Mozambique	Captures, Sofala bank	Shrimps, lobster	5.822	EU, South Africa
7	Sol & Mar Lda	Mozambique	Captures, Sofala bank	Shrimps, lobster	3.672	EU, South Africa
8	SIP, Lda	Mozambique	Captures, Sofala bank	Shrimps, lobster, crab	1.633	EU, South Africa
9	Pestrai, Lda	Mozambique	Captures, Sofala bank	Shrimps, lobster	0.636	EU, South Africa
10	Aquapesca	Mozambique and France	Aquaculture, Inhassunge	Shrimps	12.738	EU, South Africa and Middle East
11	Others (56 firms)	Mozambique and others	Captures and aquaculture	Shrimps, lobster, crab	9.703	EU, South Africa, Middle and Far East

Note: (a) The company shareholder had been rearranged recently

Data Source: Author, from the Ministry of Fisheries–Mozambique

The direction of exports to EU countries is explained by cultural and historical linkages (colonization by Portugal), the existence of fishing agreements between EU and Mozambique (EC 1987a; EC 1987b; EC 2003), the presence of EU fishing multinational subsidiaries in Mozambique, favorable prices in the EU, existence of unilateral preferential trade agreement between ACP countries and EU, and the established huge demand for highly valued shrimps in many EU countries.

Since Mozambique is poorly equipped to process fishery products, shrimps and prawns are modestly treated, consisting basically of removing objectionable materials, cleaning and control for specific parameters required for health and sanitary standards, usually at land-based processing units (aquaculturers and semi-industrial firms) and at sea (industrial capturers firms) (EC 1998c; EC 2001; EC 2006; EC 2007). Typically the outputs are block frozen headless shrimps and prawns.

As the Figure 4 shows, the crustaceans' producers, processing plants and exporters comprehend either *joint-venture* with foreign and entirely national firms. Although the most important exporting companies are subsidiary of foreign firms, it seems that their sanitary and environmental compliance level is poor, by looking to the importer's *border detection cases*, reported in the Figure 5. For Japan, however, there is no any border notification concerning shrimps and prawns or fisheries originated from Mozambique for 2006–2012, according to the Japanese Ministry of Health, Welfare and Labour (Imported Foods Inspection Services).

Although the data presented in Figure 5 does not reveal from which company the detected fishery products comes from and what are the quantities whose import was refused at the importers' borders, they show the importance of sanitary and environmental issues on the trade of crustaceans and products thereof. Spain, Portugal and Italy, the most important importers of Mozambican shrimps and prawns are the country which reported the cases. Their main concerns are on the control of the cold chain, which, once broken, leads to poor temperature, decomposition and contamination by pathogens and parasites.

In fact, located in tropical zone and surrounded by others low-income countries, Mozambique reports, annually, several cases of infectious and environmental-caused diseases. Moreover, the living, production and consumption conditions have been influenced by a destructive civil war (1977–1992), disorganized and dirty slums surrounding the main cities and villages, and by the deteriorated system of water supply, which is permeable to contamination. Additionally, the domestic system for waste management in cities, most of them located along the Indian Ocean is inappropriate to deter the outbreak of infectious diseases and the contamination with chemical products, like pesticides and heavy metals, plastics, chlorines, fossil fuel burning and waste residues.

The evident example of the effect of the sanitary and environmental issues in the trade of shrimps and prawns was the partial banishment of fishery from Mozambique, exported to the EU market, when in 1997–98 a cholera epidemic emerged in West Indian Ocean African countries, affecting Kenya, Uganda, Tanzania, and Mozambique. Believing that cholera agent can contaminate animals and animal

Figure 5 Cases Detected at the EU Borders as Violating Health and Environmental Measures Crustaceans from Mozambique, (1998–2012)

Year	Notified by	Quantity	Sanitary Reasons	Action Taken
1998	European Union	Alert	*Vibrio parahaemolyticus* and *Vibrio cholerae* in shrimps	Imports, only after additional tests
2001	Portugal	1	*Vibrio cholerae* and *Vibrio parahaemolyticus* in frozen shrimps	Import refused
	Spain	1	Rupture of the cold chain of frozen shrimps	Import refused
	Italy	1	Rupture of the cold chain of frozen shrimps	Import refused
2002	Portugal	1	Altered organoleptic characteristics and rupture of the cold chain of chilled shrimps	Destruction
2003	Spain	6	Rupture of the cold chain of frozen shrimps	Destruction
2004	Spain	4	Rupture of the cold chain of frozen shrimps	Destruction
2006	Portugal	1	Rupture of the cold chain of frozen shrimps	Re-dispatch
	Italy	1	Rupture of the cold chain of frozen shrimps	Re-dispatch
2010	Spain	3	Rupture of the cold chain of frozen shrimps	Destruction
2011	Italy	1	Improper health certificate for frozen Andaman lobster	Re-dispatch
	Spain	5	Altered organoleptic characteristics and rupture of the c--old chain of chilled shrimps	Destruction
		6	Rupture of the cold chain of shrimps	Re-dispatch
		1	Altered organoleptic characteristics and rupture of the cold chain of chilled shrimp tails	Destruction
		1	Too high sulphite in chilled prawn tails	Destruction
2012	Spain	1	Too high sulphite in frozen shrimps	Destruction
		5	Rupture of the cold chain of frozen shrimps	Import refused
Year	**Notified by**	**Quantity**	**Environmental Reasons**	**Action Taken**
2006	Spain	2	Heavy metals in frozen prawns	Re-dispatch

Note: 2012: up to 31 October 2012
Data Source: EU–RASFF (Rapid Alert System for Food and Feed); EC (2001); EC (2006); and EC (2007)

products, the EU reacted by imposing a provisional prohibition on imports to "fresh fishery products" (Article 2, Commission Decision No. 97/878/EC of 23 December 1997). The decision, however, was not applicable to "fishery products caught, frozen and packaged in their final packaging at sea and landed directly on Community territory" (Article 1, Commission Decision No. 97/878/EC of 23

December 1997).

Under that decision, exports of frozen and processed fishery products (except sterilized products) were only possible after a rigorous and repeated microbiological sampling test and detection methods for the presence of *Salmonellae* and vibrios. According to Article 6 (Commission Decision No. 97/878/EC of 23 December 1997), all expenditures incurred by the application of these stringent sampling and detection methods were charged to the consignors, consignees, or to agents. After reviewing the previous provisional decision, the EU reaffirmed their prohibiting-decision, and enacted another decision, Commission Decision No. 98/84/EC of 16 January 1998, maintaining all the measures previously taken.

Despite the WHO (World Health Organization) intervention claiming that fish were unlikely means for transmitting cholera (Oxfam 2002: 105), the banishment only terminated in July 1998, according to the Commission Decision No. 98/418/EC of 30 June 1998. The removal of the prohibition was decided after affected exporting countries agreed to provide appropriate guaranties to protect fishery, by carrying-out rigorous and additional medical supervisions on all personnel working and handling the products, in line with the Commission Decision No. 95/328/EC of 25 July 1995.

4. Methodology and Data

4.1 Export Demand Equation

To study if the performance on the sanitary and environmental indicators is determinant for the demand of fisheries products exported by Mozambique, we use the export demand function. The arguments are, basically, two: at the theoretical level, most of the empirical studies are concentrated on demand relationship (Taplin 1973; Sato 1977), and because export supply exists independent from the demand only assuming a perfectly competitive market, where prices can be taken as exogenous (Goldstein and Khan 1978). At the practical level, shrimps and prawns are competitive in the international market (FAO 2010), and we can assume that their prices will depend on the quantities.

Along the history, the demand equation was used by others studies to capture others determinants. For instance, in the food intake studies, population's age structure (Parks and Barten 1973), household sizes, degree of urbanization (Capps and Havlicek 1984); geographic distribution of the consumers, population density in cities, occupation of household head, educational level, employment status and age of household manager, number of children, ethnicity and religion (Cheng and Capps 1988), are among the variables studied. In the international trade, it was enlarged to predict the factors influencing the demand of exports originating from developing countries (Sato 1977; Lawrence 1990).

Assuming an imperfect substitute model, where neither imports nor exports are perfect substitutes for domestic goods, the country i's imports from, and exports to, are expressed in the following way:

$$\log EXPO_{jt} = a_0 + a_1 \log POWN_{jt} + a_2 \log PSUB_{it} + a_3 \log YIMP_{it} + \varepsilon_t \quad (1)$$

Where: $EXPO_{jt}$ is the quantity of exports demanded; $POWN_{jt}$ is the price of exports from j to i; $PSUB_{it}$ is the domestic prices of substitute goods of the trading partners; and $YIMP_{it}$ is the weighted average of the real incomes of the trading partners. The $a_0$is the constant term; a_1 and a_2 are prices elasticities, and a_3 is the income elasticity. The subscripts i refers to the importers, while j refers to exporting country, and ε_t is the error term.

The equation (1) presents the basic determinants of exports: prices and income. To study the impact of sanitary and environmental indicators in the demand for shrimps and prawns exports originated from Mozambique we added a new variable, the *number of border detection cases*; then the equation (1) can be specified to Mozambican case and it becomes:

$$\log EXPO_{jt} = a_0 + a_1 \log POWN_{jt} + a_2 \log PSUB_{it} + a_3 \log YIMP_{it} + a_4 SAEV_{jt} + \varepsilon_t \quad (2)$$

Where: $SAEV_{jt}$ stands for the sanitary and environmental conditions, captured by the cases detected at the importer's borders as violations of sanitary and environmental measures. Based on the export demand theory, the expected signs are positive for a_2, and a_3 and negative for a_1 and a_4.

4.2 Data Sources and Description of the Variables

The export demand equation (2) is composed by the quantity of exports demanded, the price

Figure 6 Summary of the Data Sources, Description and Units

Variable	Description	Unit of Measurement	Source
$EXPO_{jt}$	Quantity of shrimps and prawns exports' demanded	kg	EUROSTAT and Japan Customs Clearance Statistics
$POWN_{jt}$	Price of shrimps and prawns exported from Mozambique	Unit value (in 2000 USD)	EUROSTAT and Japan Customs Clearance Statistics
$PSUB_{it}$	Domestic prices of substitute goods, in the trading partners	Unit value (in 2000 USD)	EUROSTAT and Japan Customs Clearance Statistics
$YIMP_{it}$	Weighted average of the real incomes of the trading partners	GDP per capita (in 2000 USD)	World Development Indicators of the World Bank; EUROSTAT and Japan Customs Clearance Statistics
$SAEV_{jt}$	Sanitary and environmental conditions	Number of border detection cases	EU–RASFF; EC 2001; EC 2006; and EC 2007; Japanese Ministry of Health, Welfare and Labour

Source: Author (Compilation)

Figure 7 Descriptive Statistics (1998–2011)

Country	Variable	Mean	Median	Maximum	Minimum	Std. Deviation	Observation
Spain	Export Quantity	4,621,728.643	4,593,001.500	9,115,931.000	2,004,462.000	1,815,980.706	14.000
	Own Price	6.953	5.414	16.347	2.987	4.211	14.000
	Subst. Price	6.292	6.235	10.380	3.728	2.048	14.000
	GDP pc	13,633.402	13,836.703	16,351.111	10.455.794	1.958.864	14.000
	Border Detection	2.214	1.000	13.000	0.000	3.599	14.000
Italy	Export Quantity	110,136.071	76,263.500	377,562.000	1,404.000	116,754.087	14.000
	Own Price	8.955	5.983	47.567	2.987	11.499	14.000
	Subst. Price	4.987	4.427	8.645	3.141	1.664	14.000
	GDP pc	18,405.878	18.697.220	20,291.227	15,768.267	1,395.961	14.000
	Border Detection	0.357	0.000	1.000	0.000	0.497	14.000
Portugal	Export Quantity	2,308,318.071	2,100,276.000	5,493,208.000	1,051,182.000	1,133,502.996	14.000
	Own Price	6.944	5.356	18.879	2.987	4.571	14.000
	Subst. Price	6.959	7.387	9.105	4.158	1.685	14.000
	GDP pc	10,493.119	11,097.155	11,965.997	7,899.155	1,319.833	14.000
	Border Detection	0.357	0.000	1.000	0.000	0.497	14.000
Japan	Export Quantity	1,140,041.786	937,631.000	4,218,567.000	31,094.000	1,149,056.509	14.000
	Own Price	6.181	5.356	11.818	2.987	3.076	14.000
	Subst. Price	7.782	6.886	12.758	4.273	2.619	14.000
	GDP pc	36,998.053	37,291.706	40,837.267	31,008.775	2,428.200	14.000
	Border Detection	0.000	0.000	0.000	0.000	0.000	14.000

Source: Author (Compilation)

of exports, the prices (own and substitute), importers' incomes and a sanitary and environmental indicator, which capture the conditions of exports. All the variables are annual observations, referent to 1998–2011. The observed products are shrimps and prawns, frozen (HS 030613).

The $EXPO_{jt}$, $POWN_{jt}$ and $PSUB_{it}$ come from EUROSTAT (for Spain, Italy and Portugal) and Japan Customs Clearance Statistics (for Japan). The substitute prices in Spain, Japan, Portugal, and Italy were, respectively, Argentinean, Indonesian, French, and Ecuadorian frozen shrimps and prawns, since they are the most important suppliers into respective countries.

The weighted average of the real incomes was obtained by multiplying the GDP per capita (in 2000 USD) by the share of imports in each year. The data on incomes are from the World Bank's World Development Indicators, while the imports are from EUROSTAT and Japan Customs Clearance Statistics. The $SAEV_{jt}$ reports the sanitary and environmental conditions in the exporting country, and they comes from the EU–RASFF, EC (2001), EC (2006), and EC (2007) (for EU countries) and Japanese Ministry of Health, Welfare and Labour (Imported Foods Inspection Services).

The Figure 7 reports the descriptive statistics of the variables. The number of observations (14) refers to annual observations from 1998 to 2011. For these years, data on quantities and values of exports of shrimps and prawns from Mozambique are available. Since the regression is a panel, the descriptive statistics is presented in country-by-country format.

To test for the stationarity of the panel data, we used the Levin, Lin and Chu (2002) unit root test. This method tests the panel time-series data, hypothesizing, as a null hypothesis, that each individual time series contains a unit root (H_0), against the alternative hypothesis that each panel time-series is stationary (H_1), where the lag order p is permitted to vary across individuals.

The results provide an expected figure, since the majority of specifications support the alternative hypothesis, that each panel time-series is stationary. The $PSUB_{it}$ and $SAEV_{jt}$ panel time-series have no trend, contrarily to $YIMP_{it}$ which contains trend.

Figure 8 Panel Unit Root Test: Methods (Levin, Lin & Chu Method)

Variables	Level, None	Level, Intercept	Level, Trend, Intercept
$EXPO_{jt}$	−0.261***	−0.605***	−1.152***
$POWN_{jt}$	−0.179***	−0.757***	−1.135***
$PSUB_{it}$	−0.092***	−0.117	−0.630
$YIMP_{it}$	−0.056	−0.568***	−0.968***
$SAEV_{jt}$	−0.583***	−0.904**	−1.301

***, and *** denotes significant at 1% , and 5% , respectively
Source: Author

5. Results and Discussion

The regression was done using the OLS technique. The objective was to test, using Mozambican shrimps and prawns exports as a case study, whether the sanitary and environmental indicator was a determinant for the demand of exports. The column 1 presents the results of all the four markets, Spain, Japan, Portugal and Italy. The result indicates the presence of autocorrelation problem, with the Durbin-Watson statistics equal to 0.537 and wrong coefficient signals on $PSUB_{it}$, and $SAEV_{jt}$.

In the column 2, Japan was dropped, since the country did not report any sanitary and environmental hazard brought by Mozambican imports of shrimps and prawns, frozen, for 2006–2011 (period in which data are available). Therefore, the total observation is 42, and the Durbin-Watson statistics as well as the expected signs are accordingly. The column 2 is the base of the discussion which follows below:

Figure 9 Results of the Panel Regression Dependent Variable: log$EXPO_{jt}$

Variables	(1)	(2)
Cons	2.586 (0.192) ***	2.443 (0.114) ***
$logPOWN_{jt}$	− 0.062 (0.174)	− 0.347 (0.099) ***
$logPSUB_{it}$	− 0.007 (0.331)	0.798 (0.194) ***
$logYIMP_{it}$	1.055 (0.055) ***	1.016 (0.030) ***
$SAEV_{jt}$	0.002 (0.018)	− 0.018 (0.009) *
Observations	56.000	42.000
R-squared	0.925	0.983
Adj. R-squared	0.919	0.981
D–W Statistics	0.537	1.630

Note: Standard error in parenthesis
***, and * denotes significant at 1% and 10% , respectively
Source: Author

5.1 Results of Income

By theory, the demand income elasticity expresses the behavior of quantities demanded when incomes changes, holding fixed the prices. Therefore, income elasticity is expected to be positive because, generally, an increase in income tends to increase the quantity demanded for a good. However, incomes tend to be sensitive to several factors, being the developing *vs* developed (country) dichotomy the most important factor (Fabiyi 1985).

The $YIMP_{it}$ possesses a positive sign (1.016) and is significant. Since the elasticity is slightly above 1, shrimps and prawns from Mozambique are luxury goods. This result prove the findings that in

developed countries, fish and seafood tend to be highly income elastic, and explains why the technical measures required are costly (Kumar *et al*. 2005). These results explain, also, why frozen shrimps and prawns from Mozambique are, almost, exclusively exported to EU (and Japan): higher income consumers demand "luxury" goods.

5.2 Results of Prices (Own and Substitute)

The demand price elasticity measures what changes in quantity by what changes in prices, expressed in percentages. From previous studies we found a mixture of results, depending on the methodology to estimate the elasticities, the species of fishery, the data's level of aggregation or the economic statute of the studied countries (Burton 1992; Lambert *et al*. 2006). Indeed, prices tend to be highly sensitive to the species, since fisheries are not homogenous, by the consumers' point of view.

The own price ($POWN_{jt}$) returns a negative coefficient (−0.347), which means that demand for exports, in quantities, is negatively correlated to own price. When prices of Mozambican processed prawns increases by 1% , the demand in the targeted market falls by 0.35% . The result suggests that frozen shrimps and prawns from Mozambique are price inelastic. The prices of substitute's shrimps and prawns ($PSUB_{it}$) are positively (0.768) and significantly correlated with the demand of exports of frozen shrimps and prawns, from Mozambique. When the substitute's prices increases by 1 % , the demand of exports also increases by 0.77% .

5.3 Results for Sanitary and Environmental Indicator

The result shows a negative coefficient and significant value (− 0.018). It confirms that food safety issues, represented by the sanitary and environmental indicators are determining the entrance of exports in the EU. The results are consistent with the idea that to gain access to markets, exporters must upgrade their sanitary conditions, addressing the product, processing and marketing standards. Inversely, this reveals how likely are the non-complying exporters to be banned or subjected to additional checking by the importers authorities.

In applications, the results means that when the $SAEV_{jt}$ increases by one unit, the quantity of frozen shrimps and prawns, from Mozambique, demanded by Spain, Portugal, and Italy decreases by 1.8% . Since the $SAEV_{jt}$ is measured by the *cases detected at the importers' borders*, due to sanitary and environmental violations, this coefficient suggests that, in average, each detected cases reduced the demand of Mozambican exports in 83,191.116 kg in Spain, 41,549.725 kg in Portugal, and 1,982.449 kg in Italy, per year.

Taking the average of the export's values (in 2000 USD), the sanitary and environmental indicator impacted the demand of shrimps and prawns exports by reducing 784,280.28 USD, caused by rejections, at-border destructions and reorientation of exports to others markets. By importers, the

losses in Spain, Portugal and Italy amounts to 515,105.74 USD, 256,739.57 USD and 12,434.97 USD, respectively.

6. Conclusion and Policy Implications

In trying to test whether the sanitary and environmental indicators was determinant for the demand of shrimps and prawns exported from Mozambique, we regressed an export demand model with panel data, covering Spain, Japan, Italy and Portugal, the main destinations. Japanese *border detection cases* are available only from 2006, while in others markets the data offers long time-series. Howsoever, in that period there is no any sanitary and environmental detected problem in Japan involving Mozambican shrimps and prawns.

Excluding Japan, the results indicate that sanitary and environmental issues (represented by *border detected cases*) are negatively and significantly correlated with the demand of shrimps and prawns exported from Mozambique. It suggests that Mozambique shall take a proactive role both domestically and internationally to improve its sanitary status.

The nature of the problems detected at the borders suggests that the focus shall be on the domestic side. Modern vessels, processing and storage facilities, on one side, and health and environmentally food-related policies on the others are the main targets. The cold storage facilities seem to be on the hands of Mozambique, while the others (sanitary and environmental issues) require some sort of international cooperation. In fact, the effectiveness of any policy to prohibit, limit or control the usage and trade of chemical hazardous products requires the involvement of neighboring countries.

The potentiality of expanding the commercial fishing industry is dependent, thus, in the investment made on sanitary and environmental export-reducing factors, at the aquaculture plants. The high income elasticity and the positive coefficient for substitute's prices points that shrimps and prawns can be directed, in a competitive manner, to others developed and emerging countries in Europe, Asia and Americas.

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