Strategic Use of Competitiveness Towards Consolidating the Economic Sustainability of the European Seafood Sector

Economic patterns of seafood consumption and demand
Analyses of the consumption functions in the period 1990–2011

Research Report of Task 2.1

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The present report summarizes the findings of the analysis of the consumption function of seafood consumption in different countries at aggregated and species levels. The work was undertaken as part of the SUCCESS project funded by the EC (H2020, GA 635188) in cooperation with FAO as part of the External Advisory Committee. Theoretical background, the design of the general model, and the analysis of consumption and demand of aggregated seafood products in different countries of the world were developed using data provided by FAO during an expert visit of the leading researcher at FIPM in Rome along the spring of 2015, at the beginning of the project.

The works are included into the Working Package 2 (Consumer preferences, market acceptance and social awareness towards seafood), but also provides useful observations and data for Working Package 1 (Effects of global drivers, policies and regulations on growth, jobs and innovation in European fisheries and aquaculture sectors) and Working Package 5 (Economic viability and future outlook), by analyzing the effects of the key drivers of consumption and demand from a socio-economic perspective. Within WP2, the analysis of the consumption and demand system provides support for understanding the expected behaviors of seafood consumers under economic constrains. The main goal is to test the effect of the variables affecting demand and consumption as predicted in the economic theory and the contributions in the field of seafood demand. Results will provide a proxy of the demand elasticities which will allow assessing the potential impact of market improvements according to the economic conditions in different countries and for different species. The analysis is performed at country level, which allows comparing results across the different countries for the same species and identifying market segments according to similarities in the effects of the economic factors.

The methods used are described below. This document is intended to a multidisciplinary audience and the complexity of the econometrics has been decreased until providing the most satisfactory results using the less complex methodologies. The models of some countries and species can still be taken beyond, and some remaining econometric issues can be still addressed. However, most of the relations studied can be conclusive in one way or another by accepting or rejecting the influence at the present level of analysis.

1. Introduction and background

Seafood supply and consumption has risen significantly since the second half of the past century. World fish supply has increased from 20 million tonnes in 1950 to 156.2 million tonnes in 2012, while per caput consumption rose from 9.9 kg in 1960 to 19.1 kg in 2012. This trend is expected to continue in the future (World Bank, 2013; FAO/OECD, 2014). However, this increasing trend is not constant all over the world. Some countries have experience important growth in seafood consumption motivated by an increasing interest in healthy diet, urbanization and globalization of food habits and trade among other factors. While increasing consumption is becoming a fact in low consuming countries, stagnation and decline starts being normal in traditionally fish consuming societies.

Understanding the factors behind the evolution of food consumption and demand is a critical requirement for food security and nutrition improvement. One of the main causes of failure in the promotion of certain food categories lays in lack of knowledge about consumer culture and preferences and the way in which factors like population growth and economic development may affect, positively or negatively, demand of certain foods. Several attempts have been undertaken for modeling seafood consumption, mainly for forecasting purposes, with more or less success. Forecasting is not in the aims of this work but study the evolution of seafood consumption under the influence of the economic variables. Income and the evolution of prices are the only relevant variables affecting consumption under a strict economic point of view. However, when talking about foodstuffs, population is another, if not the most, relevant factor since it sets the size of demand.

Departing from the classical consumption models a general function has been tested in 20 different countries all over the world in order to assess the suitability of different designs and data in explaining the evolution of seafood consumption. This function has been applied under different variations for explaining consumption of seafood in general. Further, a more detailed analysis at species level has been undertaken in 8 countries within the European Union. Results vary across countries and species, as a consequence of different cultural patterns and consumers' preferences. However, the model has shown some consistency in many of the analyzed countries and species and high explanatory power in the many of them. Data used come from official databases available on line, being the main sources FAO Fishstat application, the FAO Food Balance Sheets and the World Bank development indicators.

The model is presented in the most simplistic linear function in order make it easier to understand by a wider audience with just a minimum knowledge and expertise in statistics and econometrics. This approach fails for forecast purposes, but is enough for identifying and confirms the significant factors affecting consumption and demand. Results are presented according to factor significance.

Since data sources at the national level can be put in question for some of the countries analyzed, rejection of the model cannot be conclusive. A rejected model only informs that the available data did not fit with the proposed consumption function, and the series used for the exogenous variables failed in the explanation of seafood consumption. A further analysis with other national data such as food expenditure and the domestic price indexes was undertaken at the EU level. However, limitations in the length of the series in some countries and little non improvements in model performance suggested using the same variables and data sources in all cases.

1.1 Theoretical background

A consumption function explains how much a country consumes as a function of income and some other explanatory variables. First attempt for modeling consumption into an econometric function was developed by Keynes (1936) in his “General Theory”, who postulates the consumption function as the relationship between consumption and disposable income. The standard Keynesian concept describes consumption as a function of current income as follows:

$$C = \beta_0 + \beta_1 I + \zeta \tag{1}$$

Where C = Consumer expenditure; β_0 = autonomous consumption; β_1 = marginal propensity to consume; I = disposable income; and ζ is the error term.

Autonomous consumption is the level of consumption that would take place even if income was zero. If an individual's income fell to zero some of his existing spending could be sustained by using savings and by public transfers. Marginal propensity to consume is the change in consumption divided by the change in income, the %age of each additional dollar earned that will be spent. There is a positive relationship between disposable income and consumer spending. The gradient of the consumption curve gives the marginal propensity to consume. As income rises, so does total consumer demand. A change in the marginal propensity to consume causes a pivotal change in the consumption function.

The Keynesian function had apparently some conflicts with empirical evidence laid out by Kuznets, Epstein, & Jenks (1946) and several revisions were proposed. Duesemberry (1949) introduced the theory of relative income, stating that the personal desire of increasing consumption is related to some weighted average of the expenditures of others with whom he comes in contact. A second point in the relative income theory is that consumption patterns are subject to habit and are slow to fall in face of income reductions. People easily increase consumption when income rises but have problems decreasing it symmetrically when income falls. This approach opens the door to social and cultural influences on consumption, which are of critical relevance in the field of food consumption (Asp, 1999).

Economic growth is regarded as one of the most important driver of food demand and consumption. With increased disposable incomes, people’s purchasing power is then expected to rise, and more money will be expended on food (Ye, 1999; Lem et al, 2014). However, this expected result may not take place in many situations. Food consumption is affected by a series of factors which are not connected with economic growth or even any quantitative variable (Asp, 1999). The effects of income on food consumption vary across countries. An increase in disposable income will have a higher and positive effect in low-income countries, but may be less significant in high-income countries. The increase in disposable income in emerging and developing countries will be followed by an increase in food consumption, and also the composition of the diet, including foodstuffs rich in healthy protein (Lem et al, 2014).

In the context of the general consumption function the price levels are not relevant. Households can shift products according to changes in their prices keeping the levels of expenditure unchanged. However, when referring to specific goods, changes in the prices may affect expenditure in the particular good, in special if the good has substitutes (Duval & Biere, 2002). If a product is a first need, it is assumed an inelastic demand and the price levels should not affect consumption, but changes in the prices implicate less or more disposable income for the good if they increase or decrease. Since consumption is given by the intersection between demand and supply, these volumes will vary when prices do change. Price has no immediate effects on production, which is the main engine of seafood consumption (Bird 1986; Fox, 1992; Ye, 1999) but may influence future production. These variations in the amount of product consumed may be estimated with the variations of the price along time, which can be measured by using price indexes. Introducing a price index in the consumption function given in (1) will result in the following equation:

$$C = \beta_0 + \beta_1 I + \beta_2 Pr + \zeta \qquad (2)$$

Where Pr is the price index and b_2 accounts for the changes in consumption of a given product when the prices of the product changes.

Finally, population size is one of the main drivers of food consumption (NACA/FAO, 2000; World Bank, 2013; Lem et al, 2014). Consumption of any given commodity is given by the intersection of demand and supply. Demand for food is expected to grow proportionally to the population since this one sets the size of demand. However, preferences for food products are affected by a variety of factors including personal, social and cultural (Asp, 1999) which may result in differences with regard the role of population on consumption in different foodstuffs and countries. In the case of seafood products, a proportional growth in consumption according to population may suggest a strong cultural pattern which is transmitted from generation to generation with regard preferences for fish and shellfish. A more than proportional relation indicates seafood consumption is growing both in absolute values and per caput. Changes in consumer preferences may also result in negative relations between population growth and seafood consumption when new generations are shifting from seafood to other alternative sources of protein such as poultry or other meats. Traditions are an important factor in food consumption choices. Culture and culinary traditions can be a cause of delay or even an insuperable barrier in the adoption of new food items or habits (Kupiec & Revell, 2001; Choo et al, 2004; Leipämaa-Leskinen, 2007; Fernandez Polanco & Luna, 2012).

Adding the effect of population size in equation (2), the resulting model is given by the equation:

$$C = \beta_0 + \beta_1 Po + \beta_2 I + \beta_3 Pr + \zeta \qquad (3)$$

Where Po is the size of the population or any other indicator of population growth.

The relationship between income and food consumption is non-linear. Assuming constant preferences consumers will increase their expenditures on food products less than their increases in income. A model with forecast purposes should take this fact into account. In the present study, the model simply attempts to test whether the correlations across the explanatory variables and seafood consumption are significant in the frame of a multivariate model. A linear function is then used in order to simplify the explanation of results.

A fourth component should also be considered in order to assess all potential effects on demand according to the economic theory. The relation across the quantities consumed and the prices of competing goods, also known as cross elasticity. The analysis of the competitive relations across seafood species is being undertaken in Working Package 4 using price integration methodologies and will be part of the corresponding report.

1.2 Methods & Materials

This section introduces the sources of data and statistical methods used in the models of seafood consumption presented in this document. All data come from the available databases provided by international institutions such as FAO and the World Bank, and are online available for researchers and practitioners. The statistical methods used are described briefly in order not to saturate the reader with a dense description on methodology. The methods used in this analysis are some of the most common in econometrics and further information is easily available for more interested readers.

1.2.1 Sources of data

Seafood consumption means the total amount of fish and fishery products consumed. This definition implicates that the models will be applied on an aggregate of the different species traded and consumed. The level of aggregation is always a matter of concern, since fish products are highly diversified. Results may be more accurate for the most popular species in terms of volume consume and the extension of the conclusions to species in more selective markets should be conservative and taken cautiously.

The first question to be solved regards the indicator of seafood consumption to be used in the models. The economic theory frequently uses the apparent consumption which, in the case of fishery products is computed with the following formula:

AC = Catches + Aquaculture + Imports – Exports (4)

Apparent consumption presents some inconveniences when used at the aggregated level. Aggregated series of seafood consumption using absolute values combine edible and no edible commodities, as well as raw and processed fish and shellfish, which are considered in absolute weight. This indicator may not be reliable for analyzing human food consumption in those cases of countries with relevant production or trade shares of no edible and processed seafood commodities. While this indicator could be appropriate from a pure economic point of view, it may not be relevant from a food security perspective.

Human seafood consumption is estimated in the FAO food balance sheets. It is a harmonized measure computing only edible commodities and estimated food weight. The Food Balance Sheet for fish and fishery products shows the pattern of fish supply and its utilization in a given country. The indicator used for this analysis is listed as total food supply. Computation is quite similar to the apparent consumption. It is an aggregate of production and imported quantities of seafood products adjusted to any change in stocks minus exports. The resulting values give the available supply of fishery products for human consumption in the country, referred to a specific year. Primary and processed fishery commodities are balanced according to the following equation:

Total seafood supply = Production – Nonfood uses + Imports – Exports + Variation in stocks (5)

The final step is the conversion of each variable for each product type into its corresponding live-weight equivalent, by making use of specific technical conversion factors. Every processed commodity is reconverted into its primary equivalent in order to obtain comparable statistics in homogeneous units applicable to all countries.

The total seafood supply from the Food Balance Sheet is computed in a similar way as apparent consumption, but converted into live weight edible seafood. Equalize supply and consumption may not be appropriate in the case of durable industrial goods, but perishable goods present different situation. Consumption of fishery products is determined by supply (Bird 1986, Ye 1999, Lem et al, 2014). Production is determined by environmental and economic factors independently of the price of seafood, and nearly equal to domestic consumption (Fox 1992). Given these particularities, the total seafood supply computed in the FAO Food Balance Sheets can be considered a quite good proxy for seafood consumption at the national level. The data used in this report from the Food Balance Sheets was provided by FAO on May 2015.

The two indicators for consumption will be compared before presenting results for total seafood consumption in the selected countries. The indicator resulting in the most efficient model performance for the 20 countries will be used for the estimation of the parameters presented in the results section, and discussion will be undertaken with that results. Unfortunately this comparison can not be done in the models at species level, since the Food Balance Sheet data is not disaggregated at such level.

Measures of the yearly disposable income are not available for all the selected countries. Gross Domestic Product, specifically per caput GDP, provides a convenient proxy for disposable income. Although this indicator may not be much realistic in the case of countries with highly unequal income distribution, a significant parameter will point to an increase of consumption in middle and upper income groups in these countries, which will result in a higher overall consumption. Since seafood consumption is measured in absolute quantities, total population will be used as explanatory variable. Both per caput GDP and population were collected from the Development Indicators of the World Bank[1].

The most difficult variable to measure in the model was the price index. Information regarding the prices in the domestic markets for the observed period is not available for the majority of the countries studied, and already existing indexes of seafood prices are not disaggregated at the national level (FAO, 2015). The FAO fish price index is referred to internationally traded commodities, and even domestic prices may and will deviate from the external trade prices (World Bank, 2013), it is the best available source. However, as previously indicated, this information is not available at country level. Following this orientation, a domestic food price index was computed using the average between import and export price per kilo of total seafood commodities of a given country and fixing the base to year 2000.

1.2.2 Statistical methods

In order to set a scale for easier comparison across countries all variables were standardized. A common consumption model described in equation (3) has been tested along the 20 selected countries. Since the variables have been standardized, the independent term β_0 equals zero and disappears from the model. The full model, which is estimated in first instance, is given by the following equation:

$$C = \beta_1 \, Po + \beta_2 \, I + \beta_3 \, Pr + \zeta \qquad (6)$$

Lack of significance of the economic parameters can be due to a strong influence of population on consumption, resulting in rejection of the influence of other variables. The economic variables may be exerting a significant effect, but compared with the high significance of population, they could be rejected in the full model. Such a case does not indicate a total absence of economic drivers on seafood consumption, but a relatively low influence compared with population. In order to test this potential issue an alternative model considering only economic variables is tested. May this economic model results significant, the influence of economic drivers, even low compared with the growth in population, cannot be rejected.

The economic model is in the form:

$$C = \beta_1 \, I + \beta_2 \, Pr + \zeta \qquad (7)$$

Finally, there is also the possibility of a strong multicolinearity across income and prices, which may affect the estimated values of the associated parameters. This issue indicates a fast market reaction to changes in consumer's purchase ability. Domestic traders may raise the prices when income increases and vice versa in order to increase their margins or keep sales volumes. When this situation happens, the parameters linked to income and price in the full and economic models could also appear non-

[1] http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators#s_i

significant. In order to solve this problem, a two equation non-recursive model, considering the relation between prices and income will be tested. The system is in the form:

$$C = \beta_{11} Po + \beta_{12} Pr + \zeta_1$$

$$Pr = \beta_{21} I + \zeta_2 \qquad (8)$$

The second equation accounts for the shocks in the price index as a consequence of changes in consumers' income.

When normality, tested using Jarque-Bera statistic, cannot be rejected in all the involved variables then OLS estimators will be computed. Rejection of a normal distribution in any of the variables of interest will require using a robust algorithm (quantile regression) for estimating parameter values and significance. Issues of autocorrelation were managed by running an AR(1) model with Cochrane-Orcutt transformation when the Durbin-Watson test indicates the existence of such kind of problems.

1.2.3 Parameter significance and values

The number of significant parameters and the consistency of their values with the theory are critical for selecting the model which better explains the influence of the observed variables on the amounts consumed in the different countries and species. The parameters connected with income and prices are of special interest in terms of economic analysis as they provide the theoretical drivers for changes in the demand side. The parameter connected with population indicates the level of penetration of seafood consumption in a given society and how it is evolving along time. The parameter associated with the income informs about the category of the product and whether a change in the purchasing power affects seafood demand. Finally, the parameter connected with the price index provides information about price sensitivity of demand.

A significant parameter in the case of population will indicate whether a consumption pattern persists across time and how it is passed to the following generations. Food consumption patterns are strongly conditioned by cultural and social factors which are not covered into these models. However, when these factors are strong enough for making the product becoming a traditional and cultural pattern, the resulting behavior, measured in terms of quantities consumed, will be statistically connected with the size of the population. A positive parameter indicates an increase in consumption more than proportional than the increase in population. This can be due to new consumers entering the seafood market or to a raise in the rates of already existing consumers. A negative parameter indicates that seafood consumption is decreasing across the population. This result may also be caused by a decrease in supply due to stagnation of the fisheries.

The parameter associated with the income informs about the propensity to consume seafood in general or a given species. A significant value indicates that the quantities consume will change when the disposable income raises or decreases. The value of the parameter also illustrates about the category of the product with regard consumer's `references and choices. A positive value reports a superior good which consumption will increase as consumers improve their purchasing ability. In contrast, a negative value is related to an inferior good, which consumers replace with a higher quality product when their income improves. To this extent, this parameter indicates the income elasticity of demand and a higher or lower value will report a more or less income elastic demand.

Finally, the parameter associated with the price index informs about consumers' sensitivity to a change in the price, which is the price elasticity of demand. This parameter is expected to be negative, and the magnitude will indicate whether the demand is more or less price elastic. Lack of significance in this parameter informs about price inelastic demands.

2. Models for total seafood consumption

The proposed models are tested in this section for explaining seafood consumption at an aggregated level in different countries of the world, including three EU members. The aim is to test whether the variables in the model allow explaining the evolution of seafood consumption in the selected countries with a minimum of reliability and whether the functions behave in a similar way across the different countries.
The countries were selected randomly across the most relevant producers and importers of seafood products in the five continents. The selection includes developed and developing countries, including wild fishery and aquaculture producers. The selected developed countries are Japan, USA, Spain, Germany, Australia and Italy. Brazil, India and Chile account for emerging and high income countries not belonging to OECD. The developing countries analyzed are Thailand, Indonesia, Morocco, Nigeria, Argentina, Namibia, South Africa, Mexico, Tanzania, Colombia and Vietnam. These countries provide a wide range of different situations, illustrating cases in which consumption has been increasing, decreasing or remains stagnated.

The models were tested using both the absolute apparent consumption and the data from the Food Balance Sheet provided by FAO. A comparative analysis on the performance of the models estimated with both indicators has been undertaken in order to decide with which series of data will be used when presenting the results of this section.

The model and the involved variables were rejected as significant factors affecting seafood consumption in only five of the total observed countries. The models in which all factors were found to be significant are presented and described individually. Variations on the initial model, with a lower number of significant variables are presented together in the same section. Finally, those countries in which the model is rejected are listed.

2.1 Compared results between apparent consumption and total seafood supply

The resulting models using the two indicators of seafood consumption were compared according to the linear association measures and parameter significance. From a statistical point of view, a model using one or the other indicator will be preferable when the explanatory capacity will be higher and a larger number of parameters resulting significant. Differences in goodness of fit and parameter values and significance in a given country will be reflecting the diversity of consumption in economic terms and food security. When these differences do not exist, then the two distributions are equal and thus no significant variations can be expected across the two models. Table 1 illustrates the compared results for the two consumption indicators. Despite apparent consumption has resulted in better statistical performance in three of the 20 countries, from a nutritional and food security point of view the models explaining the total fish supply from the FAO food balance sheet are more interesting for the purposes of this analysis. A summary of the comparison of model efficiency is given in table 1.

Table 1 - Compared model results using apparent consumption (AC) and total seafood supply (FBS) as dependent variables

Country	Comparison
Brazil	+ Similar results and same interpretation + FBS results in autocorrelation + Prices are less relevant in the FBS model + FBS results in higher effects from income
India	+ Similar results and same interpretation + FBS results in higher effects from population
USA	+ Lack of significance in the AC model. + FBS results in better statistical performance.
Morocco	+ Similar results and same interpretation after solving autocorrelation issues in the FBS model + FBS results in much better statistical performance
Thailand	+ Same results and issues in both models + FBS results in much better statistical performance
Australia	+ Same results and interpretation + FBS results in much better statistical performance
Spain	+ Lack of significance in the AC model. + FBS results in much better statistical performance
Chile	+ Lack of significance in the FBS model. + AC results in better statistical performance. However results are inconsistent with the economic theory
Nigeria	+ Similar results and same interpretation + FBS results in much better statistical performance
Mexico	+ Similar results and same interpretation + FBS results in much better statistical performance despite of inconsistent parameter value in price
Tanzania	+ Lack of significance in the AC model. + FBS results in much better statistical performance
Indonesia	+ Similar results and same interpretation + FBS results in much better statistical performance
Colombia	+ Similar results and same interpretation + FBS results in much better statistical performance
Germany	The two models radically differ + AC results in much better statistical performance. However, it may be less realistic and is affected by autocorrelation issues.
Italy	+ Lack of significance and other statistical issues in the AC model. + FBS results in much better statistical performance despite inconsistent results with price
Japan	+ Similar results and same interpretation + AC shows better statistical performance but lower dependence on income and price. However, FBS can be used as overall interpretation does not change and results in a more economic model
South Africa	+ The two models are rejected
Argentina	+ AC model is rejected + FBS results in better statistical performance but quite low significance
Namibia	+ The two models radically differ + FBS results in much better statistical performance
Vietnam	+ Same results and interpretation + FBS results in much better statistical performance

The data from the Food Balance Sheet provide better or similar results than those of the total apparent consumption in 17 of the 20 countries analyzed. The three exceptions are Chile, South Africa and Germany, which provide non-significant or inconsistent results in all cases. In the models using total fish supply from the Food Balance Sheet population becomes the most relevant driver for consumption, given this is being studied in absolute terms. This approach focuses in total consumed quantities rather than on per caput diet composition which may not be representative if substantial differences across cultural or social segments exist in the different countries.

As expected, the strong effect of population eclipses the influence of the economic variables in several cases. When this happens, the reduced economic model is estimated in order to test the effects of income and price. Given that the price index is computed using external trade data, it may not be representative of the domestic prices. In the cases in which the species traded internationally differ from those consumed in the country. The parameter associated with the effects of changes in the prices may result non-significant or inconsistent with the theory of price sensitivity of consumers.

2.2 Model results

Results have been classified in three main groups. The countries in which all or at least two of the explanatory variables resulted significant will be presented in first term and explained individually. The following section presents the countries in which only one of the explanatory variables was found to be significant. With the only exception of Mexico, in which GDP per caput was the significant variable explaining consumption, population was found the only significant driver in all cases. Finally, countries with non-significant models are listed.

2.2.1 Countries with full significant models

This section illustrates the results for the countries in which all the variables in the model have been found to be significant, whether in a full model of one single equation, or by using a simultaneous equation system or partial models. The countries in which the model, in any of its versions, has been found significant are Brazil, Japan, Nigeria, Indonesia, India, Australia, Morocco, USA, Thailand and Vietnam.

2.2.1.1 Brazil

According to the data in the Food Balance Sheet, during the observed period seafood consumption increased 140% in Brazil. Yearly per caput consumption was 5.79 Kg in 1990 rising to 10.57 Kg in 2011. Different factors have contributed to the increase in Brazilian consumption including Governmental effort in the promotion of seafood in recent years. Brazil is the main seafood importer in the Latin American continent, having a negative trade balance of 312,000 tons, including non-edible commodities, in 2010. This figures point to Brazil as one of the top seafood consumer countries in the sub-continent along with Peru and Ecuador.

All the variables in the model have also grown along with consumption, in a period of relevant economic growth boosting the country as an emergent economy in the group of middle upper income. GDP per caput increased 307% in the observed years, while population did it only 30%. The growth in the disposable income of Brazilian consumers also raised the price of seafood, which increased 92% in the full period covered and 75% between 2000 and 2010 (Figure 1).

Figure 1 - Evolution of the variables in the model for Brazil. Standardized values.

When analyzing the distributional properties of the series GDP per caput and seafood consumption were rejected normal distribution. The parameter values are therefore estimated by using quantile regression. Results indicate that more than 95% of the variations in seafood consumption in Brazil can be explained by the proposed model, being affected by all the three variables (Table 2). Population and per caput income act as promoters of seafood consumption and this will increase while population and domestic welfare will keep on increasing. The effect for income is stronger than the effect from population. This fact indicates that economic development has been more important in increasing seafood consumption than the growth in population. Brazilian consumers appear to be somehow price sensitive as seafood consumption is negatively affected by a rise in prices.

Table 2. Full model for Brazil

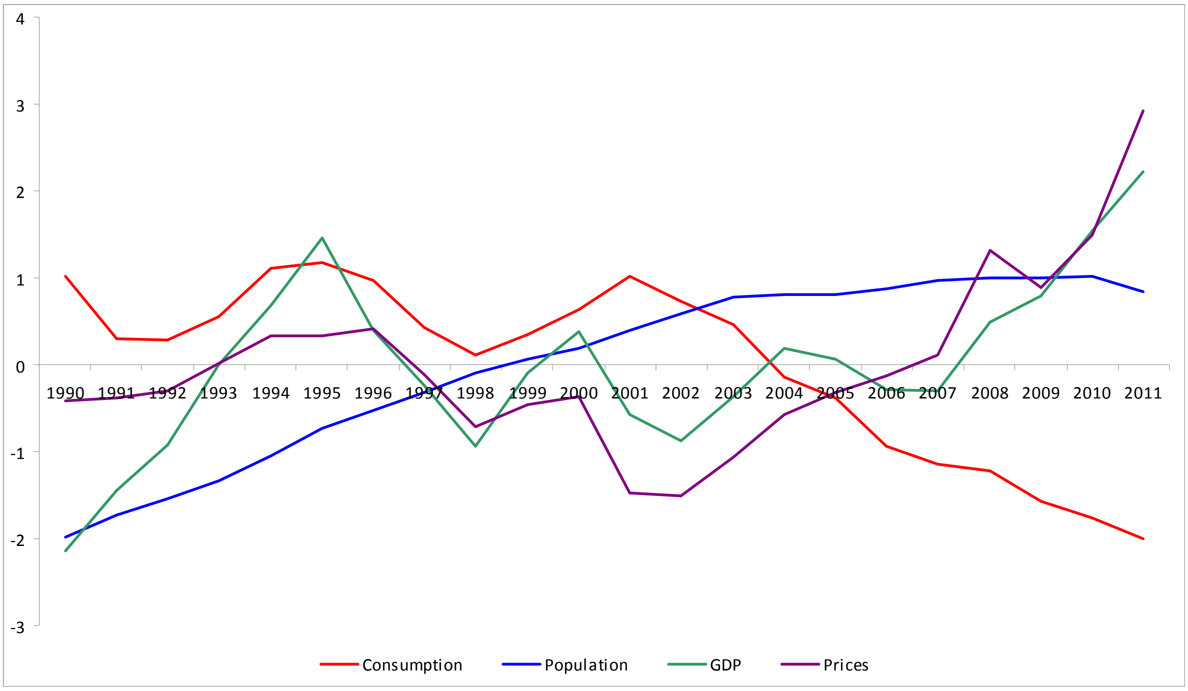
Model performance	Parameter values
$R2 = 96.4\%$	Po: 0.398***
F = 78.740***	I: 0.723***
DW = 1.674	Pr: –0.118**

2.2.1.2 Japan

Despite of being the largest market for seafood in the world, consumption among the Japanese population is decreasing. Seafood consumption dropped 25% during the observed period. Yearly per caput seafood consumption was 71.2 Kg in 1990 and remained relatively stable, with small changes up and down, until 2001, when it started decline to 51.7 registered in 2011. Within the pointed reasons for this decline is the stagnation of the Japanese economic growth in the mid 90's, which resulted in changes in consumer preferences driven to low cost meals made of poultry and other cheap meats, in special in young consumers (Kurokura et al, 2012; Kamoey, 2015).

The decreasing trend in seafood consumption is clearly appreciated in the corresponding chart (Figure 2). The graphic also shows signs of stagnation in the population growth and the fall in disposable income (GDP per caput), after 1995 and ulterior recovery in 2007. GDP per caput decreased 19.9% during the recession. Seafood prices decreased between 2000 but returned to a rising trend after 2003, resulting in an increase of almost 52% between 2000 and 2011.

Figure 2. Evolution of the variables in the model for Japan. Standardized values.



Normality was rejected for the price index and a robust estimation is required for unbiased parameter values. Like in the previous case, the model significantly fit and is able to explain almost 90% of the variation in the evolution of seafood consumption in Japan (Table 3). According to this model, seafood consumption is declining in Japan and consumers are moving into alternative sources of protein as population grows. This is evidenced by a significant negative parameter of population. However, the decline in seafood consumption may be reduced if personal income increases and the prices decrease. The rise in seafood prices and the stagnation of the Japanese economic growth appears as critical factors explaining the decline in consumption in the World most traditional and profitable market for seafood.

Table 3. Full model for Japan

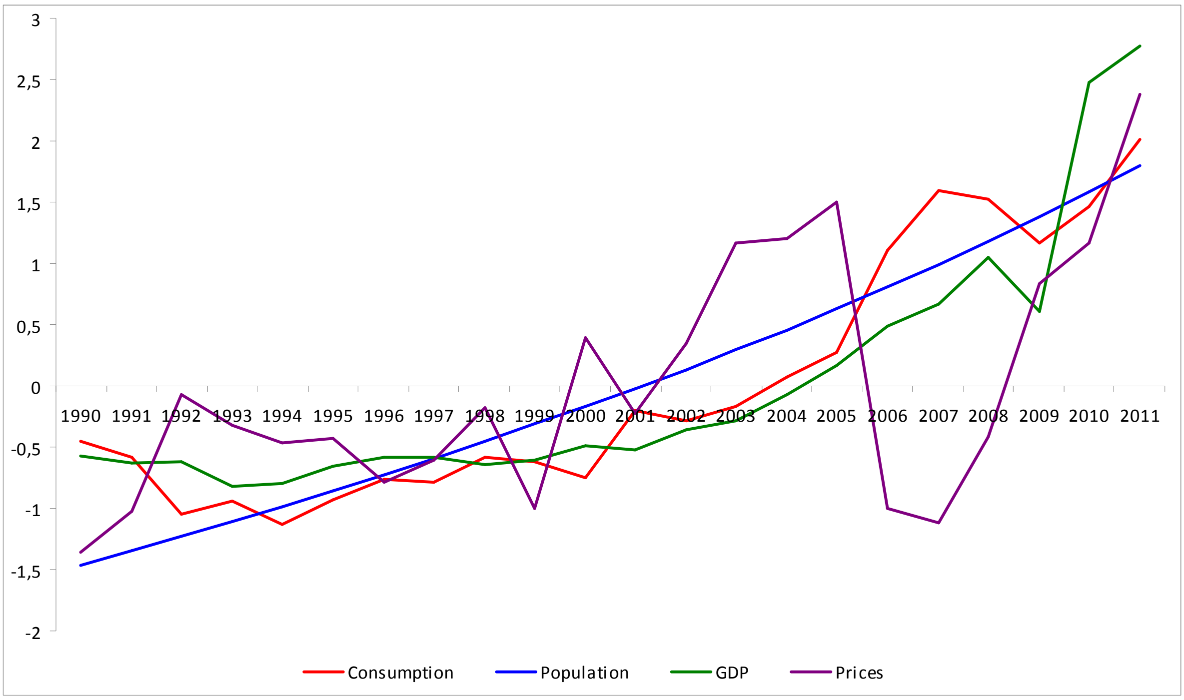
Model performance	Parameter values
R^2 = 87.3%	Po: –0.891***
F = 43.637***	I: 0.589***
DW = 1.628	Pr: –0.998**

2.2.1.3 Nigeria

Nigeria is one of the most important seafood consuming countries in Sub-Saharan Africa, and also one of the leading economies in the sub-continent. Seafood consumption grew up fast since 2003, when yearly per caput consumption was 9.3 Kg, until reaching 17.1 Kg in 2011. Such evolution in the figures of seafood consumption is motivated by a significant increase in the volumes of imports and domestic production after 2000. Production and imports evolved accordingly with national economy, boosted in the first decade of the new century.

The graphic with the evolution of the variables in the observed period shows similar trends for seafood consumption, population and GDP (Figure 3). However, while the growth in population is persistent since 1990, with an increasing rate of 70%, Seafood consumption and per caput GDP change from a relatively stable trend to a clear increase after the beginning of the century. Prices evolved randomly with significant raises and falls in all the observed period, but on a long term growth resulting in an increase of 65% since 2000 to 2011.

Figure 3. Evolution of the variables in the model for Nigeria. Standardized values.



Normality cannot be rejected for all variables excepting per caput GDP, which requires again a robust estimation method in order to avoid biases in the parameter values. Despite problems of autocorrelation cannot be totally rejected, the model fits quite well for Nigeria explaining 94% of the variations in the volumes of seafood consumption (Table 4). Population growth has been the most effective cause of the rise in seafood consumption, boosted also by economic development. Like in the previous model, rising prices is a brake for consumption, which is stronger than in Brazil but much lower than in Japan.

Table 4. Full model for Nigeria

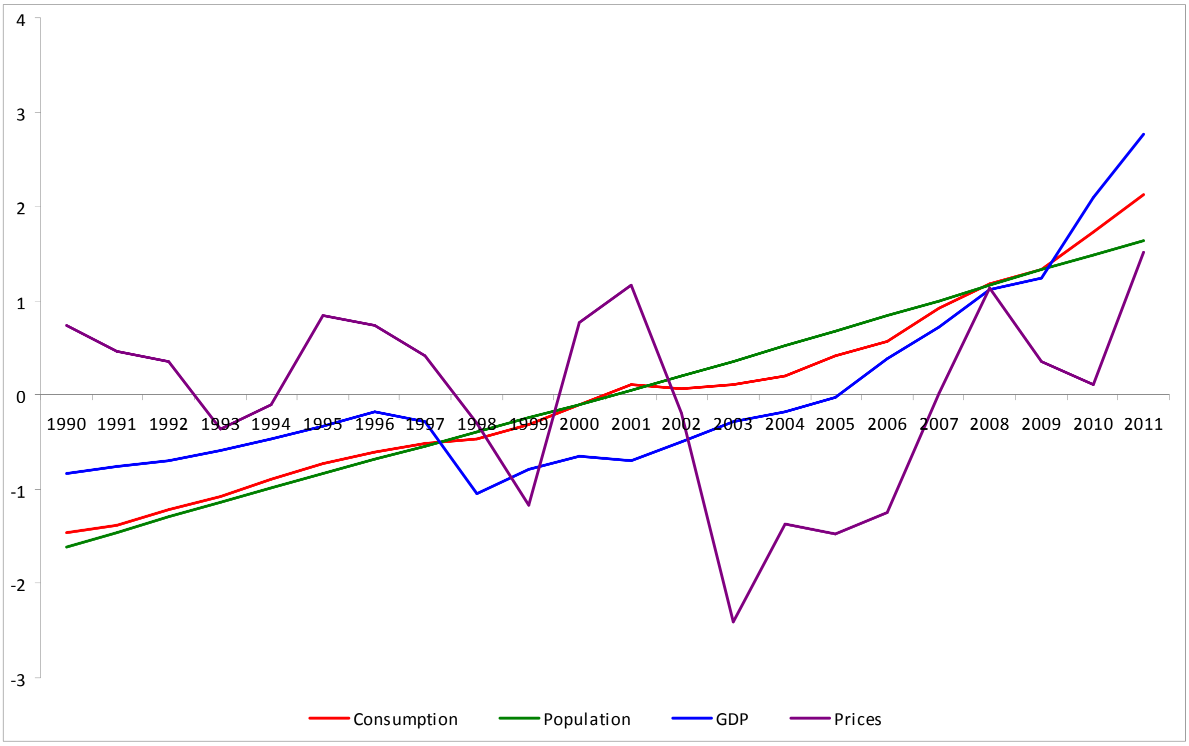
Model performance	Parameter values
R2 = 94.3%	Po: 0.809***
F = 158.132***	I: 0.413***
DW = 1.284	Pr: –0.249**

2.2.1.4 Indonesia

Indonesia has become a relevant actor in the international seafood markets and this growth in domestic the supply for exports has also come together with an increase in domestic consumption. The yearly rate of per caput consumption in 1990 was of 14.9 kg., growing up to 28.8 in 2011. Given that Indonesia is mainly a seafood exporter country, much of this growth in consumption is due to the increase in local supply.

The evolution of the variables along the observed period shows a very similar shape in the growth of seafood consumption and population. In absolute values, consumption and population increased 136 and 36% respectively from 1990 to 2011. GDP per caput was the variable with the highest growth in the years analyzed, rising from 640 USD in the first year to almost 3,500 USD in 2011. Prices, instead, kept relatively stable with an increase of 7% in the long term despite of abrupt drops which was especially significant in 2001 (Figure 4).

Figure 4. Evolution of the variables in the model for Indonesia. Standardized values.



Since normality can be rejected for GDP per caput, model fitting will require robust estimation for computing parameter values and significance. Results from quantile regression allow explaining 99 % of the variation in seafood consumption (Table 5). The evolution of seafood consumption in Indonesia is affected in first term by population growth and in much lesser extent by income and prices. Parameter values suggest that the increasing trend in seafood consumption was strong enough to not be affected by an increase in the prices. While this behavior is evident in the period between 2003 and 2011, when prices and consumption have been growing together, it is a difficult to explain result from an economic point of view.

Table 5. Full model for Indonesia

Model performance	Parameter values
$R2 = 99.5\%$ $F = 342.433^{***}$ $DW = 1.131$	Po: 0.832*** I: 0.184*** Pr: 0.057***

The value and significance of the price index should be taken cautiously since it is inconsistent with the economic theory. A possible interpretation is that seafood consumption in Indonesia is increasing despite the increase of price, and thus, this relation should be considered spurious. If the economic model is considered independently (Table 6), the effect of income remains positive, while the price index turns into a negative sign, indicating price sensitivity across Indonesian consumers. This result is more in the line of the economic theories of consumption.

Table 6. Economic model for Indonesia

Model performance	Parameter values
$R2 = 81.6\%$ $F = 44.442^{***}$ $DW = 0.457$	I: 0.915*** Pr: −0.265*

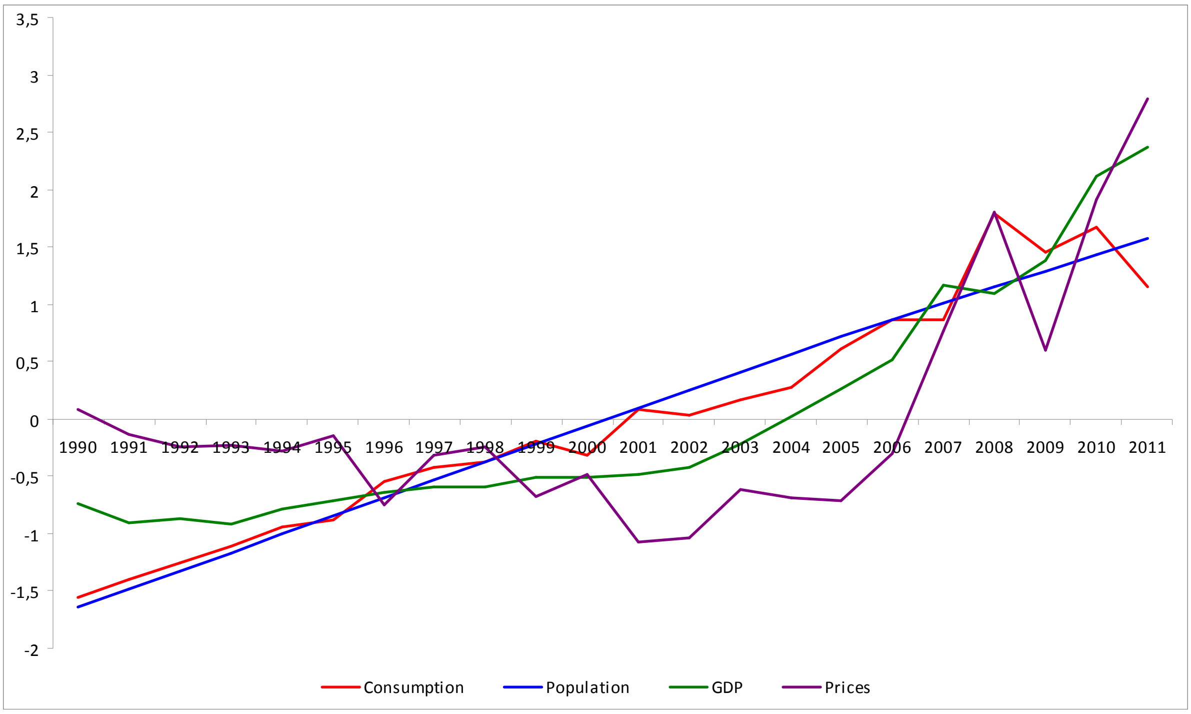
However, the Durbin-Watson test performed with OLS estimators indicates serious problems of autocorrelation across the variables in the model. This issue is worth of being solved in order to better understand the relations across the variables and their influence on seafood consumption. A Cochrane-Orcutt transformation results in a Durbin Watson of 1.189. This still suggests persisting issues of autocorrelation. However, for the purposes of this paper, the most relevant is the lack of significance in the parameter of the price index in this revision of the model. This result reinforces the idea of a spurious relation across the evolution of prices and seafood consumption in Indonesia, and points to the potential issues from using an international trade based index instead of the domestic price index already discussed in the model specification section.

2.2.1.5 India

Seafood consumption in India is very low, driven by cultural factors which are not well assessed in quantitative models and mainly concentrated in the southern coastal states. However, in the last two decades consumption increased 93.8%. Yearly per caput consumption was 3.75 Kg in 1990 and grew up to 5.16 Kg in 2011 with a maximum of 5.98 in 2008. Despite of the low consumption, India is the second largest aquaculture producer in the world, after China, and the focus on domestic markets is increasing for several new developed species such as pangasius.

Economic development has also being strong in India in the past years as represented in the evolution of GDP per caput which increased 302% in the observed period. The yearly income per caput was 375 USD in 1990 rising up to 1,509 USD in 2011. Seafood prices remained relatively stable until 2005 when they start increasing rising the price index from almost 1 to 1.75 in the last observed year. Population has also grown in an almost constant rate, increasing 40% during the period (Figure 5).

Figure 5. Evolution of the variables in the model for India. Standardized values.



Normality was rejected for the two economic variables and robust estimation will be used to avoid biases with the parameters. The model for India explains more than 95% of the variations in seafood consumption with population as the only significant variable (Table 7). Cultural and religious factors are behind food consumption in India, making it hard changing habits on the basis of economic variables. As population is increasing in India, seafood consumption also increases in absolute terms, but this is not resulting in a change in dietary habits or nutritional composition. New consumers enter the market as they born and grow into a seafood eating family or community, and economic growth or prices do not affect or change the preferences and behaviors of non-seafood eaters.

Table 7. Full model for India

Model performance	Parameter values
R2 = 95.7%	Po: 0.931***
F = 144.19***	I: 0.009
DW = 1.694	Pr: 0.072

However, the economic model resulted significant for all the two variables when estimated without including population (Table 8). Results point to the expected economic effects with a positive parameter for income and negative for the price index. Considering the cultural factors pointed above, this model may better explain the behavior of actual seafood consumers, who may increase their consumption as their income improves and decrease it as prices increase, that the behavior of the total population.

Table 8. Economic model for India

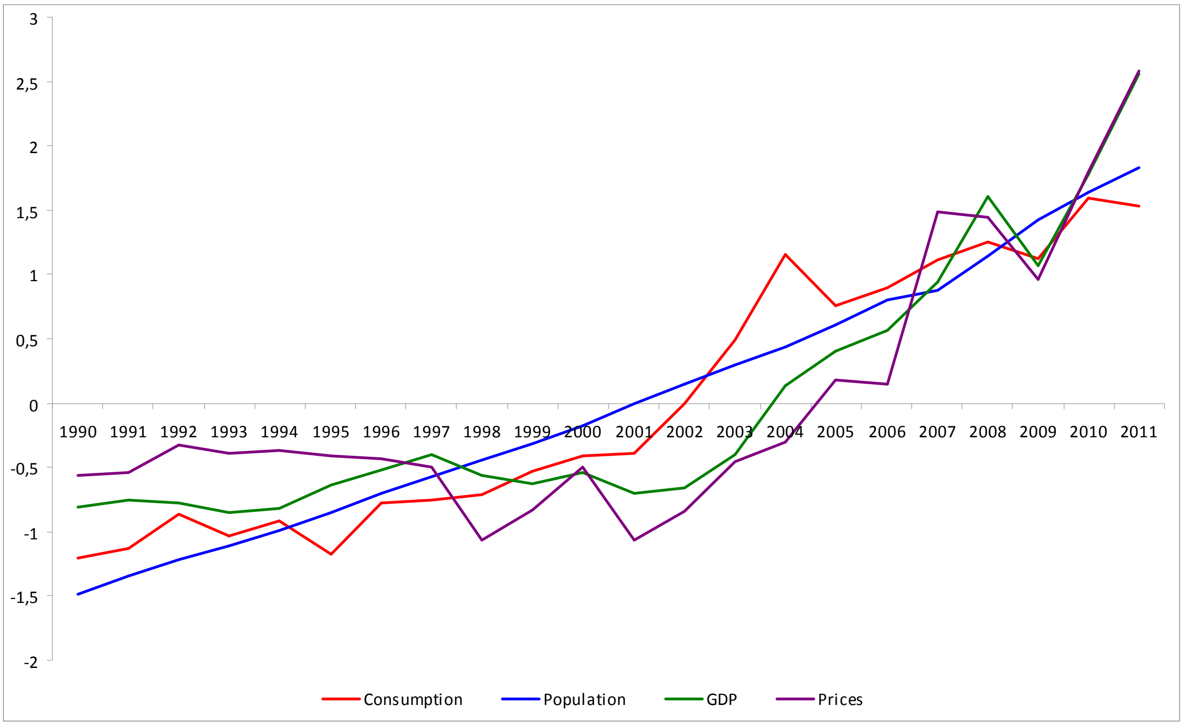
Model performance	Parameter values
R2 = 87.2% F = 137.29*** DW = 1.751	I: 1.332*** Pr: −0.598***

2.2.1.6 Australia

Seafood consumption increased in Australia 75.9% between 1990 and 2011. Yearly per caput consumption went from 19.7 Kg in the first year of the observed period to 26 Kg in the last. Like in the US and other developed countries seafood consumption is strongly dependent on imports, which have increased 105 % during the two observed decades. The increase in seafood consumption is also driven by immigration, in special from Asian countries in which seafood is a frequent consumed food.

Like seafood consumption, all the explanatory variables in the model increased during the observed years (Figure 6). Population increased 30% during the whole period. GDP per caput increased from 18,221 USD in 1990 to 62,134 USD in 2011, which means an increase of 241% in the period. The price index also increased 90% from 1990.

Figure 6. Evolution of the variables in the model for Australia. Standardized values.



Normality can be rejected for the economic variables. Parameter values will be estimated using quantile regression. Exploratory analyses revealed issues of autocorrelation in the model. Assessing these issues with the Cochrane-Orcutt transformation does not change the significance of the parameters. Quantile regression estimates for the full model are only significant for population, explaining almost 93% of the variation in seafood consumption (Table 9). Although non-significant, the parameter values for the economic variables are inconsistent with the economic theory and were studied apart in the frame of the economic model.

Table 9. Full model for Australia

Model performance	Parameter values
$R2 = 92.8\%$ $F = 123.78$*** $DW = 0.912$	Po: 0.946*** I: −0.143 Pr: 0.334

The reduced economic model resulted significant for the two parameters (Table 10). As expected, income shows a positive value and the price index negative. The interpretation suggests that seafood consumption will increase if GDP keeps increasing even the price index also increases. Although the evolution of prices negatively affects the volumes of consumed seafood, the effects from a rise in income are stronger. Like in the case of India, this relation is more likely to affect actual seafood consumers.

Table 10. Economic model for Australia

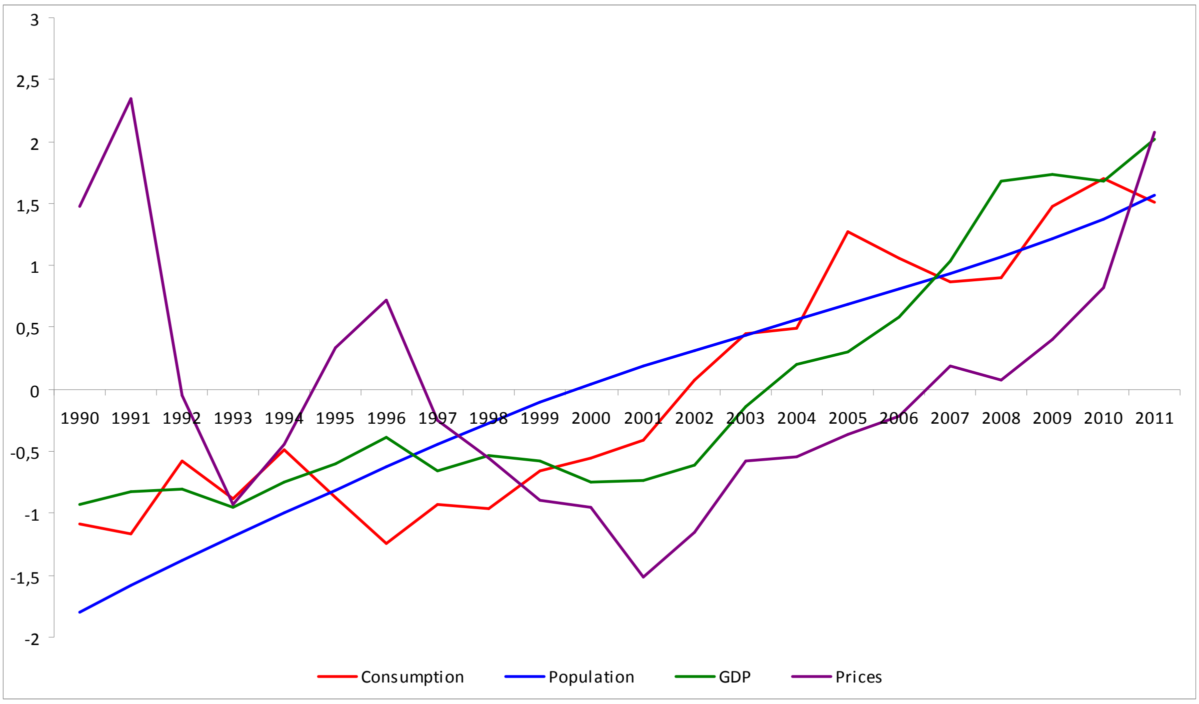
Model performance	Parameter values
$R2 = 82.9\%$ $F = 48.715$*** $DW = 0.927$	I: 1.493*** Pr: −0.585**

2.2.1.7 Morocco

Seafood consumption increased in Morocco 112.8% in total volume during the period covered in the analysis. Per caput consumption was 7.65 Kg in 1990 rising up to 12.53 Kg in 2011. Morocco is a fishing country in which aquaculture represents less than 1 % of the total seafood production. Exports, mainly to EU members, have been an important driver for the increase in catches, representing almost 40% of total production in 2011. Catches and exports increased 67.8 and 99% respectively in the same period.

Population and GDP per caput have followed a constant increasing trend in the observed period. GDP per caput went from 1,158 USD in 1990 to 3,044 in 2011, resulting in an increase of 162.7% in the two decades. Population increased 29.9% at a regular yearly rate. The price index shows the most irregular trend, decreasing until 2002 and then increasing until 2011, going back to the 80% level registered in 1991 (Figure 7).

Figure 7. Evolution of the variables in the model for Morocco. Standardized values.



Normality cannot be rejected for any of the variables in the model. OLS estimation results significant, explaining 86% of the variation in seafood consumption, and with a significant positive value in the parameter for income. However, a 0.959 Durbin Watson index indicates important issues of autocorrelation. Assessing autocorrelation with the Cochrane-Orcutt transformation results in a better model in terms of explanatory ability but with significance in the parameter for population instead of income (Table 11).

Table 11. Full model for Morocco

Model performance	Parameter values
R2 = 91.1% F = 6.696*** DW = 2.083	Po: 0.959** I: 0.136 Pr: −0.133

Despite of the lack of significance of income after assessing autocorrelation in the full model, it was worth of investigating the potential effects of the economic variables by estimating the correspondent reduced model (Table 12). Once again, autocorrelation needs to be assessed, but the results show a model with the two parameters significant. The parameter for the price index has a negative sign, which is consistent with the economic theory, but only significant at a 90% confidence level. The low level of association across GDP per caput and the fish prince index, only 12%, does not justifies a simultaneous equation model.

Table 12. Economic model for Morocco

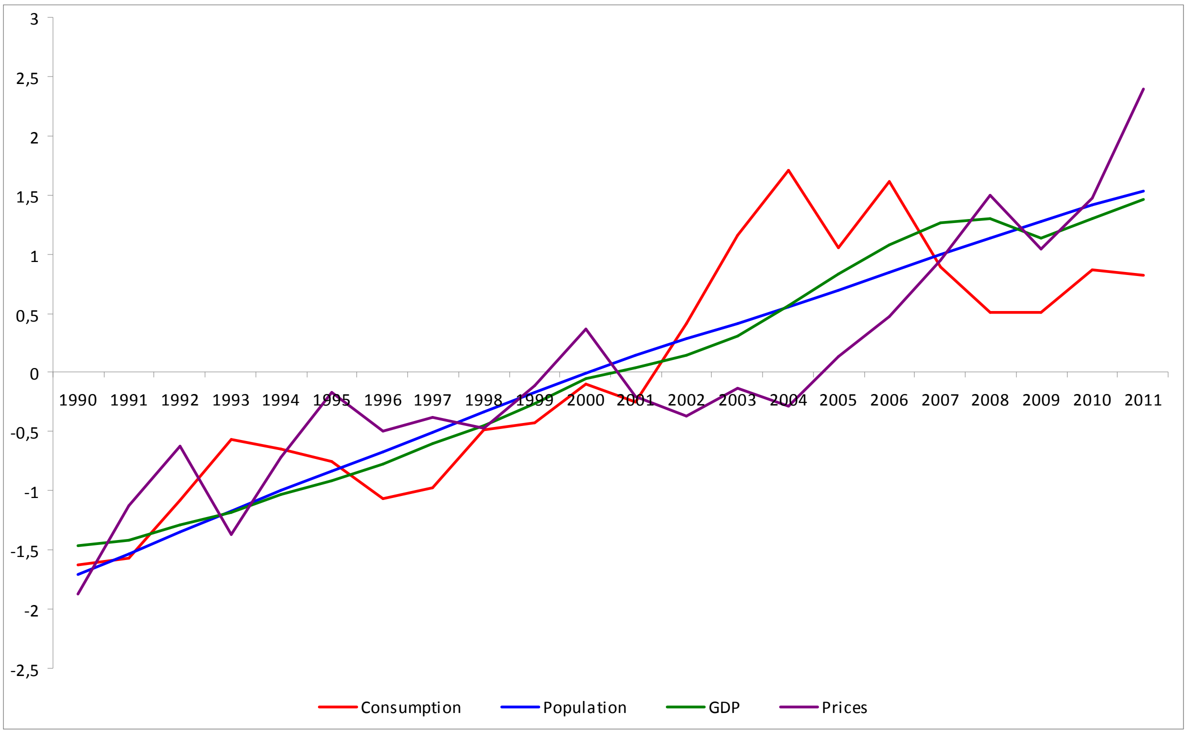
Model performance	Parameter values
R^2 = 88.3% F = 12.808*** DW = 1.906	I: 0.872*** Pr: −0. 217*

2.2.1.8 USA

Seafood consumption in total volume increased in the US 26 %, but remained almost unchanged in terms of per caput consumption. Yearly consumption per habitant was 21.09 Kg in 1990 and 21.65 in 2011. Like all developed countries, seafood consumption in the USA strongly depends on imports, mainly from developing countries. This is the case of some highly popular species across US consumers like shrimp and tilapia (Bjorndal & Norman-Lopez, 2009). These imports compensate the decrease in the volumes of domestic landings. Supply from aquaculture is still not relevant compared with the volumes of domestic consumption.

The variables involved in the model followed similar trends in the case of the USA (Figure 8). The highest growth corresponds to per caput GDP, which increased 108% in the observed period. Prices increased 25% from 2000 to 2011, but 75% in the 21 years covered. Population also increased by 24%, which is an increase similar to that of seafood consumption.

Figure 8. Evolution of the variables in the model for USA. Standardized values.



Normal distributions cannot be rejected for any of the involved variables and robust estimation is not required. After managing issues of autocorrelation using the Cochrane-Orcutt transformation, results indicate that 87% of US seafood consumption can be explained by the economic variables involved in the model (Table 13). However, the only real significant variable is the price index since GDP per caput is only significant at a 90% confidence level. The full model would reject the influence of population and economic growth in the evolution of seafood consumption in the USA

Table 13. Full model for USA

Model performance	Parameter values
R2 = 87.6% F = 14.907*** DW = 1.832	Po: −0.299 I: 1.531* Pr: −0.494**

Given the results of the full model, the case of the USA should not be included along with the countries where all variables have been found to be significant. However, looking at the inconsistencies across parameter values and significance, and the correlation levels across the explanatory variables, a problem of multicolinearity and a potential implicit function is suggested. The high correlation across the price index and GDP per caput suggests that seafood prices have been increasing as a consequence of the increase in the disposable income of the US consumers. If this relation is verified, then the parameters in the full model could be affected and biased. On the other hand, an increase in the total volume of seafood consumption with per caput consumption remaining almost unchanged is inconsistent with a negative parameter for the population although consistent with a non-significant one.

A simultaneous equation model of the form described in equation (8) was tested for the case of the US resulting in significance in all parameters (Table 13). The performance of each equation is computed after solving autocorrelation issues found in the OLS estimation of the single equations. Parameter values and significance were obtained into the simultaneous equation system using ISUR estimation. According to results in the system, income only affects seafood consumption indirectly, by its impact on seafood price. Since the prices of seafood negatively affect seafood consumption, in this an increase in the disposable income results in a negative impact on consumption through its influence on prices. The parameter for population also results significant which make sense with an increase in the volumes consumed at the same rate per caput.

Table 13. Simultaneous equation model for USA

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 85.6% F = 9.977*** DW = 1.825	Po: 1.391*** Pr: −0.586***	R2 = 81.2% F = 21.707*** DW = 1.511	I: 0.885***

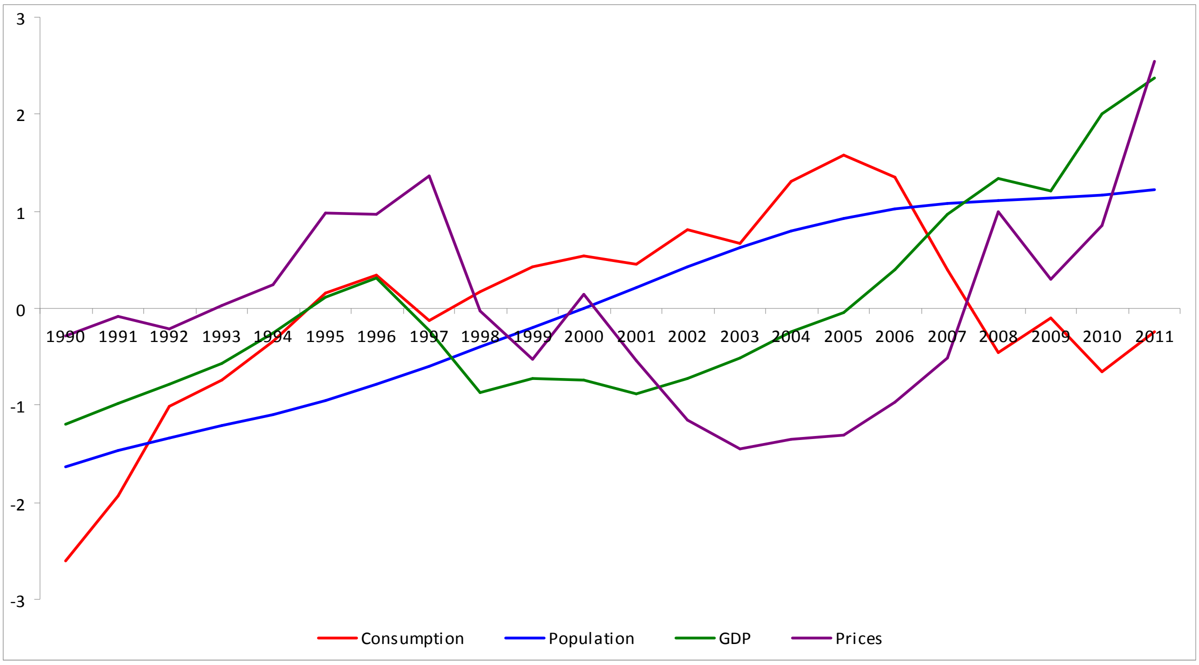
2.2.1.9 Thailand

Seafood consumption increased 54% in Thailand during the observed years. However, it is declining since 2005 in a rate of 21% until 2011. Consumption per caput sharply increased in the 90's rising from 20 Kg in 1990 to 33.9 Kg in 2005 and then drop to 26.9 in 2011. The contraction in seafood consumption in Thailand is related to a decrease in domestic supply in the second half of the last decade. Thailand is a large exporter of seafood products. Exports kept increasing while aquaculture production was declining due to environmental and health issues affecting shrimp farming. Total domestic supply of seafood decreased in Thailand 25.9 % from 2005 to 2011, while exports increased 12%. Imports did not increase enough to fill the gap between demand and supply.

Graphically, the price index and GDP per caput appear to be related in their evolution, and behaving opposite to seafood consumption (Figure 9). Prices decreased 20% between 2000 and 2003 and remained at this level until 2006 when the price index started raising until reaching an increase of 31%

in 2011 with regard 2000 (62% increase since 2005). GDP per caput decreased in the 90's to a minimum of 1,831 USD in 2001 and then increased 183% in the following years up to 5,192 USD in 2011. Population growth also stagnates after 2005. Average yearly population growth was 0.99% between 1990 and 2005, and 0.32% from 2005 to 2011.

Figure 9. Evolution of the variables in the model for Thailand. Standardized values.



Normality test did not reject any variable at a 95% confidence level and the full model was fitted using OLS estimation. A first attempt indicated autocorrelation issues which were managed with the Cochrane-Orcutt transformation. Results present a model in which population explains 94% of the evolution in consumption, and none other variable is significant (Table 14).

Table 14. Full model results for Thailand

Model performance	Parameter values
R2 = 94.5%	Po: 0.804***
F = 20.871***	I: 0.085
DW = 1.971	Pr: 0.054

Besides the fact that a model based in population fits with the evolution of the two series along the observed period, there is also a strong correlation across the price index and the GDP per caput which may be a source of multicollinearity issues biasing the values and significance of the parameters. In order to deal with these issues a simultaneous equation system is tested using ISUR estimation (Table 15). The new model improves the results in terms of parameter values and the price index results a significant factor but positively affecting the changes in seafood consumption. Income affects consumption indirectly, and being a cause of the increase in the price this effect is also negative.

Table 15. Simultaneous equation model results for Thailand

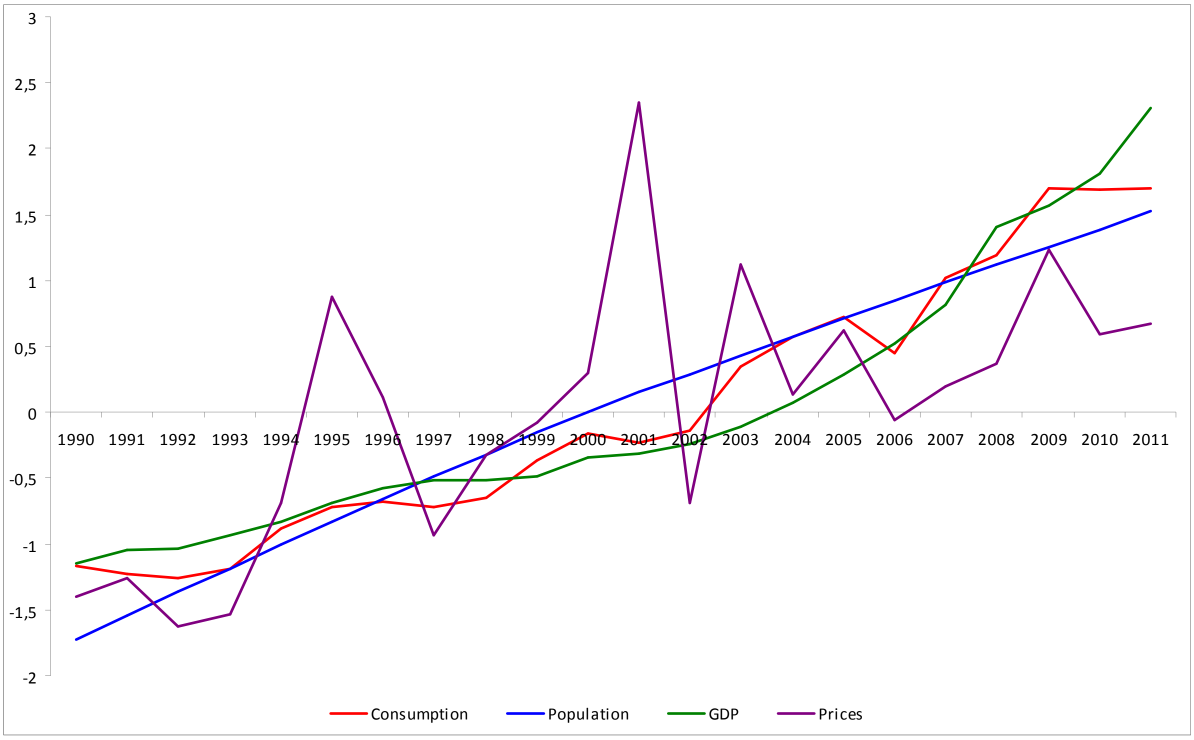
Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 94.5% F = 35.653*** DW = 1.986	Pr: 0.904***	R2 = 92.1% F = 116.67*** DW = 2.201	I: 0.961***

2.2.1.10 Vietnam

Seafood consumption dramatically increased in Vietnam in the last two decades. Seafood became more available for Vietnamese consumers due to the strong recent development of the industry, whether wild fishery or aquaculture, pulled by exports. As a result of the increase in the volumes of seafood, Yearly per caput consumption went from 12.67 Kg in 1990 to 33.64 Kg in 2011. The increase in the total volumes of consumed seafood was of 246% in the observed period.

Along with seafood consumption, all the variables included in the model have increased in the long term (Figure 10). Population and GDP per caput show quite stable trend along time, but prices have been experienced strong fluctuations all along the observed years. Yearly GDP per caput was 98 USD in 1990 and increased to 1,543 USD in 2011. Prices increased 56% in the full period, but with high peaks and drops which appear stabilize after 2003. Population growth was less pronounced, than the economic variables, with an increase of 33% in the full period analyzed.

Figure 10. Evolution of the variables in the model for Vietnam. Standardized values.



All variables were found to be normally distributed allowing OLS estimation. The full model explains almost 98% of the changes in seafood consumption in Vietnam with significance in population and income. The first estimation indicated some minor issues of autocorrelation which were assessed using the Cochrane-Orcutt transformation (Table 16). Price is non-significant and appears following a different evolution than consumption. Accepting the assumption that changes in prices negatively affect consumption, this result may be indicating a quite different trend in domestic prices with regard those in external trade.

Table 16. Full model results for Vietnam

Model performance	Parameter values
R2 = 97.5% F = 152.35*** DW = 1.934	Po: 0.551*** I: 0.447*** Pr: 0.051

A first estimation of the economic model resulted significant for the two variables, but with a positive sign in the price index and a Durbin Watson index of 1.172 indicating issues of autocorrelation. When these issues were assessed with the Cochrane-Orcutt transformation the price index no longer results significant. Given the results of the economic model, the final model for Vietnam remains as described in table 16.

<u>2.2.2 Countries with partial models</u>

This section presents the results of the model in those countries where only one variable was found to be significant. These countries are Colombia, Namibia, Spain, Mexico and Tanzania. The main driver of seafood consumption in almost all these countries, according to the proposed model, was the population size. Mexico is the only exception being income the only one significant variable in the reduced economic model. Model performance and parameter values are presented in table 17.

Table 17. Model results for countries with only one significant variable in the seafood consumption model

Country	Model performance	Parameter values	Estimation
Colombia	R2 = 91.9% F = 40.138*** DW = 1.909	Po: 1.193*** I: −0.485 Pr: 0.275	OLS plus Cochrane-Orcutt
Namibia	R2 = 87.9% F = 7.768** DW = 1.935	Po: 1.093*** I: 0.171 Pr: −0.551	OLS plus Cochrane-Orcutt
Spain	R2 = 81.5% F = 3.784** DW = 2.224	Po: 1.166** I: −0.921 Pr: 0.415	OLS plus Cochrane-Orcutt
Mexico	R2 = 85.3% F = 7.661** DW = 1.316	I: 0.746*** Pr: −0.017	OLS plus Cochrane-Orcutt
Tanzania	R2 = 42.8% F = 4.742** DW = 2.272	Po: −1.105** I: 0.797* Pr: 0.071	Quantile regression

Seafood consumption increased in Colombia from a per caput 2.9 kilos in 1990 to 5.9 in 2009. OLS estimation was used in this case since no variable was rejected normality. The main issue of this model deals with autocorrelation, which was assessed with the Cochrane-Orcutt transformation. The resulting model allows explaining almost 92% of the variations in seafood consumption with only population as the significant parameter. Although non-significant, the parameter values for income and the price index are inconsistent with the economic theory. The economic model results significant for the income with a positive sign, but not for the price which appears in negative sign. However, after assessing autocorrelation issues none of the parameters result significant and the model is rejected.

Seafood consumption increased in Namibia until 2007, when per caput consumption reached 14.3 Kg from a starting value of 10.2 kilos in 1990. This increasing trend reverted in the following years and per caput consumption recorded 11.6 kilos in 2011. Namibia shows almost the same results given for Colombia, with the only exception of the sign of the parameters in the economic variables, which are consistent with the theory. However, these parameters are non-significant and thus they do not affect at all the evolution in seafood consumption in the full model. Like in the previous example, the economic model was rejected after assessing the autocorrelation issues. The model based in population allows explaining almost 88 % of the variations in seafood consumption.

Spain is a country with a large tradition in seafood consumption. However, after a considerable increase from 35 kilos per caput in 1990 to 46 kilos in 1998, consumption has stagnated at an average of 43 kilos in the following years. The levels of seafood consumption are much bigger in Spain than in Colombia and Namibia, but the results of the models are very similar. Normality cannot be rejected for all variables. First estimation results in issues of autocorrelation. Assessing the problem improves model explanatory ability. Results provide a significant model with population as the main driver for consumption allowing explain 81.5% of the variation in seafood consumption. Like in the case of Colombia and Namibia, the economic model is rejected after assessing the issues of autocorrelation detected in the first OLS estimation.

Consumption of seafood in Mexico is stagnated and, although it has risen 22% in absolute quantities, it follows a flat trend on an average of 10 kilos per caput. This is mainly due to cultural reasons and a strong preference for meats across the population. Mexico is a particular case within this section in which population results non-significant and the full model is rejected after assessing autocorrelation. However, the economic model cannot be rejected, explaining 85% of the variation in seafood consumption, with a positive significant parameter for the income.

Seafood consumption has declined in Tanzania during the observed period falling from a per caput rate of 16 kilos in 1990 to 5.7 in 2011. Shortages in domestic supply due to environmental and overfishing issues in Lake Victoria are behind this fall. Tanzania is the only country in this section where normality was rejected for some of the involved variables and robust estimation was used for computing parameter values and significance. Issues of autocorrelation were rejected in the preliminary OLS estimation. The model can only explain 43% of seafood consumption. Shortages in domestic seafood supply may be a cause of the negative value in the parameter linked with population, indicating that consumption of seafood is declining as population growths. The economic model was rejected.

2.2.3 Countries with non-significant models

The full model for Argentina only results in significant values when autocorrelation has been assessed. Population is the only one variable with a significant negative parameter, which reflects the decreasing trend in seafood consumption in the country. However, the model was rejected attending to the F statistic test. Chile, South Africa, Germany and Italy failed in provide any significant result whether in the full or economic models. Italy is a particular case in which model performance is optimal but no significant parameters were found after addressing autocorrelation issues (Table 18). Italy is the only country where seafood consumption has increased in the observed period. It is stagnated in Chile, Germany and Italy and has significantly decreased in Argentina.

Table 18. Model results for countries with no significant variables in the seafood consumption model

Country	Model performance	Parameter values	Estimation
Argentina	R2 = 56.9% F = 1.491 DW = 2.031	Po: −1.001* I: −0.345 Pr: 0.637	OLS plus Cochrane-Orcutt
Chile	R2 = 57.7% F = 0.158 DW = 1.335	Po: 0.160 I: 0.197 Pr: −0.040	OLS plus Cochrane-Orcutt
South Africa	R2 = 10.5% F = 1.062 DW = 1.331	Po: −0.614 I: −0.047 Pr: 0.785	OLS
Germany	R2 = 32.4% F = 2.879 DW = 2.276	Po: 0.144 I: 0.562 Pr: −0.083	Quantile Regression
Italy	R2 = 90.0% F = 8.897*** DW = 1.804	Po: 0.522 I: −0.408 Pr: 0.692	OLS plus Cochrane-Orcutt

2.3 Summary

A function of seafood consumption based in previous research has been tested in 20 countries from different continents and economic development levels. The model as a whole, including all the three variables, was successful in 10 countries. In Brazil, Japan, Nigeria, Indonesia, India, Australia, Morocco, USA, and Thailand, the involved three parameters resulted significant. In the case of Vietnam the effects of the price index were rejected. In other 5 more countries, Colombia, Namibia, Spain, Mexico and Tanzania, one of the three parameters was found significant. Population was the relevant factor in these countries excepting Mexico, where the disposable income, measured by the GDP per caput, was the only one significant variable. Finally, the consumption model was rejected in Argentina, Chile, South Africa, Germany and Italy. In all these last countries the models using apparent consumption as dependent variable resulted significant with the exception of South Africa, where both models were rejected.

Successful models indicate that seafood consumption is dependent on population, income and the changes in the prices. Positive parameters are the most common results for population and income. However, negative parameters in population were found in countries where consumption is decreasing, indicating changes in consumer preferences in the case of Japan, or decreases in supply as seen in Tanzania. Income has been found to be positively related with seafood consumption in all the cases in which the GDP per caput has been found significant. The price index, computed with international trade data, exerts a negative effect consistent with the economic theory in all the cases in which a significant influence was not rejected.

3. Consumption of selected species in EU countries

According to the results of the previous section, seafood consumption across EU members appears to be stagnated. The function of seafood consumption has been found to be more efficient in situations of continued increase or decrease of consumption, but less efficient in countries with a less pronounced trend, as it is the case of the selected EU countries. Consumption in the EU appears to be stagnated, varying around an average quantity of fish and other seafood products along the years observed. In order to reach this average amount, different species of different origins have to compete among themselves and the amounts consumed of each species varies differently according to changes in the social environment. Not just the information about a particular species is lost, but also the results and interpretation of the models could be affected. When two dominant species behave in an opposite way, as it could be the case of a superior and an inferior good, the effects of a relevant factor such as disposable income could be compensated if the total quantities of the two species are aggregated. The resulting total figures may not change along time and an econometric model could be rejected.

Moreover, the SUCCESS project assumes the heterogeneity of the seafood sector and the tasks undertaken so far are confirming that different species face different market conditions. It is not just the range of prices for the different species. Some species are strongly sensitive to changes in the price and other keep being consumed in the same quantities even if the prices rise. Low value species are less demanded in periods of income growth. However, some low cost species are so popular across customers and consumption may also rise when consumers income improve. Finally, there are species which are consumed simply because they are in the market and consumption is not affected by changes in the economic or social conditions. The way in which the economic factors affect the evolution of demand for a selected group of seafood species of interest within the SUCCESS project will be tested in this section using the same models described in the precious section for analyzing the evolution of total seafood demand.

The role of population has been addressed in the previous section. More attention is being paid here to the economic models. The simultaneous equation systems have been reduced including only the economic variables. A significant effect from population is connected with other underlying behavioral variables such as culture and tradition which difficultly can be addressed in a time series econometric model. These variables are out of the scope of this report but will be analyzed in further stages of Working Package 2.

The FAO Food Balance Sheet does not disaggregate the data at the species level as it is required in this section. The dependent variable for these models will be total apparent consumption computed using the formula presented in (4) which includes both local and imported supply, as well as fresh and processed products. This calculus results in an issue in terms of estimating the real quantities of a given species which are consumed by a citizen, and is problematic for studying food security. However, it is a reasonable proxy for analyzing economic behavior, since these quantities should evolve in a similar trend as the demand for the species and the different products made of the same species.

3.1 Selection of countries and species

The selected species are included within the different case studies undertaken in the SUCCESS project. The species selected cover whitefish, marine aquaculture, flatfish, bivalve shellfish and freshwater aquaculture. Cod, one of the most popular whitefish in the EU markets, has been used to illustrate the case of whitefish consumption. Marine aquaculture is represented by salmon and gilthead seabream. The two species differ in the market coverage. While salmon is a global commodity, consumption of seabream is still concentrated in the Mediterranean countries. Sole and plaice illustrate the case of flatfish comparing a high versus a low value fish. Mussels and scallops represent two well differentiated shellfish in terms of value and harvest technologies. Finally, carps, with consumption concentrated in Central Europe illustrate the case of freshwater aquaculture.

With the exception of carps, the main destination of all the observed species is human food consumption. Consumption of carps as a foodstuff in mainly located in the countries of Central Europe. In countries outside this region carps are almost exclusively used as an ornamental fish for private and public gardens. This can be, in fact, a strong cause of differentiation in terms of market behavior which should be taken into account when considering the results for this species.

Countries were selected along the nationalities of the consortium partners including the most relevant markets in the EU in total seafood and at the species level. The largest markets covered in the analysis are Spain, France, Italy, the UK and Germany. Poland, Greece and the Netherlands are minor markets in terms of absolute quantities, but relevant for some of the selected species such as carps, seabream and plaice. Poland provided no external trade data until 1994, so the models had to be tested for a shorter period. In the case of the Netherlands, the high activity in transshipments of seafood products has to be taken into account as a potential source of bias, and could be behind some results pointing to a differentiated demand behavior.

The influence of Intra-EU trade flows on the series of apparent consumption can be clearly appreciated in some of the cases illustrated below. The most evident are the similarities in the evolution of apparent consumption of sole in Spain and in the Netherlands. In other cases the potential intra-EU linkages are less clear, but it does not mean that the issue doesn't exist. Trade flows of seafood products across EU member states goes beyond the aims of this report and is going to be analyzed using price integration techniques in Working Package 4.

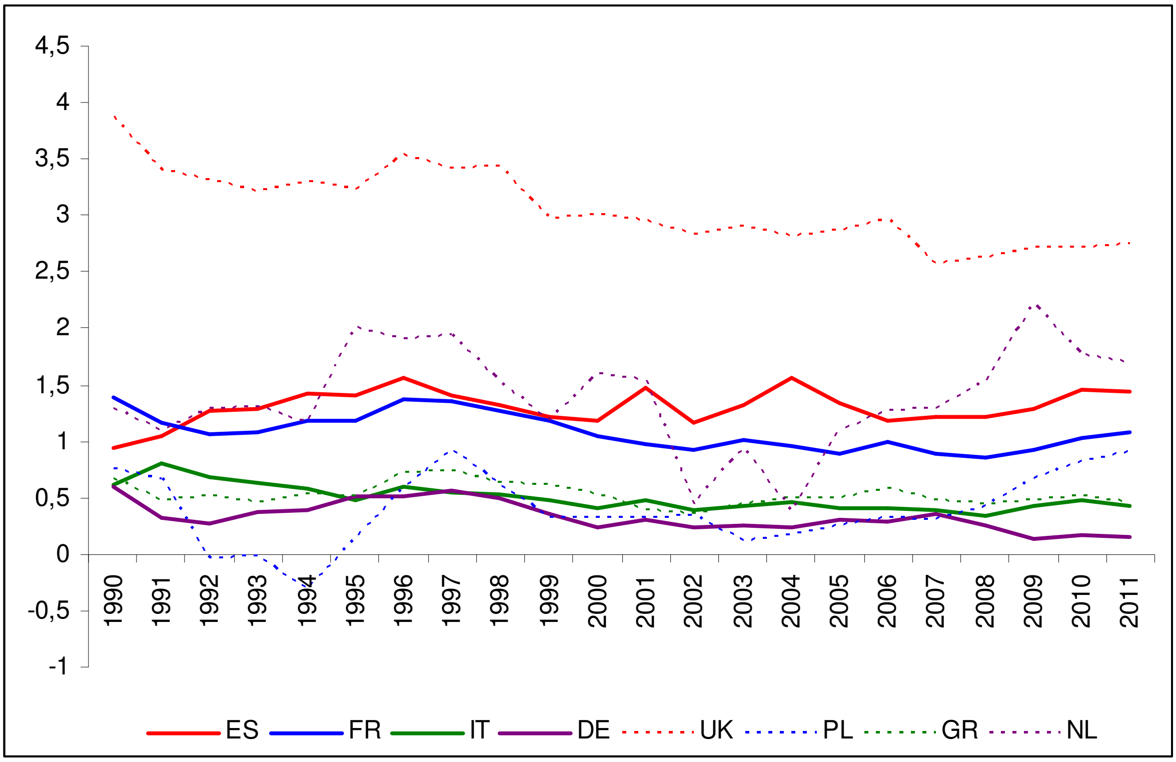
3.2 Consumption of Cod

Cod is one of the most popular whitefish consumed in Europe. The most traditional presentation is salted cod, which has been consumed for Centuries. Nowadays, the market for frozen and fresh cod has grown in all EU countries, replacing the traditional style. The UK is the country with the highest consumption per person during the observed period, followed by the Netherlands and Spain. In contrast, Germany and Poland registered the lowest consumption rates per person. Cod consumption is declining in all the countries except in Spain and the Netherlands, where imports of frozen and salted cod have been increasing in the last decade (Table 19; Figure 11)).

Table 19– Evolution of cod consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	1,31	52,32%
France	1,08	-22,66%
Italy	0,50	-30,46%
Germany	0,33	-75,12%
UK	3,06	-29,15%
Poland	0,40	-389,57%
Greece	0,52	-30,29%
Netherlands	1,38	32,40%

Figure 11. Evolution of per caput consumption of cod by countries.



All the variables involved in the models of cod consumption have been successfully tested for normality with the exception of the population in Germany. Robust estimation will be used for the models tested in this country.

3.2.1 Model results by countries

3.2.1.1 Spain

The results of the full model are overall significant but only 50% of cod consumption in Spain can be explained by the variables involved (Table 20). Indeed, the only significant variable is the price index, at a 90% confidence level. The full model would reject the influence of population and economic growth in the evolution of cod consumption in Spain.

Table 21. Full model for cod consumption in Spain.

Model performance	Parameter values
R2 = 50.9% F = 6.582*** DW = 1.708	Po: 0.783 I: 0.448 Pr: −1.495*

The economic variables alone provide a better model in terms of parameter significance, not loosing much association across dependent and independent variables or lack of autocorrelation issues. The model points to a significant positive effect of income on cod consumption, which is counterbalanced by significant sensitivity to an increase in prices (Table 21). The effects from income are stronger than those from the changes in the price. Indeed, the variations in the price index are positively related to the changes in income. Thus, cod consumption in Spain is directly conditioned by consumers' disposable income and indirectly through its impact on the evolution of prices.

Table 21. Simultaneous equation model for cod consumption in Spain.

Equation 1: C = f(I,Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 48.0% F = 9.233*** DW = 1.517	I: 1.332*** Pr: −1.772**	R2 = 77.5% F = 8.524*** DW = 1.193	I: 0.441***

3.2.1.2 France

The models for cod consumption in France are affected by issues of autocorrelation and Cochrane-Orcutt estimators were used for fitting a model with the issues addressed. The corrected model allows explaining almost 74% of the variation in the quantities of cod consumed in France. The resulting values and tests for the full model also exclude significance for the population, like in Spain, but do not reject an economic model (Table 22).

Table 22. Full model for cod consumption in France.

Model performance	Parameter values
R2 = 73.8% F = 5.284*** DW = 1.674	Po: -0.221 I: 1.555** Pr: −5.097***

The economic model slightly improves overall statistical performance. Both parameters are significant and in opposite sign. While income is exerting a positive effect on cod consumption, this is moderated by stronger price sensitivity (Table 23). Income exerts once again a double influence since there is a significant positive and direct effect on cod consumption and an indirect effect though the changes in the prices, which are positively correlated with the disposable income.

Table 23. Simultaneous equation model for cod consumption in France.

Equation 1: C = f(I,Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 73.9% F = 7.943*** DW = 1.724	I: 1.338*** Pr: −5.667***	R2 = 88.8% F = 17.741*** DW = 0.508	I: 0.312***

3.2.1.3 Italy

The models for Italy resulted in a poor performance. The series of cod consumption, income and the price index in Italy resulted in no significant models of any kind. Variance analysis tests allow rejecting both the full and the economic models at a confidence level over 90% with no significant variables in any case (Table 24).

Table 24. Full model for cod consumption in Italy.

Model performance	Parameter values
R2 = 29.9% F = 4.061* DW = 0.811	Po: -0.156 I: 0.199 Pr: −1.893

The price index results significant only when a bivariate model is considered. In such a case, a negative effect on the quantities of consumed cod from a rise in the prices should be expected. However, this effect disappears when autocorrelation is handled with the Cochrane-Orcutt estimation.

3.2.1.4 Germany

A significant effect from population is also rejected in the case of Germany. Income, with a positive sign, and the price index, with a stronger negative sign, are the only significant variables of the full model, which explain 73% of the variation in the quantities of cod consumed in Germany (Table 25).

Table 25. Full model for cod consumption in Germany.

Model performance	Parameter values
R2 = 58.6% F = 9.001*** DW = 1.029	Po: −0.013 I: 0.789* Pr: −4.567***

The economic model confirms the significance and values of the parameters connected with income and the price index. A simultaneous equation model confirms a double effect from income also in this case. Anyway, price sensitivity is stronger than the positive direct effect on income (Table 26).

Table 26. Simultaneous equation model for cod consumption in Germany.

Equation 1: C = f(I,Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 70.1% F = 8.697*** DW = 1.311	I: 0.657** Pr: −4.658***	R2 = 79.6% F = 82.352*** DW = 0.424	I: 0.245***

3.2.1.5 UK

The full model is rejected in the UK despite significant values in the overall hypothesis test. No parameter results significant, which points to potential multicolinearity issues (Table 27).

Table 27. Full model for cod consumption in the UK.

Model performance	Parameter values
R2 = 56.8% F = 12.521*** DW = 1.213	Po: -0.245 I: -0.717 Pr: 0.447

The economic model is affected by the same issues, resulting in non-significant parameters when autocorrelation is addressed. The best model is provided by a simultaneous equation system with no direct links between income and cod consumption (Table 28). This model shows a significant negative parameter connecting consumption with the price index. Prices, on their side, are directly affected by income in a second equation.

Table 28. Simultaneous equation model for cod consumption in the UK.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 37.5% F = 12.598*** DW = 0.699	Pr: −1.556***	R2 = 80.3% F = 5.445** DW = 0.720	I: 0.451***

3.2.1.6 Poland

Despite income resulted significant in the initial estimation of the full model using OLS, all parameters lost significance when autocorrelation is addressed and the resulting model is rejected (Table 29).

Table 29. Full model for cod consumption in Poland.

Model performance	Parameter values
R2 = 34.9% F = 0.305 DW = 1.428	Po: 0.150 I: 0.167 Pr: -0.301

The economic model provides a single equation with significant parameters and a positive value for income and negative for the price index (Table 30). A simultaneous equation model results in loss of significance in the correlation across the changes in the price and the quantities consumed.

Table 30. Economic model for cod consumption in Poland.

Model performance	Parameter values
$R2 = 75.5\%$ $F = 7.075^{***}$ $DW = 1.117$	I: 1.527*** Pr: -1.457***

3.2.1.7 Greece

Results from the full model show an absolute lack of correlation between the observed variables (Table 31). The model, in all its forms is unable to explain the evolution of cod consumption in Greece.

Table 31. Full model for cod consumption in Greece.

Model performance	Parameter values
$R2 = 0.05\%$ $F = 0.555$ $DW = 0.853$	Po: -0.015 I: 0.057 Pr: -0.271

3.2.1.8 Netherlands

The full model for cod consumption in the Netherlands resulted significant only for the economic variables (Table 32). The model allows explaining less than 37% percent of the variation in cod consumption.

Table 32. Full model for cod consumption in the Netherlands.

Model performance	Parameter values
$R2 = 36.9\%$ $F = 5.567$ $DW = 1.353$	Po: -0.065 I: 1.542*** Pr: -1.334**

Cod consumption in the Netherlands is directly affected by income and prices. Income exerts a positive effect which is compensated by a rise in the prices. Indeed, as seen in other countries, changes in the prices of cod products are directly dependent on changes in the disposable income (Table 33).

Table 33. Simultaneous equation model for cod consumption in the Netherlands.

Equation 1: C = f(I,Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
$R2 = 36.8\%$ $F = 11.678^{***}$ $DW = 1.356$	I: 1.512** Pr: −1.363***	$R2 = 83.8\%$ $F = 109.411^{***}$ $DW = 0.919$	I: 0.915***

3.2.2 Summary

With the exception of Italy and Greece, a model was found to be significant in all the other countries. The dominant models are purely economic, indicating an elastic demand and a double impact of income on consumption. Income has a positive direct effect on demand, by increasing consumption when the purchasing power improves. But also has a negative and indirect effect, by increasing the prices. This double effect was not confirmed in the case of the UK, where income was found to be only indirectly connected with consumption by the effects on the prices. Beyond the exceptions, cod appears as a superior good, which consumption will increase if disposable income improves. However, it is also sensitive to an increase of prices, which will negatively affect the volumes of demand. An increase in prices is also a consequence of an increase in the income, which partially counterbalances the positive direct effect on demand (Table 34). The performance of the model varies from the lack of significance in the case of Italy and Greece, to a relatively high coefficient of determination of 73% in the case of France and Germany.

Table 34. Cod consumption: summary of results by country.

	Population	Income	Price
Spain	Non significant	Elastic	Elastic
France	Non significant	Elastic	Elastic
Italy	Non significant	Inelastic	Inelastic
Germany	Non significant	Elastic	Elastic
UK	Non significant	Inelastic	Elastic
Poland	Non significant	Elastic	Elastic
Greece	Non significant	Inelastic	Inelastic
Netherlands	Non significant	Elastic	Elastic

3.3 Consumption of Salmon

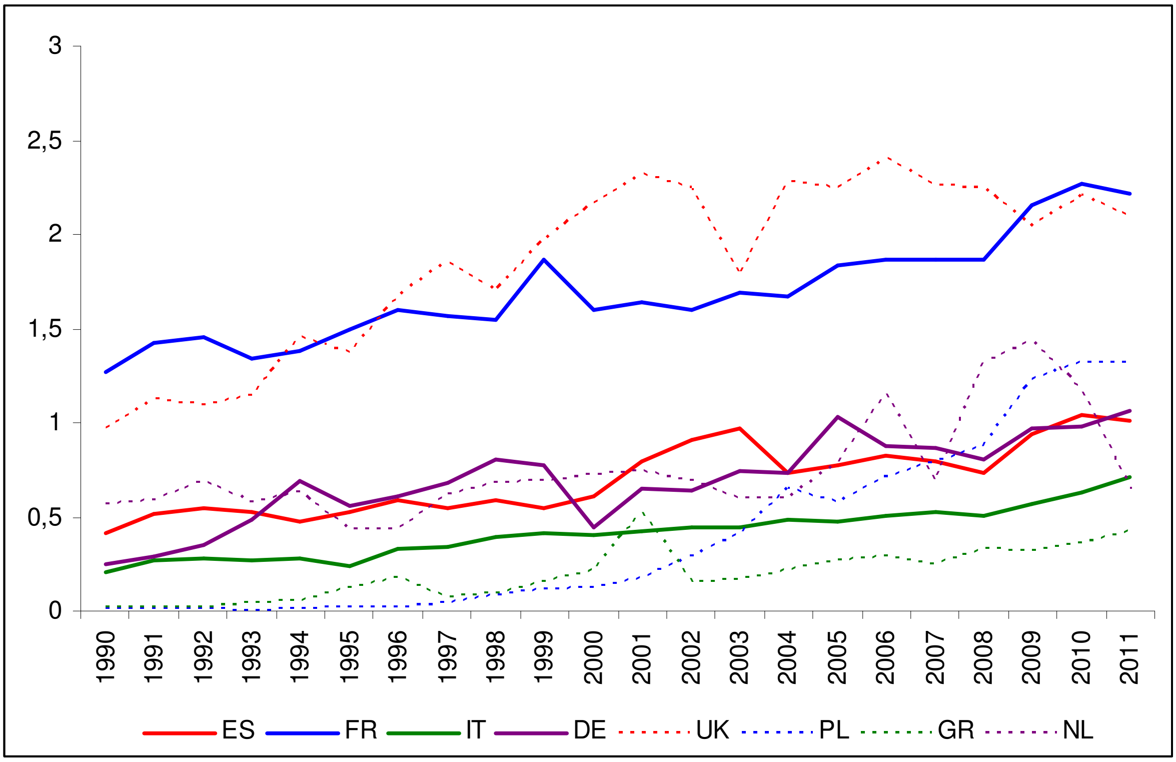
Salmon is a global commodity, widely consumed all around the world. Most the quantities of salmon consumed in the EU are of farmed fish, harvested mainly in Norway and Scotland. Salmon is a well-diversified commodity which is traded fresh, frozen and smoked including whole fish fillets and more elaborated processed products.

The UK and France are the two countries with the highest rates of salmon consumption, followed by the Netherlands, Spain and Germany. Greece, Italy and Poland, on the opposite, record the lowest levels of consumption per person. Salmon consumption has increased in all the observed countries, but especially in those with the lowest consumption rates showing an impressive power of penetration and growth (Table 35; Figure 12).

Table 35. Evolution of salmon consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	0,70	147,86%
France	1,69	75,61%
Italy	0,42	235,98%
Germany	0,69	335,52%
UK	1,85	115,68%
Poland	0,49	8440,34%
Greece	0,19	2221,18%
Netherlands	0,75	14,88%

Figure 12. Evolution of per caput consumption of salmon by countries.



All the involved variables have succeeded the normality tests with the exception of the consumption quantities in the Netherlands and the price index in Germany. For these two countries parameters of the full and economic models will be computed using robust estimation.

3.3.1 Model results by countries

3.3.1.1 Spain

The results of the full model in Spain provide strong levels of association with population and income, but the effects from the price index lost significance when autocorrelation is addressed using the Cochrane-Orcutt estimation. The model can explain 91% of the variability in salmon consumption in the Spanish market (Table 36).

Table 36. Full model for salmon consumption in Spain.

Model performance	Parameter values
R2 = 91.4%	Po: 1.957***
F = 38.07***	I: -1.069***
DW = 1.699	Pr: –0.101

The negative parameter for income is the result of a much higher positive effect from population. The sign changes when a binary regression is estimated using income as the exogenous variable. However, the parameter lost significance when autocorrelation is addressed. On the other hand, there is no significant correlation across income and the price index. Given these two issues, the economic and the simultaneous equation models can be rejected. Under these conditions population appear as the main driver for salmon consumption in Spain.

3.3.1.2 France

Like in the previous case, the models for salmon consumption in France are affected by issues of autocorrelation. However, the resulting full model, after addressing this issue, does not differ much from the initial OLS estimators in terms of parameter significance and value. Results show a strong influence from population growth which is the only significant variable in the model. Once again, the performance indicators show a strong level of association and the model is able to explain 89% of the variation in the quantities of salmon products consumed in France (Table 37).

Table 37. Full model for salmon consumption in France.

Model performance	Parameter values
R2 = 89.8% F = 23.383*** DW = 1.896	Po: 1.069*** I: -0.203 Pr: 0.127

The economic model provides a more logical interpretation in terms of parameter values and significance. Removing population from the full model results in significant parameters for the economic variables. Income shows a positive effect on consumption, while changes in the price index negatively affect salmon consumption. However, model performance worsens (Table 38). A simultaneous equation system fails connecting income and the price index and is then rejected.

Table 38. Economic model for salmon consumption in France.

Model performance	Parameter values
R2 = 79.3% F = 76.627*** DW = 1.123	I: 0.945*** Pr: –0.144*

3.3.1.3 Italy

The full model for salmon consumption in Italy also shows a strong influence from population, but differs from the two previous countries in a significant negative effect from the price index (Table 39). Model performance is also strong, explaining 92% of the variations in the amounts of apparent consumption.

Table 39. Full model for salmon consumption in Italy.

Model performance	Parameter values
R2 = 92.3% F = 115.279*** DW = 1.699	Po: 0.211*** I: -0.165 Pr: –0.841***

Income becomes positive and significant in the economic model, decreasing the influence of the price index. These values persist in the simultaneous equation model, which results significant in the two equations. However, the connection between income and the price index is not as strong as it has been observed in the models of other species (Table 40).

Table 40. Simultaneous equation model for salmon consumption in Italy.

Equation 1: C = f(I,Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 76.3% F = 64.443*** DW = 1.679	I: 1.007*** Pr: -0.534*	R2 = 37.5% F = 6.289* DW = 0.520	I: 0.295***

3.3.1.4 Germany

Salmon consumption in Germany differs from the previous cases in a lower effect from population, which results significant only at a 90% confidence level. Another difference regards to a positive significant parameter from income which is the most influential variable in the model (Table 41).

Table 41. Full model for salmon consumption in Germany.

Model performance	Parameter values
R2 = 73.4% F = 5.941*** DW = 1.399	Po: 0.429* I: 0.737*** Pr: –0.007

The economic model improves the performance of the price index which results significant and negative. Model performance also improves, given the low significance of population in the full model, which has been removed in this one (Table 42. The new model allows explaining 75% of the variation in the dependent variable. No significant connection between income and the price index has been found and the simultaneous equation model is then rejected.

Table 42. Economic model for salmon consumption in Germany.

Model performance	Parameter values
R2 = 75.6% F = 62.103*** DW = 1.829	I: 0.885*** Pr: –0.241***

3.3.1.5 UK

All parameters in the full model of salmon consumption in the UK have been found to be significant with excellent levels of performance (Table 43. As expected from the assumptions of the full model, salmon consumption in the UK is positively affected by population growth and income, and negatively affected by prices. The full model allows explaining 92% of the variations in the apparent consumption of salmon.

Table 43. Full model for salmon consumption in the UK.

Model performance	Parameter values
R2 = 92.1% F = 110.669*** DW = 2.102	Po: 0.504*** I: 0.423*** Pr: –0.316***

3.3.1.6 Poland

OLS estimation of the full model for Poland shows similar results as those of Germany, with income as the most relevant variable and a low significance of the parameter connected with population, which shows negative sign. The initial model indicates issues of autocorrelation which have been addressed with the Cochrane-Orcutt transformation. The parameter connected with income loses significance when autocorrelation is addressed (Table 44). Besides these issues, the variables in the model allow explaining 92% of the variations in apparent consumption. The model should be further investigated and the issues addressed in order to assess the influence of the involved variables.

Table 44. Full model for salmon consumption in Poland.

Model performance	Parameter values
R2 = 92.4% F = 41.922*** DW = 1.768	Po: –0.247* I: 0.400 Pr: 0.405

The economic model is affected by nulticolinearity across income and the price index, and rejects any influence from a change in the prices on the evolution of salmon consumption (Table 45). This issue is solved in a simultaneous equation model, but results in a positive and significant parameter for the price index. This is inconsistent with the expected role of prices on demand, even there is a strong association across income and prices. As a consequence, with the available variables, salmon consumption in Poland can only be explained by disposable income.

Table 45. Economic model for salmon consumption in Poland.

Model performance	Parameter values
R2 = 90.4% F = 38.625*** DW = 1.673	I: 0.641** Pr: 0.318

3.3.1.7 Greece

Results from the full model of salmon consumption in Greece show only significance for the population. Model performance is lower than in the previously observed countries. The full model can only explain 63% of the variation in salmon consumption, which is the lowest in all the countries studied for this species (Table 46).

Table 46. Full model for salmon consumption in Greece.

Model performance	Parameter values
R^2 = 63.9% F = 11.212*** DW = 1.1695	Po: 0.595** I: 0.218 Pr: –0.148

Preliminary OLS estimation of the economic model shows significance in the two parameters, with positive sign in the case of income and negative in the case of the price index (Table 47). Effects from income are stronger that those from the price index. The model is slightly affected by some autocorrelation issues which cause non significance of the price index when corrected. The simultaneous equation model resulted no significant in any of the parameters and was rejected.

Table 47. Economic model for salmon consumption in Greece.

Model performance	Parameter values
R^2 = 55.1% F = 6.376*** DW = 1.737	I: 0.683*** Pr: –0.269

3.3.1.8 Netherlands

Like in the case of the UK, The full model for salmon consumption in the Netherlands resulted significant in all the three variables (Table 48). The parameter connecting population growth with salmon consumption is negative, which may be reflecting the slow increase of consumption in the observed period. Income is positively related to consumption, while prices are exerting a negative effect.

Table 48. Full model for salmon consumption in the Netherlands.

Model performance	Parameter values
R^2 = 54.9% F = 7.733*** DW = 1.666	Po: –0.599** I: 1.406*** Pr: -0.545***

3.3.2 Summary

In contrast with cod consumption, which was found to be strongly dependent on economic variables in general, and income in particular, salmon consumption is driven by population growth in most of the observed countries. The economic model only improves performance in the case of Germany. With the exception of Poland and the Netherlands, the parameter associated with the population is positive. Salmon is a farmed fish whose production has been increasing in the last decades. The positive sign in the parameter of the population shows how the increase in the supply of salmon has been absorbed by an increasing demand, by raising the amounts consumed per country and person. The results from the economic model indicate a positive influence of income on consumption, and a negative parameter in the case of the price index. In this case, the absolute value of the parameter is higher in the income than in the price. These results indicate that income elasticity exerts more influence on consumption than price elasticity. A raise in demand motivated by an increase in the disposable income will be of a higher magnitude than that in the case of cod, since the effects of price elasticity are lower (Table 49).

The models allow explaining about 90% of the changes in the quantities of apparent consumption of salmon in most of the countries. In Greece and the Netherlands this coefficient falls to 50% according to the model considered.

Table 49. Salmon consumption: summary of results by country.

	Population	Income	Price
Spain	Positive	Elastic	Inelastic
France	Positive	Elastic	Elastic
Italy	Positive	Elastic	Elastic
Germany	Positive	Elastic	Elastic
UK	Positive	Elastic	Elastic
Poland	Negative	Elastic	Inelastic
Greece	Positive	Elastic	Elastic
Netherlands	Negative	Elastic	Elastic

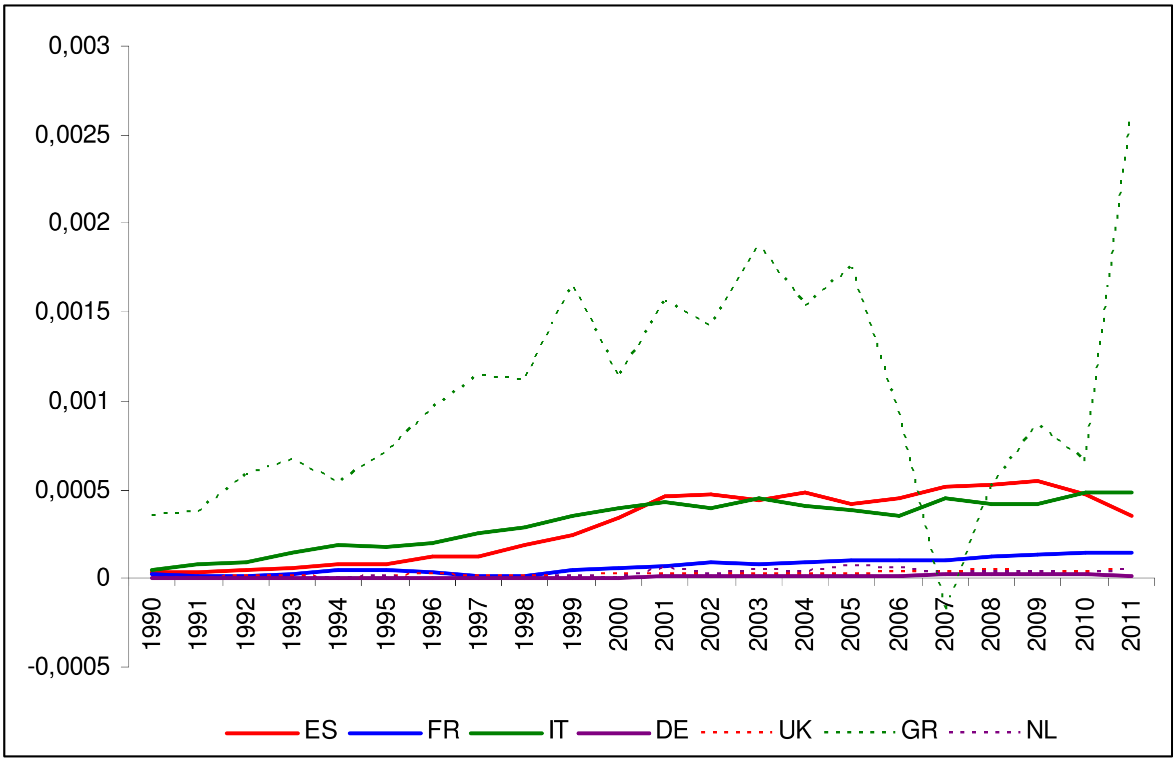
3.4 Consumption of Seabream

Seabream is another major aquaculture fish mainly consumed fresh in the Mediterranean region and surrounding countries. Over 90% of the total supply is coming from the farms located in the Mediterranean countries, including non member states like Turkey. Greece, Italy and Spain show the highest rated of consumption per person. Consumption falls dramatically in non Mediterranean countries. However, it has been significantly rising along the observed years in all the countries studied (Table 50; Figure 13).

Table 50. Evolution of seabream consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	0,296	890,66%
France	0,070	400,58%
Italy	0,313	833,40%
Germany	0,011	380,64%
UK	0,022	637,39%
Greece	1,034	646,76%
Netherlands	0,023	629,77%

Figure 13. Evolution of per caput consumption of seabream by countries.



The series from Poland have missing data in some of the observed years and the consumption models can not be analyzed in this section. Beyond the population in Germany, all the other series in the models were found to be normally distributed for the rest of the countries.

3.4.1 Model results by countries

3.4.1.1 Spain

The full model of seabream consumption in Spain is affected by autocorrelation. The initial OLS estimation found the price index to be significant and with a negative parameter. However, when addressing autocorrelation the parameter loses significance (Table 51).

Table 51. Full model for seabream consumption in Spain.

Model performance	Parameter values
R2 = 92.7%	Po: 0.586
F = 1.077	I: –0.086
DW = 1.206	Pr: –0.045

The economic model is less affected by autocorrelation, and the Cochrane-Orcutt transformation does not improve the values of the Durbin-Watson index. The results from the OLS estimation show significance for the two independent variables. Income is exerting a positive effect on the quantities of seabream consumed in Spain, while the changes in the prices act negatively (Table 52). A simultaneous equation model failed connecting income and prices. This model allows explaining 86% of the evolution of the quantities consumed.

Table 52. Economic model for seabream consumption in Spain.

Model performance	Parameter values
R2 = 86.1% F = 124.399*** DW = 1.151	I: 0.841*** Pr: –0.442***

3.4.1.2 France

The full model in France identifies population as the only significant variable affecting seabream consumption, and explaining almost 96% of the variation in apparent consumption (Table 53). The economic model rejected any influence from the price index, but a positive effect from income was found to be significant in the preliminary OLS estimation. However, this influence from the income is rejected after addressing autocorrelation issues. Population growth is, therefore, the main driver for seabream consumption in France.

Table 53. Full model for seabream consumption in France.

Model performance	Parameter values
R2 = 95.7% F = 54.956*** DW = 1.732	Po: 0.170*** I: –0.059 Pr: 0.055

3.4.1.3 Italy

Despite of a high level of association, the full model in Italy shows low significance in the parameters of population and the price index after addressing autocorrelation (Table 54).

Table 54. Full model for seabream consumption in Italy.

Model performance	Parameter values
R2 = 92.3% F = 3.243* DW = 1.894	Po: 0.489* I: 0.159 Pr: –0.242*

The initial OLS estimation of the economic model resulted significant for the two exogenous variables, but both were rejected after addressing autocorrelation. The simultaneous equation model fails in the equation connecting the price index with the quantities of apparent consumption. Alternatively, a simultaneous equation model succeeds when the income is considered along the price as a direct influence on consumption (Table 55). However, this new model has to be considered cautiously since it is affected by autocorrelation issues.

Table 55. Simultaneous equation model results for seabream consumption in Italy.

Equation 1: C = f(I,Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
$R2 = 86.4\%$ $F = 127.306^{***}$ $DW = 1.103$	I: 0. 953*** Pr: −0.692***	$R2 = 15.72\%$ $F = 3.742^{*}$ $DW = 0.359$	I: 0.397*

3.4.1.4 Germany

Income was the only significant variable in the full and economic models of seabream consumption in Germany. Association across variables was found to be relevant and mainly due to the effects of income on consumption, as found with the quantile regression estimators (Table 56). The model is affected by issues of autocorrelation.

Table 56. Full model results for seabream consumption in Germany.

Model performance	Parameter values
$R2 = 76.4\%$ $F = 30.828^{***}$ $DW = 0.636$	Po: 0.033 I: 0.682*** Pr: 0.028

The economic model confirmed the significance of the income but was inconclusive with the price index. While robust estimation returned a significant and positive parameter for the price, this result may be rejected after addressing issues of autocorrelation.

3.4.1.5 UK

Population was found to be the only significant variable in the case of the UK, after failing the economic models (Table 57). Despite of the lack of significance in the parameters associated with the income and the price index, the full model explains 93% of the variations in the apparent consumption of seabream.

Table 57. Full model results for seabream consumption in the UK.

Model performance	Parameter values
$R2 = 93.1\%$ $F = 127.223^{***}$ $DW = 1.662$	Po: 0.807*** I: 0.166 Pr: 0.028

3.4.1.6 Greece

All the variables in the full models for seabream consumption in Greece were found to be significant. The model allows explaining almost 63% of the variations in the amounts consumed (Table 58). However, even a negative parameter in the income can be explained from an economic point of view, the positive effect of the price index is inconsistent with the theory. The positive sign of the price index was not reverted in the economic or the simultaneous equation models, and performance significantly worsened.

Table 58. Full model results for seabream consumption in Greece.

Model performance	Parameter values
$R2 = 62.9\%$ $F = 7.848$*** $DW = 1.722$	Po: 2.849*** I: –2.205*** Pr: 1.101**

3.4.1.7 Netherlands

The full model in the Netherlands shows significance in the parameter associated with population, with positive sign, and in the price index, with negative sign (Table 59). This model explains 63% of the variation in the apparent consumption.

Table 59. Full model for seabream consumption in the Netherlands.

Model performance	Parameter values
$R2 = 63.7\%$ $F = 16.716$*** $DW = 2.296$	Po: 0.932*** I: –0.013 Pr: –0.341*

The economic model shows significance in the parameter associated with the income, but not in the case of the price index (Table 60). A similar result is found in the simultaneous equation model.

Table 60. Economic model for seabream consumption in the Netherlands.

Model performance	Parameter values
$R2 = 44.1\%$ $F = 15.715$*** $DW = 1.532$	I: 0.806*** Pr: –0.343

3.4.2 Summary

Like in the case of salmon, the parameter associated with the population is significant and positive in the majority of the countries. This result confirms the penetration of farmed fish in the markets, in which an increase in supply is being balanced with an increase in demand. Beyond population, income and price play their role in most of the observed countries. With the exception of Greece, all the parameters of the price index, was found to be negative in the cases where it was significant. On the other side, income is exerting a positive effect on consumption of a greater magnitude than price. The superiority of the income elasticity over price elasticity in affecting the quantities demanded was also found in the case of salmon (Table 61). Like with salmon, model performance is quite high, with coefficients of determination over 90% in Spain, Italy, France and the UK, and from 40 to 70% in The Netherlands, Greece and Germany.

Table 61. Seabream consumption: summary of results by country.

	Population	Income	Price
Spain	Non significant	Elastic	Elastic
France	Positive	Inelastic	Inelastic
Italy	Positive	Elastic	Elastic
Germany	Non significant	Elastic	Inelastic
UK	Positive	Inelastic	Inelastic
Greece	Positive	Elastic	Elastic
Netherlands	Positive	Elastic	Elastic

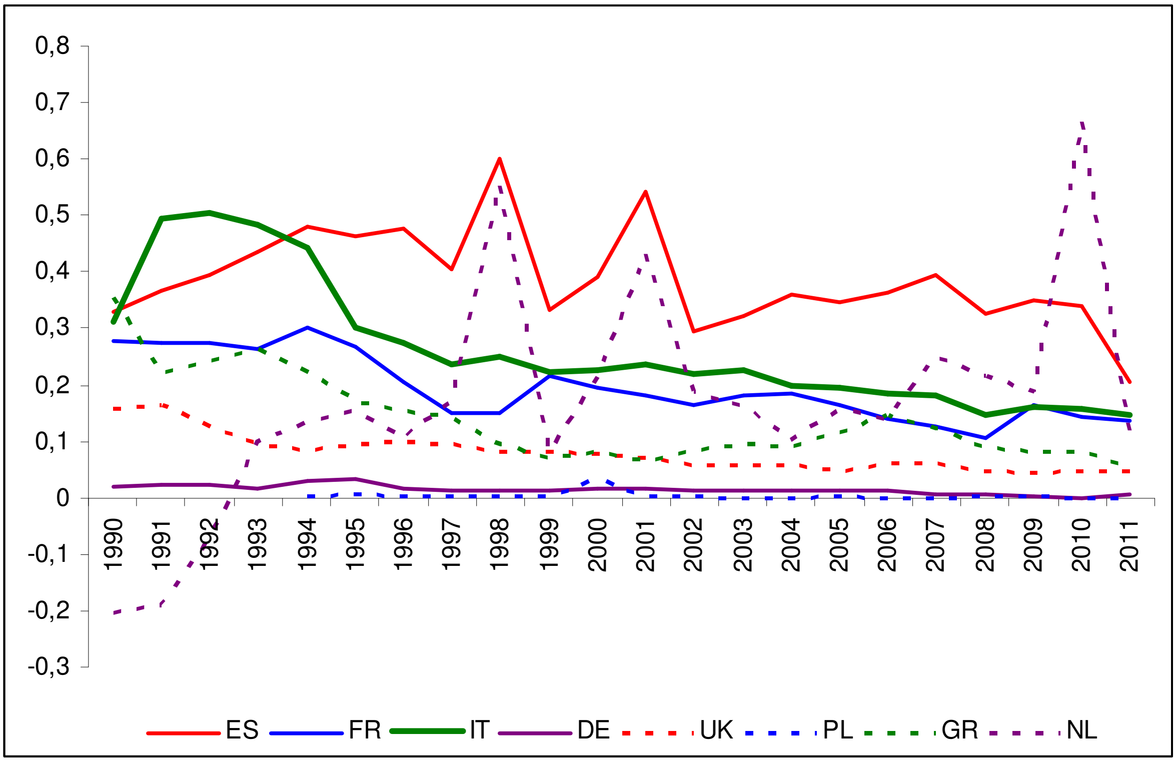
3.5 Consumption of Sole

Sole is a high value flatfish which is commonly traded fresh or frozen with not much processing. Although there is an incipient aquaculture production, mainly in the Southern countries, more than 99% of the total supply is caught in the wild. During the observed period Spain and Italy were the countries with the highest rates of consumption per person. France, the Netherlands and Greece showed rates over 100 grams per person and the UK, Germany and Poland were below this quantity. Consumption of sole has been declining since 1990 due to a decrease in landings. The decrease in consumption has been less pronounced in Spain, France and Italy (Table 62; Figure 14). The parallel evolution of consumption in Spain and the Netherlands in the years between 1996 and 2003 could be potentially explained as the effects of transshipments and intra-EU trade across the two countries, rather than the real evolution of sole consumption in the Netherlands.

Table 62. Evolution of sole consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	0,39	-37,40%
France	0,19	-51,08%
Italy	0,26	-53,05%
Germany	0,01	-74,95%
UK	0,08	-70,53%
Poland	0,00	-95,98%
Greece	0,14	-84,47%
Netherlands	0,17	-153,08%

Figure 14. Evolution of per caput consumption of sole by countries.



The series of sole consumption and price index have more distributional issues than any of the previously studied species. Normality was rejected in Poland for the two variables at the maximum confidence level. Consumption in Greece and Italy, and the price index in the UK, were also rejected normality with a 90% confidence level.

3.5.1 Model results by countries

3.5.1.1 Spain

The results of the full model in Spain allow rejecting any significant correlation across the involved variables. Sole consumption in Spain cannot be explained by any of the models considered here, and only the evolution of supply can provide any information about the factors affecting sole consumption (Table 63).

Table 63. Full model for sole consumption in Spain.

Model performance	Parameter values
$R2 = 9.13\%$	Po: –0.495
F = 0.955	I: 0.384
DW = 2.095	Pr: –0.695

3.5.1.2 France

On a first OLS estimation all parameters in the full model for sole consumption in France resulted significant. However, this is a model with several issues of autocorrelation and multicoliniearity affecting the values and significance of the estimators. When autocorrelation is addressed all the parameters lost significance (Table 64). However, the level of association across the observed variables is still high, suggesting analyzing the model in more detail by mean of the economic model.

Table 64. Full model for sole consumption in France.

Model performance	Parameter values
R2 = 75.1% F = 3.965 DW = 1.957	Po: −0.592 I: 0.512 Pr: −1.964

Using bivariate regressions, effects on sole consumption from population and the price index resulted significant and with negative value, but any direct effect from income was rejected. The economic model results in the same issues which were solved at the parameter level with the simultaneous equation model, addressing the indirect effect of income through the changes in the price index (Table 65).

Table 65. Simultaneous equation model for sole consumption in France.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 73.8% F = 7.112*** DW = 2.021	Pr: −2.134***	R2 = 91.1% F = 97.253*** DW = 1.649	I: 0.318***

3.5.1.3 Italy

The full model in Italy results non significant but shows certain levels of correlation which will be investigated in the economic model (Table 66).

Table 66. Full model for sole consumption in Italy.

Model performance	Parameter values
R2 = 79.1% F = 0.593 DW = 0.776	Po: −0.085 I: −0.259 Pr: −1.163

The economic model is also rejected on the basis of the lack of significance of the parameters estimated. The relatively high levels of association are justified by the association of the income and the price index, which is quite significant. However, no variables in the model were found to be connected with the evolution of apparent consumption of sole in Italy.

3.5.1.4 Germany

The full model of sole consumption in Germany is also affected of autocorrelation issues which result in non significant parameters. However, initial OLS estimation showed the price index as the only significant variable (Table 67). This result is confirmed in the economic model after addressing autocorrelation.

Table 67. Full model for sole consumption in Germany.

Model performance	Parameter values
R2 = 63.1% F = 16.204*** DW = 1.506	Po: −0.151 I: 0.045 Pr: −2.735

A simultaneous equation model confirms the negative influence of price and an indirect effect of the income on the volumes of consumption through its connection with the changes in the price index (Table 68).

Table 68. Simultaneous equation model for sole consumption in Germany.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 64.3% F = 14.884*** DW = 1.832	Pr: −2.935***	R2 = 91.6% F = 71.081*** DW = 1.753	I: 0.236***

3.5.1.5 UK

The models of sole consumption in the UK show the same issues as in Italy, where the parameters of income and price were found to be non significant, rejecting any direct influence on the volumes of apparent consumption of sole. In the case of the UK, there is a negative parameter in population which shows significance at a 90% confidence level. However, the overall model is rejected (Table 69). However, a bivariate model using population as independent variable resulted significant with a negative parameter.

Table 69. Full model for sole consumption in the UK.

Model performance	Parameter values
R2 = 86.7% F = 1.551 DW = 1.601	Po: −0.597* I: 0.259 Pr: −0.118

3.5.1.6 Poland

None of the variables included in the models was found to have any significant effect on sole consumption in Poland (Table 70).

Table 70. Full model for sole consumption in Poland.

Model performance	Parameter values
R2 = 14.1% F = 0.822 DW = 1.982	Po: –0.121 I: –0.214* Pr: –0.092

3.5.1.7 Greece

All the variables resulted significant in the full model of sole consumption in Greece using robust estimation. However, the price index shows a positive parameter, which could be reflecting an implicit relation across prices and income (Table 71). Anyway, the overall performance of the model is poor and only significant at a 90% confidence level. The model allows explaining only 24% of the variations in apparent consumption.

Table 71. Full model for sole consumption in Greece.

Model performance	Parameter values
R2 = 24.2% F = 3.037* DW = 2.407	Po: −1.379*** I: 0.401*** Pr: 0.215**

The parameter of the price index turns negative when estimated in a simultaneous equation system addressing the influence of income on prices in a separate equation (Table 72). Once again, model performance is very poor and results should be taken cautiously.

Table 72. Simultaneous equation model for sole consumption in Germany.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 16.2% F = 3.875* DW = 0.316	Pr: –0.560***	R2 = 58.1% F = 8.088** DW = 1.857	I: 0.745***

3.5.1.8 Netherlands

The full model for the Netherlands excludes a direct influence from the income on the volumes consumed in the observed period, not rejecting significance of the population and the price index, with positive and negative values respectively (Table 73).

Table 73. Full model for sole consumption in the Netherlands.

Model performance	Parameter values
R2 = 51.7% F = 6.802** DW = 1.753	Po: 0.911** I: 0.399 Pr: –0.905**

The economic model results significant for the two parameters, with a positive influence from the income and negative from the price index (Table 74). An indirect effect from the income on sole consumption has also been confirmed in a simultaneous equation model. However, the significance of price decreased in the new model and the parameter turned into positive sign.

Table 74. Economic model for sole consumption in the Netherlands.

Model performance	Parameter values
R2 = 39.51% F = 5.133** DW = 2.102	I: 1.285*** Pr: −1.184***

3.5.2 Summary

The negative value found in the parameters of population reflects the decrease in consumption, which is mainly caused by a decline in supply. This decline in supply is also behind the lack of significance and consistency of the models in some of the countries studied, in special in those with the highest rates of consumption like Spain and Italy. The lack of significance in the economic variable suggests that consumption of sole will persist meanwhile there will be available supply. There is a negative impact from a raise in the prices in most of the observed countries. However, elasticity of demand seems not being affecting too much the levels of consumption in the large markets for sole like Spain, Italy and France. Income has been found to have little effect on sole consumption and was only significant in Greece and Poland. In both cases the effects are contradictory, positive in Greece and negative in Poland. The only significant effect of income is through the indirect positive influence on the price index (Table 75). Model performance is poor for the case of sole. The highest coefficients of determination were recorded in the UK and France, with 80 and 70% respectively. The model was rejected in Spain, Italy and Poland.

Table 75. Sole consumption: summary of results by country.

	Population	Income	Price
Spain	Non significant	Inelastic	Inelastic
France	Non significant	Inelastic	Elastic
Italy	Non significant	Inelastic	Inelastic
Germany	Non significant	Inelastic	Elastic
UK	Negative	Inelastic	Inelastic
Poland	Non significant	Inelastic	Inelastic
Greece	Negative	Elastic	Elastic
Netherlands	Positive	Elastic	Elastic

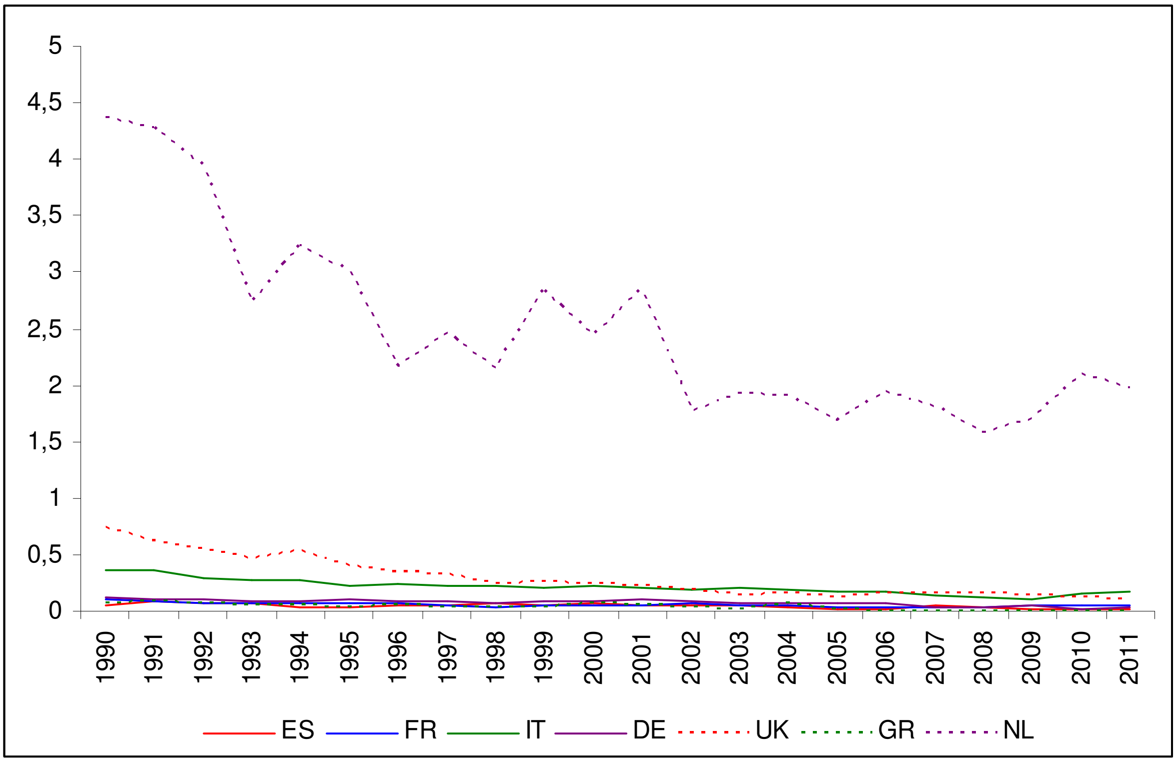
3.6 Consumption of plaice

Plaice is another flatfish competing with other low value similar species like megrim, flounder and witch. Supply of all these species comes exclusively from the wild fishery. Plaice consumption varies according to the most frequent species caught by the local fleets. The Netherlands is, with difference, the country with the largest consumption per habitant in the observed period. Following the Netherlands, The UK and Italy recorded figures around 200 – 300 grams per person. Consumption of plaice declines bellow 100 grams in the rest of the countries. Like in the case of sole, apparent consumption has been declining in all the cases during the observed years (Table 76; Figure 15).

Table 76. Evolution of plaice consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	0,046	-60,89%
France	0,057	-59,24%
Italy	0,217	-53,63%
Germany	0,075	-72,96%
UK	0,289	-84,74%
Greece	0,035	-98,33%
Netherlands	2,492	-54,83%

Figure 15. Evolution of per caput consumption of plaice by countries.



Poland in not included in the analysis since external trade series had missing data in some of the years and the price index could not be computed. All variables were found to be normally distributed with the exception of the Greek price index.

3.6.1 Model results by countries

3.6.1.1 Spain

Although overall significant, the full model in Spain fails at the parameter level. None of the three independent variables were found to be significant (Table 77).

Table 77. Full model for plaice consumption in Spain.

Model performance	Parameter values
$R2 = 47.2\%$ $F = 8.506^{**}$ DW = 1.594	Po: −1.081 I: 0.582 Pr: −0.368

The economic model shows the same kind of issues which are solved in a simultaneous equation model by considering the effect of income indirectly through the price index (Table 78). A direct effect from income has been rejected.

Table 78. Simultaneous equation model for plaice consumption in Spain.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
$R2 = 41.1\%$ $F = 3.827^{***}$ DW = 1.579	Pr: -1.488^{***}	$R2 = 79.4\%$ $F = 9.009^{***}$ DW = 0.845	I: 0.409^{***}

3.6.1.2 France

The full model of plaice consumption in France is significant only at a 90% confidence level (Table 79) and autocorretation had to be addressed. The price index, with negative sign is the only significant parameter after the Cochrane-Orcutt transformation.

Table 79. Full model for plaice consumption in France.

Model performance	Parameter values
$R2 = 63.6\%$ $F = 2.882^{*}$ DW = 1.795	Po: −0.324 I: 0.109 Pr: -0.547^{*}

The economic model improved the significance of the model and the price index, still the only significant parameter. A simultaneous equation model confirmed the negative effect of the price index and an indirect effect of income by affecting the changes in the price index (Table, 80).

Table 80. Simultaneous equation model for plaice consumption in Spain.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
$R2 = 24.4\%$ $F = 2.608^{**}$ DW = 0.541	Pr: -1.117^{***}	$R2 = 59.4\%$ $F = 5.546^{***}$ DW = 1.646	I: 0.490^{***}

3.6.1.3 Italy

The full model in Italy shows similar issues as seen in the case of France. The initial OLS estimation resulted no significant parameters and showed issues of autocorrelation. When these issues were addressed the model became significant at a 90% confidence level, with the price index as the only significant parameter but with positive sign (Table 81).

Table 81. Full model for plaice consumption in Italy.

Model performance	Parameter values
R2 = 89.2% F = 3.572* DW = 2.154	Po: −0.147 I: −0.491 Pr: 0.325*

Both income and price resulted significant in the economic model. However, in this case, income has a negative parameter, suggesting an inferior good, and the price index results with a positive sign. Effects from income are stronger that that from a change in the prices. A simultaneous equation model reveals that the significance of the price index is in the borderline of the 90% confidence level (Table 82).

Table 82. Simultaneous equation model for plaice consumption in Italy.

Equation 1: C = f(I, Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 63.4% F = 34.756*** DW = 0.517	I: −1.093*** Pr: 0.763*	R2 = 63.1% F = 5.982*** DW = 1.912	I: 0.445***

3.6.1.4 Germany

Robust estimation rejects any influence of the population and the price index in Germany. The only relevant effect is observed in the income, which has a negative sign as same as in the Italian model (Table 83).

Table 83. Full model for plaice consumption in Germany.

Model performance	Parameter values
R2 = 85.8% F = 57.624*** DW = 2.191	Po: −0.146 I: −0.898*** Pr: 0.460

The economic model confirms the significance of the income and the negative sign, but rejects any effect from the price (Table 84). As well as in Italy, plaice appears as an inferior good also in Germany.

Table 84. Economic model for plaice consumption in Germany.

Model performance	Parameter values
R2 = 82.7% F = 96.266*** DW = 1.918	I: −1.044*** Pr: 0.468

3.6.1.5 UK

Population and the price index, both with negative sign, were the only significant parameters in the initial OLS estimation of the full model in the UK. Unfortunately this estimation is affected by autocorrelation issues and the price index looses significance when this issue is addressed. The resulting model, based in population, allows explaining almost 94% of the variation in the apparent consumption, which is the best performance in the case study of plaice (Table 85).

Table 85. Full model for plaice consumption in the UK.

Model performance	Parameter values
R2 = 93.7% F = 3.108** DW = 2.277	Po: −0.503** I: 0.336 Pr: −1.007

Despite of the previous result, the price index is also a significant factor affecting the evolution of apparent consumption of plaice in the UK. Price results significant and with negative sign in a simultaneous equation model, explaining 63% of plaice consumption. The model also confirms a direct and positive effect of the income on the price index (Table 86).

Table 86. Simultaneous equation model for plaice consumption in the UK.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 63.1% F = 5.990*** DW = 0.453	Pr: −2.538***	R2 = 90.7% F = 14.351*** DW = 1.105	I: 0.314***

3.6.1.6 Greece

Using robust estimation, the full model in Greece shows significance in population and income but rejects any effect from the price index. Both parameters are negative, accounting for the decline in supply along the observed years, in the case of population, and suggesting an inferior good behavior, in the case of the income (Table 87). The economic model confirmed the negative sign of the parameter connected with the income, and the rejection of the price index, not improving model performance.

Table 87. Full model for plaice consumption in the UK.

Model performance	Parameter values
R2 = 71.9% F = 24.311** DW = 2.054	Po: −0.244** I: −0.687*** Pr: 0.055

3.6.1.7 Netherlands

Population, with negative sign, was the most relevant variable affecting apparent consumption of plaice in the Netherlands in the full model (Table 88). Income is also significant in the borderline, but resulted non significant in the economic model.

Table 88. Full model for plaice consumption in the Netherlands.

Model performance	Parameter values
R2 = 74.1% F = 18.067*** DW = 1.884	Po: −1.164*** I: 0.841* Pr: −0.568

<u>3.6.2 Summary</u>

Price and income elasticities of plaice demand differ across countries resulting in two main groups. Income elasticity is dominant in explaining apparent consumption in Italy, Germany and Greece. In all these three cases, plaice is an inferior good, which consumption will decline when income improves due to substitution with higher valued species. Another group is represented by Spain, France and the UK, where price sensitivity has been found to be the main driver of demand, with no significance in the parameters of income. In general, model performance is better in the income elastic countries. The Netherlands is the exception to this classification since apparent consumption of plaice is almost only driven by population, confirming the decline in supply (Table 89). Models for plaice performed better than those of sole. The UK shows the highest coefficient of determination, explaining 93% of the changes in apparent consumption. The lower coefficients were found in Spain, 40% and France and Italy, 60%.

Table 89. Plaice consumption: summary of results by country.

	Population	Income	Price
Spain	Non significant	Inelastic	Elastic
France	Non significant	Inelastic	Elastic
Italy	Non significant	Inelastic	Elastic
Germany	Negative	Elastic	Inelastic
UK	Negative	Inelastic	Elastic
Greece	Negative	Elastic	Inelastic
Netherlands	Negative	Elastic	Inelastic

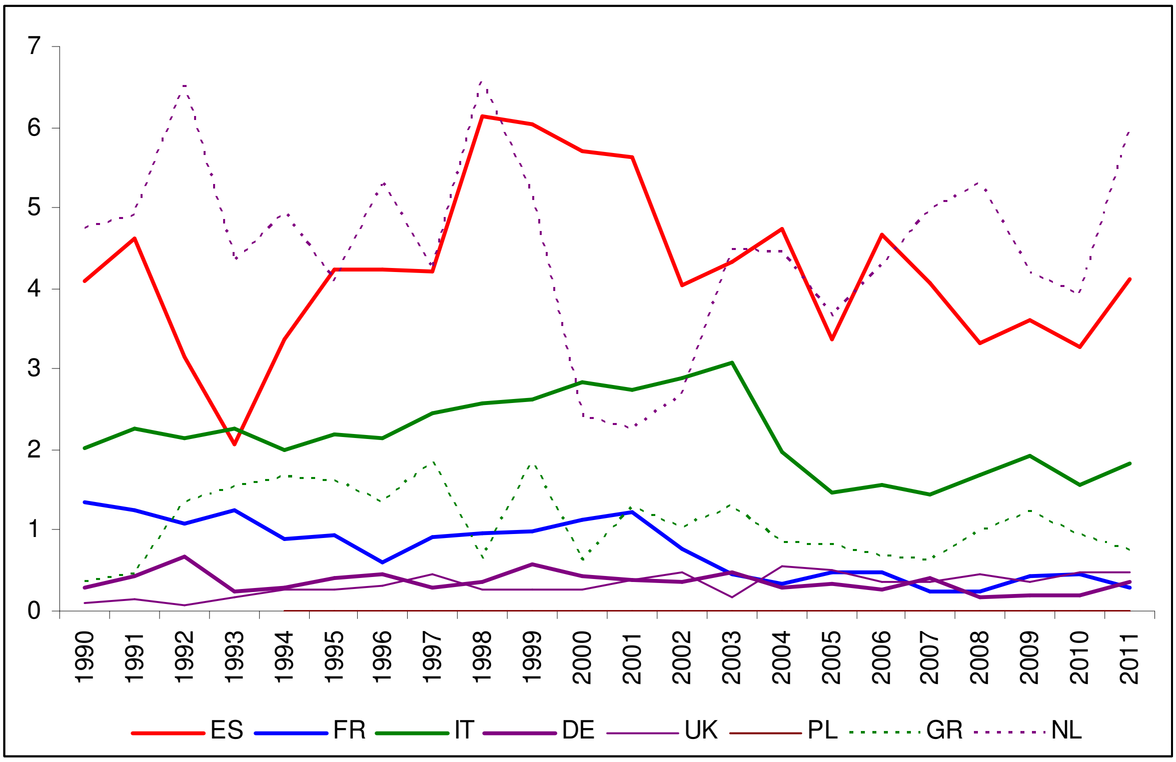
3.7 Consumption of Mussels

Mussels are the most relevant farmed shellfish produced in the EU in terms of quantity, but also one of the cheapest species analyzed in this report. Mussels can be found in the market in several different presentations and preparations. These include fresh, frozen, canned, with or without shell. Spain is the largest producer and the second biggest consumer per person following the Netherlands. Mussel consumption is also relevant in Italy and Greece. In the opposite, Poland account for the lowest rate of consumption. During the observed period, the volumes of apparent consumption remained stable in Spain and increased in almost all countries excepting France and Italy (Table 90; Figure 16).

Table 90. Evolution of mussel consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	4,23	0,51%
France	0,76	-79,10%
Italy	2,17	-9,45%
Germany	0,36	20,41%
UK	0,33	358,50%
Poland	0,01	184,27%
Greece	1,08	103,60%
Netherlands	4,52	25,42%

Figure 16. Evolution of per caput consumption of mussels by countries.



All the variables included in the models have succeeded the normality tests with the exception of the price index in Greece, where the parameters will be estimated using robust regression.

3.7.1 Model results by countries

3.7.1.1 Spain

The full model in Spain was found to be non significant and none of the variables were found to be statistically connected with the evolution of Mussel consumption, which remained stable along the observed years (Table 91).

Table 91. Full model for Mussel consumption in Spain.

Model performance	Parameter values
R2 = 4.68% F = 0.467 DW = 1.024	Po: 0.952 I: −1.016 Pr: 0.873

3.7.1.2 France

According to the results of the full model, mussel consumption in France is only affected by the changes in the price, which exerts a negative effect on the quantities consumed (Table 92). The model explains 88% of the variation in apparent consumption.

Table 92. Full model for mussel consumption in France.

Model performance	Parameter values
R2 = 88.4% F = 18.232*** DW = 2.008	Po: 0.040 I: -0.236 Pr: -2.671**

The economic model persists in the prevalence of price over income on affecting the changes in the volumes of consumption. In fact, changes in the disposable income do not have a direct effect on mussel consumption, but indirect through the positive link with the changes in the prices (Table 93).

Table 93. Simultaneous equation model for mussel consumption in France.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 88.1% F = 57.788*** DW = 1.946	Pr: −3.553***	R2 = 91.1% F = 68.168*** DW = 1.746	I: 0.251***

3.7.1.3 Italy

The full model in Italy results non significant but shows certain levels of correlation which will be investigated in the economic model (Table 94).

Table 94. Full model for mussel consumption in Italy.

Model performance	Parameter values
$R2 = 66.5\%$ $F = 2.161$ $DW = 1.624$	Po: −0.355 I: −0.194 Pr: −0.430

Even in the borderline of significance, the economic model provides some interesting results differing from the previous case. Income becomes significant and negative in the economic model. This negative effect can be explained by a shift in consumption to other high valued shellfish such as clams and oysters. In this case, mussels are acting in Italy in the way of an inferior good. Direct linkages across changes in the price index and the volumes of apparent consumption are rejected (Table 95).

Table 95. Economic model for mussel consumption in Italy.

Model performance	Parameter values
$R2 = 65.9\%$ $F = 3.503$* $DW = 1.636$	I: −0.497* Pr: −0.418

3.7.1.4 Germany

The full model of mussel consumption in Germany provides similar results as those described in France, with the price index as the sole significant variable (Table 96). However, the performance of the model in explaining the evolution of the volumes consumed is only 35%.

Table 96. Full model for mussel consumption in Germany.

Model performance	Parameter values
$R2 = 35.3\%$ $F = 3.463$** $DW = 2.409$	Po: 0.180 I: −0.036 Pr: −5.735*

The economic model confirms and improves the influence of price and an indirect effect of the income on the volumes of consumption through its connection with the changes in the price in a simultaneous equation model (Table 97).

Table 97. Simultaneous equation model for mussel consumption in Germany.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
$R2 = 42.1\%$ $F = 18.704$*** $DW = 2.307$	Pr: −4.271***	$R2 = 76.3\%$ $F = 64.590$*** $DW = 1.431$	I: 0.104***

3.7.1.5 UK

Population and price are the significant variables in the full model for mussel consumption in the UK (Table 98). Both parameters are positive, which is easy to explain in the case of the population, but introduces some inconsistencies in the case of the price index which should be further investigated. A simultaneous equation model in which the changes in the price index are an effect of changes in the disposable income can not be rejected. However, even in this model, the parameter of the price index on the volumes of apparent consumption remains positive.

Table 98. Full model for mussel consumption in the UK.

Model performance	Parameter values
R2 = 61.8%	Po: 0.549**
F = 15.807***	I: –0.240
DW = 2.049	Pr: 1.321**

3.7.1.6 Poland

The models of mussel consumption in Poland show the same issues as in the UK. In this case, the price index is the only significant variable in the full model, also with a positive sign (Table 99). A simultaneous equation model confirms the influence of income on the prices of mussels, but the sign of the parameter accounting for the effects of a change in the price index remains positive.

Table 99. Full model for mussel consumption in Poland.

Model performance	Parameter values
R2 = 58.1%	Po: –0.104
F = 6.918***	I: 0.226
DW = 2.257	Pr: 0.518**

3.7.1.7 Greece

The full model of mussel consumption in Greece poorly fits in terms of model performance, and shows significance only for the price index at the parameter level (Table 100).

Table 100. Full model for mussel consumption in Greece.

Model performance	Parameter values
R2 = 24.2%	Po: –0.330
F = 3.037*	I: -0.106
DW = 2.407	Pr: –0.709**

Effects from income on mussel consumption are rejected also in the economic model (Table 101). The simultaneous equation model also rejects any statistically significant association between changes in the disposable income and the price index. With these results, price elasticity appears the only relevant factor affecting the volumes of apparent consumption of mussels.

Table 101. Economic model for mussel consumption in Greece.

Model performance	Parameter values
$R2 = 23.7\%$ $F = 6.214^{**}$ $DW = 2.323$	I: −0.328 Pr: −0.574***

3.7.1.8 Netherlands

The full model for the Netherlands shows two significant parameters and excludes the price index as a factor affecting changes in the apparent consumption of mussels (Table 102). Despite consumption has increased, the parameter connected with population presents negative sign. Income, as expected exerts a positive influence on the volumes of consumption. The economic model was rejected due to lack of significance, which points population as the main driver for mussel consumption. However, this is also rejected in a bivariate regression model. As a conclusion, due to inconsistencies and lack of statistical significance in paired correlations, the models for mussel consumption can be rejected in the Netherlands.

Table 102. Full model for mussel consumption in the Netherlands.

Model performance	Parameter values
$R2 = 41.3\%$ $F = 4.457^{**}$ $DW = 1.975$	Po: −1.082*** I: 1.758*** Pr: −0.630

3.7.2 Summary

Mussels provide different scenarios according to certain groups of countries, but price is the dominant variable in affecting consumption in the majority of them. Negative income elasticity has been found in Italy and, even non significant, in Greece and the UK. This result could be explained if mussels would be behaving as an inferior good, if consumers shift to other high valued bivalves as their disposable income improves. The positive sign of the price index parameter found in Poland may be explained by the stage in the product life cycle of mussels in the local market. In an early stage new consumers access the market, causing a displacement in the demand curve. This results in higher equilibrium quantities and prices, and a positive correlation across both in the long run. In this case, the increase in demand is pulling the prices up, and they will keep increasing as new consumers will enter the market and until the equilibrium will be achieved. At this point the product will enter in the maturation stage and the relation across quantities and prices should become negative. However, while this rationale may work in the case of Poland, where mussels are a relatively new product, it is less likely to the case of the UK. In all the other cases, the price index was found to have a negative effect on consumption. Price sensitivity is stronger than income elasticity in almost all cases, with the exception of the Netherlands, where the price index resulted non significant, and in Spain, where all the variables in the model were rejected (Table 103). The performance of the models of mussel consumption was not so high. Only France shows a relatively optimal coefficient of determination of 88%, falling to 60 and 40% in the other cases. The models were rejected in Spain, being the biggest producer of mussels in the EU.

Table 103. Mussel consumption: summary of results by country.

	Population	Income	Price
Spain	Non significant	Inelastic	Inelastic
France	Non significant	Inelastic	Elastic
Italy	Non significant	Elastic	Inelastic
Germany	Non significant	Inelastic	Elastic
UK	Positive	Inelastic	Elastic
Poland	Non significant	Inelastic	Elastic
Greece	Non significant	Inelastic	Elastic
Netherlands	Negative	Elastic	Inelastic

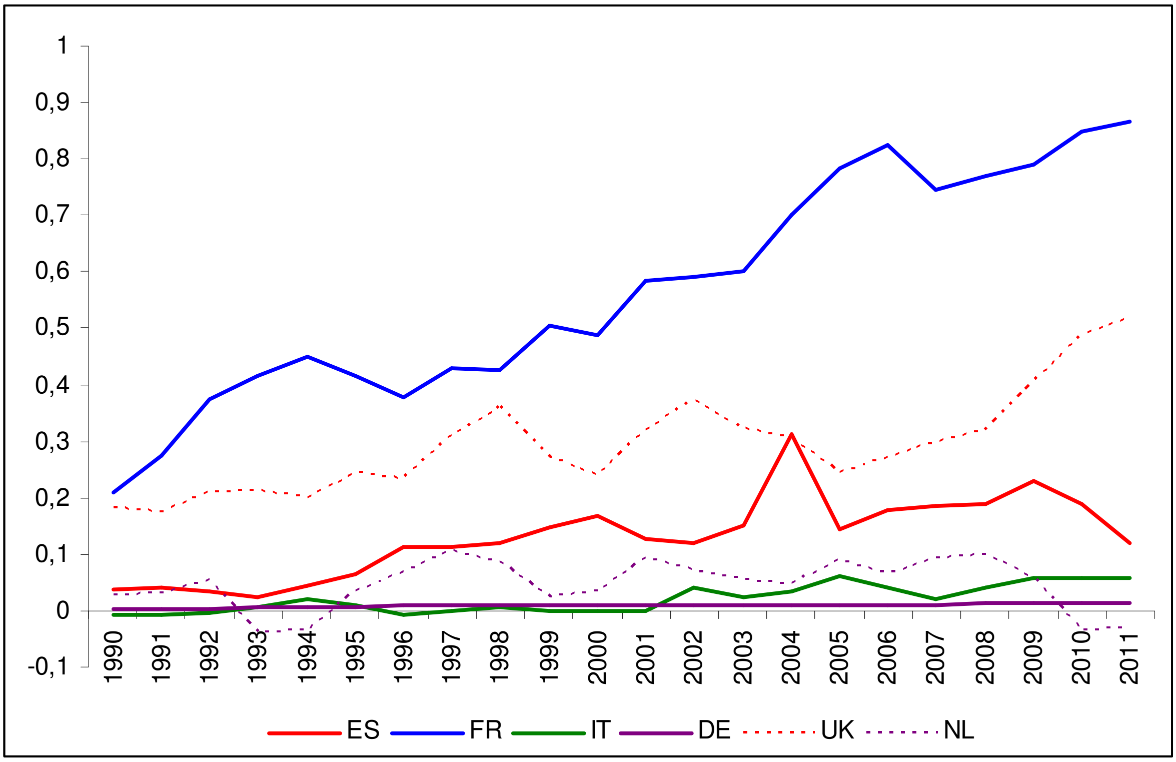
3.8 Consumption of scallops

Scallop is a bivalve shellfish much appreciated by consumers in the Atlantic. The highest rates of consumption were found in France, the UK and Spain. Although some subspecies can be farmed, the majority of the supply comes from the wild fishery. In contrast with mussels, scallop is a high value product and a potential substitute of mussels when income rises. Consumption of scallops increased in all countries excepting in the Netherlands (Table 104; Figure 17)). In both cases the figures have to do with a lack of a continuous trend. Consumption raises and falls from one year to the other according to international trade flows and other factors which resulted in a strong difference across the quantities of apparent consumption in 1990 and 2011.

Table 104. Evolution of scallop consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
Spain	0,130	209,71%
France	0,567	312,39%
Italy	0,020	743.20%
Germany	0,009	371,09%
UK	0,296	185,77%
Netherlands	0,045	-215,86%

Figure 17. Evolution of per caput consumption of scallops by countries.



The data of external trade in Poland and Greece could not provide a complete series for the price index and thus the two countries were excluded from the analysis. The price index in France was rejected normality and the model parameters in this country will have to be robustly estimated.

3.8.1 Model results by countries

3.8.1.1 Spain

The full model of scallop consumption in Spain is rejected at the parameter level although the overall hypothesis test can not be rejected at a 95% confidence level (Table 105). Autocorrelation has been addressed but the issues with the parameters persisted.

Table 105. Full model for Scallop consumption in Spain.

Model performance	Parameter values
R2 = 58.1%	Po: 0.370
F = 3.986**	I: 0.384
DW = 1.829	Pr: –0.174

The economic model, instead, results highly significant for the income, but rejects any influence from the price index (Table 106). Scallop is, therefore, a superior good which consumption increases as income rises with a price inelastic demand.

Table 106. Economic model for Scallop consumption in Spain.

Model performance	Parameter values
$R2 = 57.5\%$ F = 5.201*** DW = 1.927	I: 0.707*** Pr: –0.131

3.8.1.2 France

Parameter estimators for the full model in France showed population as the only one significant factor affecting scallop consumption. The performance of this model is high, predicting 96% of the variation in the quantities of apparent consumption (Table 107).

Table 107. Full model for Scallop consumption in France.

Model performance	Parameter values
R2 = 96.1% F = 153.570*** DW = 1.057	Po: 0.914*** I: –0.101 Pr: 0.290

The economic model in France provides the same conclusions as in Spain (Table 107). Demand is inelastic since the parameter connected with the price index resulted significant. Income is instead highly significant and positive (Table 108).

Table 108. Economic model for Scallop consumption in France.

Model performance	Parameter values
R2 = 78.9% F = 74.934*** DW = 0.721	I: 0.864*** Pr: 0.101

3.8.1.3 Italy

The case of Italy provides the same interpretation as in Spain and France. Population is the only significant parameter in the full model, with positive sign even consumption had decline in the overall observed period (Table 109).

Table 109. Full model for Scallop consumption in Italy.

Model performance	Parameter values
R2 = 75.6% F = 7.505*** DW = 1.893	Po: 1.296*** I: –0.533 Pr: 0.051

Like in the precious two cases the economic model shows significance for the income, with negative sign, but rejects significance for the price index (Table 110). The parameter associated with Income is also positive here, suggesting a superior good.

Table 110. Economic model for Scallop consumption in Italy.

Model performance	Parameter values
R2 = 64.2% F = 9.029*** DW = 1.805	I: 0.767*** Pr: –0.075

3.8.1.4 Germany

Population was also the only significant variable in the full model of scallop consumption in Germany, although the initial OLS model showed being affected by autocorrelation (Table 111).

Table 111. Full model for Scallop consumption in Germany.

Model performance	Parameter values
R2 = 75.9% F = 19.949*** DW = 0.781	Po: 0.520*** I: 0.375 Pr: 0.084

The economic model is also affected by autocorrelation. OLS estimators were significant both for the income and the price index (Table 112). The parameter connected with the income is positive like in the previous cases. However, significance was lost when autocorrelation was addressed.

Table 112. Economic model for Scallop consumption in Germany (OLS).

Model performance	Parameter values
R2 = 59.4% F = 29.279*** DW = 0.821	I: 1.566*** Pr: –2.276**

3.8.1.5 UK

The full model in the UK showed significance in the parameters connected with population and income (Table 113). The parameter of income was found to be negative which confronts with the results obtained in the previous countries. The economic model was rejected and none of the explanatory variables were significant. The significance of the income in the full model could be spurious.

Table 113. Full model for Scallop consumption in the UK.

Model performance	Parameter values
R2 = 84.7% F = 11.862*** DW = 1.791	Po: 1.316*** I: –0.724** Pr: 0.514

3.8.1.6 Netherlands

The full model and all the involved variables were rejected in the Netherlands due to lack of correlation (Table 114).

Table 114. Full model for Scallop consumption in the Netherlands.

Model performance	Parameter values
R2 = 3.2%	Po: 0.296
F = 0.323	I: −0.103
DW = 0.948	Pr: −0.068

3.8.2 Summary

The model of scallop consumption appears quite stable across countries. With the exception of the Netherlands, where the full model was rejected in the first estimation, and the unsolved autocorrelation issues in Germany, there is a common behavior and a satisfactory level of performance. Scallop consumption appears mainly driven by population, in special in the Atlantic countries, which point to a traditional consumption. The parameter connected with the income was positive in most of the cases, which suggests a superior good. Lack of significance in the parameter connected with the price index also suggests a price inelastic demand (Table 115). The models of scallops performed better than the models of mussels. With the exception of the Netherlands, were all relations were rejected, and Germany, which a lower performance, over 60% of the changes in apparent consumption can be explained in the other countries.

Table 115. Scallop consumption: summary of results by country.

	Population	Income	Price
Spain	Non significant	Elastic	Inelastic
France	Positive	Elastic	Inelastic
Italy	Positive	Elastic	Inelastic
Germany	Positive	Elastic	Elastic
UK	Positive	Elastic	Inelastic
Netherlands	Non significant	Inelastic	Inelastic

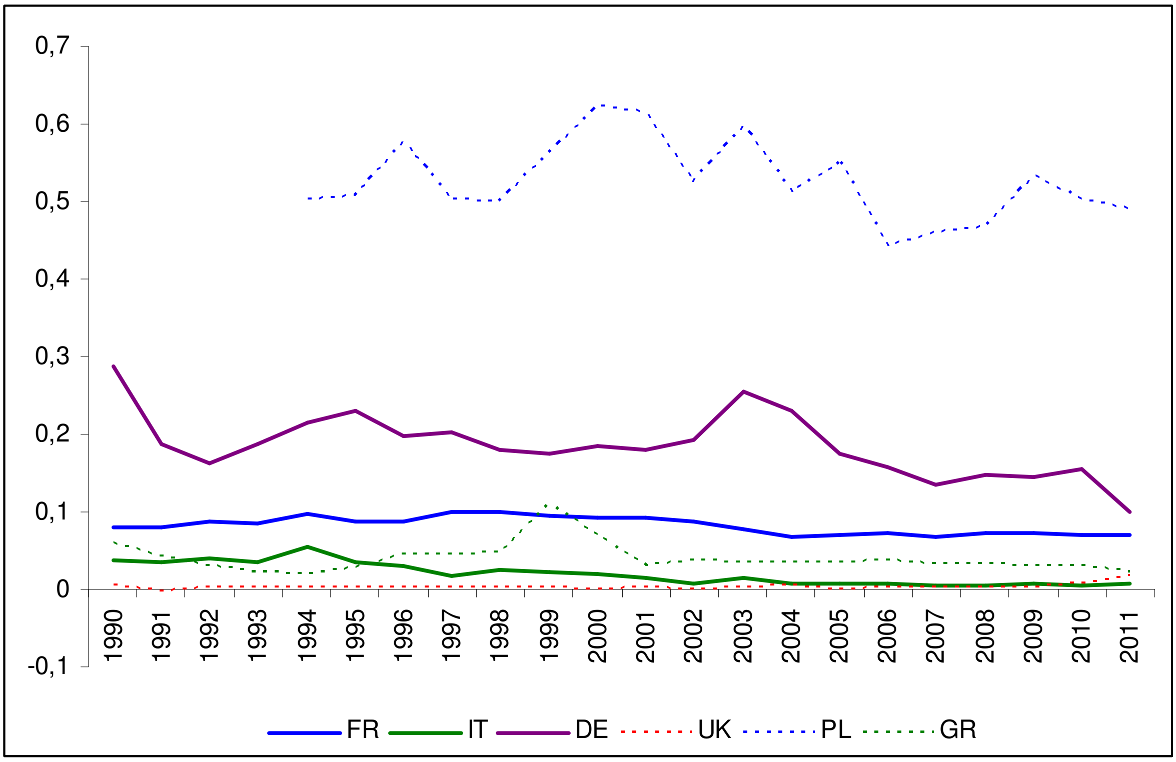
3.9 Consumption of carps

Carp is a freshwater fish traditionally farmed in Central and Eastern Europe with very low consumption outside this region. Consequently, the highest rates of consumption are found in Poland and Germany. In contrast with other farmed fish, consumption of carps has decreased during the observed period (Table 116; Figure 18). The high increase in consumption observed in the case of the UK should be considered a bias due to the very small quantities recorded in the years analyzed, and should not be taken in consideration. It has to be mention that carps are also used as an ornamental fish in many cases. This means that carp consumption in many of the analyzed countries may not be considered food consumption.

Table 116. Evolution of carp consumption by countries.

	Average Per caput in Kg	Variation 1990 - 2011
France	0,082	-12,65%
Italy	0,020	-79,07%
Germany	0,186	-65,06%
UK	0,003	260,86%
Poland	0,526	-2,42%
Greece	0,040	-60,77%

Figure 18. Evolution of per caput consumption of carp by countries.



The series in Spain and the Netherlands were incomplete, so the two countries can not be included in the analysis. All the rest of the series were found to be normally distributed with the exception of the apparent consumption in Greece, and the UK.

3.8.1 Model results by countries

3.9.1.1 France

The full model for carp consumption in France rejects significance for the population and the price. The parameter connected with the income resulted significant and negative, suggesting an inferior good (Table 117).

Table 117. Full model for carp consumption in France.

Model performance	Parameter values
$R2 = 75.1\%$ $F = 3.628^{**}$ $DW = 1.834$	Po: 0.338 I: −1.135** Pr: 0.659

The economic model confirmed the previous result, rejecting any significant effect from a change in the price index (Table 118).

Table 118. Full model for carp consumption in France.

Model performance	Parameter values
$R2 = 74.8\%$ $F = 5.331^{**}$ $DW = 1.895$	I: −0.891** Pr: 0.557

3.9.1.2 Italy

The full model was rejected in Italy before and after autocorrelation was addressed, resulting in no significant parameters (Table 119).

Table 119. Full model for carp consumption in Italy.

Model performance	Parameter values
$R2 = 75.3\%$ $F = 1.268$ $DW = 2.268$	Po: −0.312 I: 0.014 Pr: −0.631

The economic model resulted significant for the income, with a negative sign, in the initial OLS estimation (Table 120). However, parameter tests failed after autocorrelation was addressed and the model was rejected.

Table 120. Economic model for carp consumption in Italy (OLS).

Model performance	Parameter values
$R2 = 57.2\%$ $F = 26.783^{***}$ $DW = 0.751$	I: −0.598** Pr: −0.631

3.9.1.3 Germany

Results of the full model in Germany low significance for the income but the overall model was not rejected (Table 121). The economic model provided significance for the income at a 90% confidence level, which was rejected after addressing autocorrelation.

Table 121. Full model for carp consumption in Germany

Model performance	Parameter values
R2 = 51.6% F = 2.802* DW = 1.213	Po: –0.223 I: –0.781* Pr: 0.634

3.1.9.4 UK

The only significant variable affecting consumption in the full model in the UK was the population (Table 122). The economic model confirmed rejection of any effect from the income or the price index.

Table 122. Full model for carp consumption in the UK.

Model performance	Parameter values
R2 = 42.6% F = 7.055*** DW = 1.483	Po: 0.633*** I: –0.291 Pr: –0.044

3.1.9.5 Poland

Poland is the country with a larger tradition in carp consumption. However, significance of the parameter connected with population is in the borderline of 90% confidence level, and the parameter is negative (Table 123). All the other two parameters involved in the model were rejected, resulting in a low performance.

Table 123. Full model for carp consumption in Poland.

Model performance	Parameter values
R2 = 48.2% F = 4.658** DW = 2.246	Po: –0.570* I: –0.117 Pr: –0.914

The economic model was also rejected but a simultaneous equation model resulted significant parameters for the price index and for the income on the price in a second equation. Direct effects from a change in the income on carp consumption were rejected in Poland under any of the alternative models (Table 124). The resulting model can only explain 35% of the variation in carp consumption.

Table 124. Simultaneous equation model for carp consumption in Poland.

Equation 1: C = f(Pr)		Equation 2: Pr = f(I)	
Eq. performance	Parameter values	Eq. performance	Parameter values
R2 = 35.1% F = 8.646*** DW = 1.777	Pr: –0.569***	R2 = 87.3% F = 110.808*** DW = 1.151	I: 0.934***

3.9.1.6 Greece

No model was found to be significant for explaining carp consumption in Greece and the influence of all the variables was rejected (Table 125).

Table 125. Full model for carp consumption in Greece.

Model performance	Parameter values
R2 = 33.5% F = 4.801* DW = 1.262	Po: 0.023 I: −0.202 Pr: 0.111

3.9.2 Summary

The results of the models of carp consumption were heterogeneous across countries, and not much significant. Demand was found to be income elastic and with negative sign in France and Italy, suggesting an inferior good. Price was only significant in the case of Poland, where a price sensitive demand was observed (Table 126). In general, model performance is low, with a maximum coefficient of determination of 75% in the case of France.

Table 126. Carp consumption: summary of results by country.

	Population	Income	Price
France	Non significant	Elastic	Inelastic
Italy	Non significant	Elastic	Inelastic
Germany	Non significant	Inelastic	Inelastic
UK	Positive	Inelastic	Inelastic
Poland	Negative	Inelastic	Elastic
Greece	Non significant	Inelastic	Inelastic

3.10 Summary of results at species level

Cod consumption is driven by economic factors. With the exception of Italy and Greece, the only two countries locked in the Mediterranean Sea, the simultaneous equation model was the most suitable in terms of the number of significant parameters. The results provide an interpretation of a superior good, which is more demanded as consumer’s purchasing ability improves, but also with an important price elasticity, which brakes the raise of consumption when the income increases when the improvement in purchase ability results also in a raise in the price. To this extent, in most of the countries price elasticity of cod has been found to be stronger than income elasticity.

Consumption of salmon has been found to be less dependent on economic variables and mostly driven by changes in the population size. In this sense, salmon consumption is increasing since supply is increasing in the market, allowing both the entrance of new consumers and the raise of the consumption in existing consumers. However, the role of the economic variables is still relevant. Like cod, salmon is also a superior good which consumption increases at the time of the income, and is also price elastic. In this case, income elasticity is stronger than price elasticity and the direct effect of a raise on income compensates the effect of a raise in the prices.

Consumption of seabream, another fish species with a major supply from aquaculture, is also rising in all the countries studied. Like in the case of salmon, the relevance of the parameter associated with population was verified with positive sign in 5 of the 8 countries, confirming the increase in the demand. Although seabream demand was found to be price elastic, the effects of a rise in the income have a greater effect than an increase in the price. The prevalence of income elasticity is another point in common of farmed fish.

In contrast with salmon and seabream, supply of flatfish has been declining and it may explain the negative parameters connected with population and the low performance of the models with sole and plaice. The market for sole was found to be price elastic in most of the countries. Indeed, the price index was found to be the only direct influence on consumption in France, Italy, Germany, Greece and the Netherlands. However, the performance of these models is quite low in general, and do not provide much reliable predictors of the expected market behavior. Unless aquaculture production results a feasible source of supply in the near future, supply will keep on decreasing, and prices are expected to rise. The models for plaice returned better performance dividing the countries into two main groups. Italy, Germany and Greece are income elastic and plaice acts as an inferior good decreasing demand as the income improves. France, Spain and the UK are price elastic, and changes in the income appear not be affecting demand.

Mussels are associated with a low price product, and thus, an inferior good. A negative parameter associated with the income in several countries suggests such a conclusion. Anyway, demand for mussels is price sensitive in most of the observed countries. In contrast, scallops is suggested a superior good, with a significant positive effect from income in almost all the observed countries and a price inelastic demand.

Finally, carp consumption is concentrated y Poland and Germany, and model performance was very low in general. Demand was found to be price elastic in Poland, but all models were rejected in Germany. Outside Central Europe, carps are mainly used as ornamental fish, much popular in public gardens. The combination of these two different markets may have also affect the poor performance of the models for this species.

4. Summary and conclusions

The performance of the variables described in previous research as factors affecting consumption and demand of seafood has been tested under different conditions. Population, income and price, together or individually, have been found to be significant factors affecting seafood consumption in most of the cases analyzed. However, the relative importance of each of the explanatory variables changes across countries and species. Some cases have succeeded in testing the full model described in equation (6) with all the explanatory variables significant at aggregated and species level. More cases were only successful in partial models, mainly economic models. The prevalence of the economic model was more frequent at the species level that at the aggregated level, where population was found to be a major significant factor in the majority of the cases. The influence of all the proposed explanatory variables on the evolution of consumption was rejected only in 5 cases at the aggregated level and in 10 at the species level. When a model for one country or species has been found significant, results are usually consistent with the theory, adding reliability to the data and analysis. However, rejection of one variable or a full model cannot be conclusive since it can be due to data issues.

The limitations of the analysis are related with the efficiency of the data as a proxy of the variable which is intended to measure. This is the case of the price index, which is referred to the prices of imports and exports of the given country. The prices at the domestic markets could be following different trends of those of the international markets. On the other side, GDP per caput is intended to be a proxy of the disposable income, which is a source of issues itself. Expenditure in food does not have to be significantly related with disposable income. In developed countries an increase in disposable income not necessarily results in an increase on expenditure in food. Income may raise and expenditure in food could remain constant. This means that consumers had previously achieved the desired levels of food consumption and are investing the surplus in different kinds of goods. In developing countries an increase in disposable income results in an increase in food consumption, but this can be more than proportional and it can also be dedicated to different sources of protein rather than seafood. Further research on the economic factors affecting seafood consumption should use more accurate and closely related data at the national level such as domestic price indexes for different foodstuffs and expenditure in different categories. Unfortunately, these data are not always public or available in long enough series for most of the countries included in this report.

Another potential issue regards to the level of aggregation. Demand for seafood species is well segmented, and the purchasing behavior varies significantly across segments (Asche et al, 2001). The market prices of the various seafood species can strongly differ across categories, as well and consumer's preferences and the corresponding elasticity of demand. When aggregating all the different species, all the different market behaviors may be compensating their effects resulting in lack of significance of relevant parameters in the aggregated models. Aggregated models perform better in countries with trended evolutions in consumption, whether increasing or declining, but were rejected totally or partially in countries where consumption has remained stable along the years.

Although the involved variables were found to be significant in many of the models at the species level, the best models differ by species, showing different patterns of consumption. The differences exist also across countries, however, in most of the cases there is an almost common, or more frequent, behavior in the different countries when the same species is considered. Consumption of the analyzed species in the EU is segmented geographically. There are also some differences in the role of the economic factors across countries for some species which could be reflecting some kind of market segmentation which will be further investigated into Working Package 2. Demand for cod in Italy and Greece, countries not fishing these species, is inelastic in contrast with the countries in the Atlantic. Seabream demand is price and income elastic in Spain, Italy and Greece, who are the largest EU producers and markets for this species. With the exception of Germany and the Netherlands, which may require further analysis in the future, all the other countries were price and income inelastic. Income elasticity is more relevant for plaice consumption in Italy, Germany and Greece, but non relevant in Spain, France and the UK, where demand in affected by price elasticity. Demand for mussels is price inelastic in Spain, Italy and the Netherlands, also large producers of these species. Carp demand is price elastic only in Poland, where consumption records for the higher levels. In contrast, there is a common or dominant pattern across the countries in consumption of salmon, sole and scallops.

Some relations across species can be inferred on the light of the results. Farmed species are increasing consumption at the cost of wild species. The variation of per caput consumption of wild caught species is negative in all cases, but positive for farmed fish like salmon and seabream. This is a consequence of the evolution of production in both sources of supply, but also has other consequences in terms of model performance and results. The role of population is also more relevant in farmed than in wild species, as corresponds to an increasing trend. Model performance has been found to be also better with farmed fish and less price sensitive than those of the wild species. Income elasticity provides some other relations across species in the case of flatfish and shellfish. Sole is a superior good and consumption will increase as disposable income improves. Contemporary, consumption of plaice will decrease as income rises since plaice is an inferior good in the flatfish category. The contrary will occur if income falls, with a decrease in consumption of sole and an increase in plaice. The same changes in consumption can be expected in the shellfish market. In the cases analyzed in this report mussel appears as an inferior good and scallop as the superior.

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