PrimeFish

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Deliverable D4.3

Report on the development of fish consumption and demand in France and Finland

February 2017

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Executive Summary

This document reports the analysis of demand for fish in France and Finland, with a special focus on PrimeFish species. Those two countries have relatively high levels of fish consumption by European standards, and have experienced significant growth in fish consumption over the last 40 years, although the level of consumption appears to have plateaued since the start of the century. The overview of consumption trends and structures in the two countries sheds light on important changes and differences. For instance, in the fresh fish market, salmon remains the main species in terms of consumption volumes in both countries, but its relative importance is much more pronounced in Finland, where demand for herring has collapsed over the last two decades. In France, negative press and rising prices have hindered growth in salmon consumption in recent years.

A detailed econometric analysis of demand for different types of fish products, defined in terms of both species and processing method, then uses data from large consumer panels in order to identify the economic and socio-demographic drivers of household-level fish consumption. By estimating the degree of substitution among potentially competing products, we identify empirically the main fish products competing with PrimeFish species for consumers' euros in different fish sub-markets (fresh, smoked, canned, and frozen). The results demonstrate that, while the main competition among species often occurs within a market segment (e.g., between trout and salmon among smoked products in France), substitutions also take place much more broadly - for instance, canned tuna is an important substitute for all PrimeFish species in the French fresh fish market.

The simulation of simple scenarios of changes in the economic environment, using the empirically estimated demand systems, then provides a quantitative summary of our analysis at the level of PrimeFish species. Thus, among PrimeFish species, growth in consumer expenditure is particularly favourable to consumption of cod and seabass in France, as well as trout in Finland. In the French fish market, salmon occupies a special place in the sense that its demand is mainly driven by its own price, but its price has a strong influence on demand for other species, including trout and herring. Cod and seabass, meanwhile, appear to form a separate market segment where little substitution with other species takes place, maybe because those fishes lie higher up on the quality ladder.

The analysis of the influence of households' socio-demographic characteristics on fish preferences and consumption reveals a high level of heterogeneity among consumers, hence suggesting the need for segmentation of the market and targeted marketing strategies. However, few relationships between socio-demographics and consumption hold across all PrimeFish species and product groups. This is illustrated by the result that, in both countries, while consumption of fresh fish tends to increase with the age of the household head, the relationship applies to salmon but not trout. Thus, market segmentation needs to be adapted to each product defined in terms of species and processing method.

The elasticities of demand for fish reported in this report will be used further to simulate the sustainability effects of raising fish consumption as part in task 4.3.2.

Contents

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1. Introduction

This document reports the results of task 4.3.1 entitled "Household purchases in France and Finland," which is one of the quantitative studies included in WP4 on "Products, consumers and seafood market trends." The objectives as stated in the description of work are, first, to present an overview of the evolution of fish and seafood consumed by French and Finnish households, and, second, to analyse the determinants of that consumption, focusing in particular on prices, income and household's socio-demographics as drivers of demand.

The work is first intended to generate new knowledge that will be valuable by itself. Thus, the responsiveness of consumer demand for a seafood product to the price of that product is a key parameter that firms need to know, at least at an intuitive level, in order to define an optimal pricing strategy or assess the desirability of developing price promotions. Further, measuring cross-price substitutions is a simple way of letting the data reveal which products compete with each other, both within and outside of the fish/seafood category. This should help stakeholders better understand the market within which they operate and identify emerging threats. For instance, in very concrete terms, should trout producers in Finland follow more closely the price of salmon or that of chicken in order to understand changes in consumer demand for their products?

Similarly, the response of demand to changes in the food budget and income permits to anticipate market implications of medium to long-term economic growth or short-term recessions. Finally, characterizing the relationship between demand and socio-demographics allows for the identification of different consumer segments, including those that should be more actively targeted by advertising or promotions. Combined with trends of the main socio-demographic variables (e.g., household size), it also permits to anticipate future demand.

In addition to those new insights, the task is also designed to deliver information, in the form of demand elasticities, which is necessary to carry out simulations in other tasks. Thus, task 4.3.2, which investigates the role that fish consumption could play in improving the sustainability of diets, relies on the elasticities reported in this document.

The deliverable is organised as follows: the next section presents the methodology and is rather technical. The reader with limited knowledge of microeconomics may want to skip it altogether and go directly to the results section (4), which can be understood without any prior knowledge and starts with a non-technical explanation of how elasticities can be interpreted. Section 3 gives an overview of the data used in the empirical analysis, while section 5 is a synthesis seeking to bring together a large volume of empirical results. The last section offers some conclusions and directions for future work.

2. Methods

The overview of trends in French and Finnish consumption of fish and seafood uses simple graphs and descriptive statistics that are self-explanatory, but we now present the approach adopted to analyse demand in cross-sections of households.

2.1 Demand analysis

The economic theory of consumer choice

The economic theory of consumer choice provides the conceptual underpinning of the analysis. Accordingly, consumers are assumed to choose the goods that they consume and their quantities so as to maximize their well-being, or utility, subject to a budget constraint. Minimal assumptions on preferences over combinations of goods are imposed to ensure the rationality of choices. For instance, transitivity requires that if bundle A is strictly preferred to bundle B, and bundle B to bundle C, then bundle A is also strictly preferred to bundle C. The budget constraint arises because, for given levels of income and prices, only certain combinations of goods (i.e., consumption bundles) can be afforded.

The main purpose of the analysis of demand is then to characterise consumer preferences from observed consumption choices or, in other words, to let the data "reveal" preferences. This differentiates the approach from the group of "stated preferences" methods that are also widely used to investigate consumer behaviour, including in PrimeFish WP4. Both groups of methods have their strengths and weaknesses, but in cases where markets exist, revealed preference methods are usually considered superior because they do not suffer from the hypothetical biases that plague stated preference methods (Murphy et al., 2005). On the other hand, revealed preference methods are less suited to assess demand for a new product that is not currently available to consumers, or to shed light on the cognitive and psychological processes underlying choices.

In our framework, the theory guides the empirical inquiry first by identifying the variables that should be legitimately included in the demand equations. Hence, the generic form of the demand function for good *i*, denoted $x_i(\boldsymbol{p}, m, \boldsymbol{z})$ takes several arguments:

- A vector of prices $\boldsymbol{p}$, which means that demand for a good is a function of its own price, but also the prices of substitute and complement goods.
- Income, or total expenditure, *m*, which defines the level of the budget constraint
- Socio-demographic variables **z** (e.g., education, age) that may be related in a systematic way to consumer preferences.

At the estimation stage, the theory establishes criteria to compare specifications, reduces the number of parameters to estimate, and ensures the realism of the simulations derived from the model (e.g., adjustments of consumption to a price change remain compatible with the budget constraint). In practice, three groups of restrictions follow from the axioms imposed on consumer preferences (Deaton and Muellbauer, 1980): 1) Adding-up, which ensures that the total value of demand exhausts the available budget; 2) Homogeneity, which imposes the absence of money illusion (i.e., the fact that the same proportional increase in all prices and total budget does not modify choices); and 3) Symmetry, which is less intuitive and relates to the derivatives of the compensated demand functions. The fourth theoretical property of negativity or concavity is usually not imposed but only checked ex-post.

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The theoretical concepts of compensated (or Hicksian) demand and its difference with uncompensated (or Marshallian) demand, are important to understand the model and interpret its results. Marshallian demand denotes demand for a consumer operating under a budget constraint, while Hicksian demand denotes demand for a consumer operating under a utility constraint (i.e., holding his/her level of well-being constant). The first concept is of course closer to reality, but understanding what happens when a price changes requires knowledge of the second concept. For instance, assuming that the price of salmon increases, two different effects determine the adjustment in Marshallian demand of a given household: first, the substitution effect captures the reduction in consumption of salmon resulting from the fact that its price has suddenly become higher relative to that of substitute goods (e.g., trout). Empirically, that substitution effect is measured by the change in Hicksian demand, whose sign should be unambiguously negative (i.e., demand for a good decreases with its own price). However, the rise in the price of salmon also means that the real income/expenditure of the household has decreased, or in other words that that consumer has become poorer. The change in Marshallian demand also captures that second so-called income effect, and the above decomposition can sometimes be useful to explain seemingly paradoxical results, as illustrated in the results section.

The approximate Exact Affine Stone Index (EASI) demand system

The first step in the parametric estimation of demand relationships is the choice of a functional form for the demand system, in order to allow imposition of the theoretical restrictions while preserving flexibility (i.e., limit the restrictions on the system implicit in the functional form). Several competing systems have been proposed, as reviewed by Barnett and Serlettis (2008) with Deaton and Muelbauer's Almost Ideal Demand System, or AIDS, remaining the most popular one (Irz, 2010).

The AIDS model, however, presents two limiting features. First, it only allows income to influence demand in a linear or log-linear form, when it is now well established that Engel curves are often highly non-linear and vary widely in shapes across goods (Banks et al., 1997; Lewbel, 1991). Second, the AIDS model does not allow for preference heterogeneity, which unfortunately is recognized as a fundamental feature of consumer microdata (Crawford and Pendakur, 2013), as indicated by the typically relatively poor fit of statistical models estimated from such data.

As a way of addressing both issues, Lewbel and Pendakur (2009) have proposed the Exact Affine Stone Index (EASI) demand system. The system's Engel curves can be polynomials or splines of any order in real expenditures and are therefore highly flexible. Further, the EASI error terms equal random utility parameters, and the model therefore accounts for unobserved preference heterogeneity in a theoretically consistent manner.

However, estimation of the model is complicated by endogeneity and non-linearity issues, which means that iterative GMM or three-stage least squares procedures are called for. For demand systems with censored data as specified in this study, it is likely that the computational problems created by those procedures are insurmountable, and estimation of the full EASI model was therefore deemed too challenging. Thus, we only estimate a simplified – or approximate - version of the EASI model. Support for this simplification comes from Pendakur (2009), who provides evidence that both linearity and endogeneity are only relatively small issues in practice. In particular, that author finds that the linearized version of the model estimated by Ordinary Least Squares (OLS) performs almost as well as fully-efficient endogeneity-corrected nonlinear estimation.

Derivation of the EASI demand system starts from a dual representation of preferences in the form of a minimum cost function:

$$\ln C(p,u,z,\boldsymbol{\varepsilon}) = u + \sum_{j=1}^{J} m^j(u,z)\ln p^j + 1/2\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk}\ln p^j \ln p^k + \sum_{j=1}^{J}\boldsymbol{\varepsilon}^j \ln p^j \quad (1)$$

where $\boldsymbol{p}$ is the J-vector of good prices; u denotes utility; $\boldsymbol{z}$ is a vector of observed socio-economic characteristics (e.g., education); $\boldsymbol{\varepsilon}$ is a J-vector of unobserved preference heterogeneity parameters; and $m^j(.)$ denotes an unrestricted function. Note that the specification of parameters a^{jk} as constants rather than a function of socio-demographic variables restricts the influence of those variables on price responsiveness. By application of Shephard's lemma, we obtain the Hicksian cost share equations:

$$\omega^j(p,u,z,\varepsilon) = m^j(u,z) + \sum_{k=1}^{J} a^{jk}\ln p^k + \varepsilon^j \quad (2)$$

A few manipulations generate the implicit utility or real income y:

$$y = u = \ln(x) - \sum_{j=1}^{J}\omega^j \ln p^j + 1/2\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk} l\, n\, p^j \ln p^k \quad (3)$$

That manipulation represents the key step of the approach, as it permits to replace the unobservable utility level u by y, which is solely a function of observables and parameters. The implicit Marshallian budget shares then follow by substituting y, as expressed in equation (3), for u in the Hicksian budget shares (2).

$$w^j(p,y,z,\varepsilon) = m^j(y,z) + \sum_{k=1}^{J} a^{jk}\ln p^k + \varepsilon^j \quad (4)$$

The advantages of the EASI model are evident in that expression. First, the functions $m^j(y, z)$ are completely unrestricted in their dependence on implicit utility y and observable demographic characteristics $\boldsymbol{z}$. Thus, the model can accommodate homothetic preferences (i.e., independence of w from y), linear Engel curves as in the AIDS, quadratic Engel curves as in the quadratic-AIDS model (Q-AIDS), or much more complex geometries of Engel curves. Second, the unobserved preference heterogeneity parameters ε show up as error terms in the estimated equations and as cost shifters in the cost function, and are thus an integral part of the theoretical model.

We simplify the model further by assuming that the functions $m^j(.)$ are additively separable in y and $\boldsymbol{z}$, linear in $\boldsymbol{z}$ and polynomial of degree R in y:

$$m^j(y,z) = \sum_{r=1}^{R} b_r^j (y)^r + \sum_{t=0}^{T} g_t^j z_t \qquad (5)$$

The Marshallian budget share equations become:

$$w^j = \underbrace{\sum_{r=1}^{R} b_r^j (y)^r + \sum_{t=0}^{T} g_t^j z_t}_{m^j(y,z)} + \sum_{k=1}^{J} a^{jk} \ln p^k + \varepsilon^j, \; j = 1,\ldots,J \qquad (6)$$

Let's note that a constant is introduced as the first ***z*** variable, so that there are only *T* real socio-demographic characteristics in the model. More importantly, real income *y* is itself a function of the parameters a^{jk} and the cost shares w through equation (3). This implies first that model (6) is non-linear in parameters, which complicates estimation. This first issue is addressed by approximating implicit utility (3) by the value of expenditure deflated by a Stone price index:

$$y \approx \ln(x) - \sum_{j=1}^{J} w^j \ln p^j \qquad (7)$$

However, that simplification does not address the endogeneity issue, since the right hand-side of equation (7) remains a function of vector ***w***. To circumvent that problem, we replace those observation-specific shares with sample averages, denoted with a bar:

$$\hat{y} = \ln(x) - \sum_{j=1}^{J} \overline{w}^j \ln p^j \qquad (8)$$

The system of equations (6), using (8) to approximate *y*, defines the unrestricted demand system, to which we impose the properties derived from microeconomic theory. One advantage of the EASI specification is that those theoretical constraints are linear in parameters. First, homogeneity implies *J* constraints: $\sum_{k=1}^{J} a^{jk} = 0, \;\; \mathrm{j} = 1,\ldots,J$. Thus, in each share equation, the price coefficients sum to zero. This property can be imposed on the coefficients of the unconstrained model or, alternatively, all prices can be expressed relative to the price of an arbitrarily chosen nume raire good. The second theoretical property, symmetry, implies: $a^{jk} = a^{kj} \text{ for all } j,k.$ Hence, with *J* share equations (i.e., goods), there are *J*(J-1)/2* such restrictions (i.e., the number of non-diagonal elements of a *J*J* matrix divided by 2). Finally, adding-up implies that the sum of the J coefficients associated with the constant of each share equation (denoted z_0) is equal to unity: $\sum_{j=1}^{J} g_0^j = 1$; and the sum of the *J* coefficients associated with any other variable (i.e., price, socio-demographic, or expenditure) is equal to zero:

$$\sum_{j=1}^{J} a^{jk} = 0, \quad k = 1,\ldots,J \; ; \quad \sum_{j=1}^{J} b_r^j = 0, \quad r = 1,\ldots,R \; ; \quad \sum_{j=1}^{J} g_t^j = 0, \quad t = 1,\ldots,T.$$

Altogether, the model features *JxJ* price coefficients, *Jx(T+1)* socio-demographic coefficients (including the constant terms), and *JxR* income coefficients, for a total of *Jx(J+T+R+1)*. There are *J* homogeneity constraints, *Jx(J-1)/2* symmetry constraints, and *R+J+T+1* adding-up constraints, but it is easy to show that, for the price coefficients, imposing symmetry together with any of the other two constraints implies that the third constraint is automatically satisfied. Thus, there are only *J(J+1)/2+R+T+1* independent constraints, and *(J-1)(R+T+1+J/2)* independent coefficients to estimate.

The numerous parameters of the model are not interpretable directly, so that the next step in the analysis is to compute elasticities. In general, the elasticity of any endogenous variable *x* with respect to an exogenous variable *p* is defined as $\frac{\partial x / x}{\partial p / p} = \frac{\textbf{\% change in x}}{\textbf{\% change in p}}$. This unitless quantity thus measures the responsiveness of *x* to *p*. The results section of this report therefore presents the estimates of elasticities of demand with respect to prices, total expenditure (i.e., budget), and socio-demographic variables. The exact derivation of the elasticity formulae is presented in Appendix 1, and those elasticities are, in practice, estimated at the sample mean.

2.2 Multi-stage budgeting

The food choices that real-world consumers make involve thousands of products, which cannot be modelled simultaneously within the framework of traditional demand theory. The usual solution to this problem is to make *a priori* assumptions about consumers' preferences and decision making processes (Edgerton et al., 1996, p. 69). Here, the simplifying assumption is that of multi-stage budgeting. Thus, it is assumed that, as depicted in Figure 1, the consumer's food budget is allocated in a first stage to broad categories of products, including an aggregate of all fish and seafood products. In Stage 2, the fish budget is itself allocated to different categories of fish products as defined by the type of processing method. For both countries, those categories include fresh fish, smoked/marinated fish, canned fish and frozen fish, but the French model also covers two additional categories: fish-based prepared dishes, as well as other fish-based preparations (e.g., seafood spread). The third stage brings the analysis to the level of the species.

At each stage, a demand system is estimated while holding total expenditure on the upper-level aggregate constant. That is, the demand system for fresh fish estimates demand functions for each species under the assumption that total expenditure on fresh fish remains constant, which generates conditional elasticities (i.e., conditional on a constant fresh fish budget). Obviously real consumers do not impose that sort of constraints upon themselves, so that in simulation exercises, realism requires knowledge of unconditional elasticities, i.e. elasticities reflecting the response of demand to a change when only total income (or expenditure, or the food budget) is held constant. Carpentier and Guyomard (2003) have derived formulae to combine stage-specific elasticities into unconditional elasticities, and the empirical section uses those formulas to calculate unconditional elasticities.

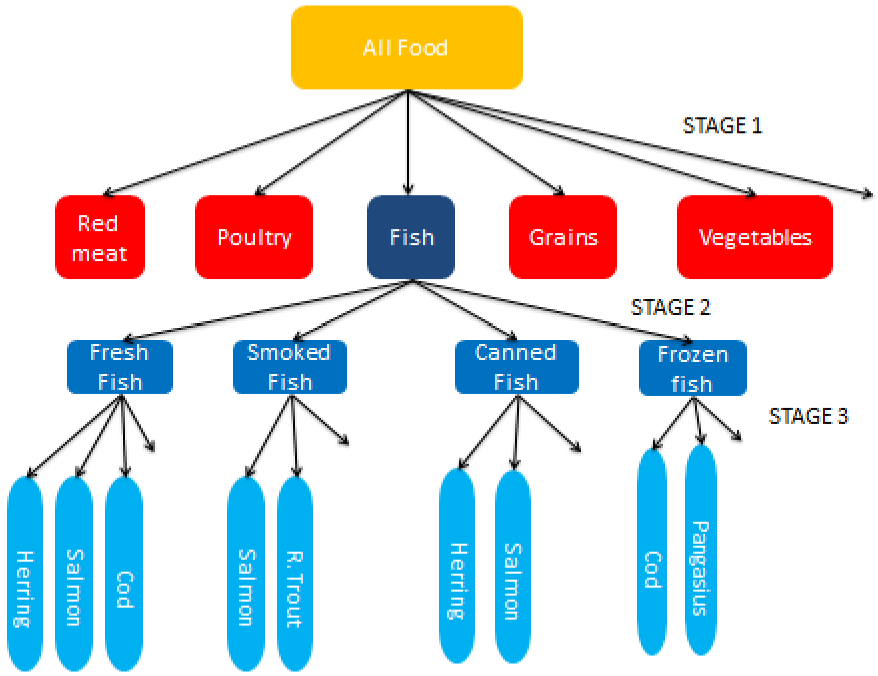


Figure 1: Multi-stage decomposition of the household's food budget

2.3 Other econometric issues

From unit values to prices

At least since the seminal contribution of Theil (1952), it has been known that heterogeneous commodity aggregates cannot be treated as homogenous goods in demand models. In particular, as shown by Deaton (1988), unit values, defined as the ratio of expenditure to physical quantity for a product aggregate, do not measure prices accurately since they also reflect endogenous quality choices. For example, higher income may induce households to expand their consumption of a heterogeneous commodity, such as the aggregate "fish", by different means: either by consuming larger physical quantities of fish, or by switching to higher-priced fish (e.g., from herring to salmon, or from whole salmon to salmon filets). Consequently, the use of endogenous unit values in place of exogenous prices when estimating demand models results in biased elasticities. The level of the approximation that is made when considering that unit values measure prices depends of the level of product aggregation and inherent heterogeneity of the products gathered into a single aggregate. Thus, in the present study, the problem is likely to be more severe for the systems estimated in stages 1 and 2 than for those in stage 3. We also note that in addition to this quality adjustment issue, the use of unadjusted unit values as prices creates other problems related to sample selection (as only purchasing households are observed) and measurement errors.

Fortunately, the literature on the subject offers several options to correct unit values to make it possible to use them as price variables, as reviewed partially in Aepli (2014). Cox and Wohlgenant

(1986) paved the way by showing how regressions of unit values on variables thought to influence quality choices (e.g., household size, education) can be used to "clean" unit values of their quality component. Their method, which is very close to that subsequently proposed by Park and Capps (1997), remains widely used in microeconometric analysis of household consumption. Base d on the theoretical model of quantity versus quality choice of Houthakker (1952), a unit value equation is specified as relating the unit value to: 1- Forces with a strong influence on supply conditions (hence prices), which are of particular importance in order to identify demand relationships. Typically, regional, seasonal and, where appropriate, yearly dummies are included, or the unit value equation are expressed in terms of deviation from regional/seasonal/annual means; and 2- Variables thought to influence quality choices, such as household size, or income. More recent developments of the approach also include the physical amount of the category aggregate to accommodate the possibility that the same goods purchased in larger quantities entail lower unit values. In a second stage, adjusted prices are calculated by removing from unit values the estimated effect of all the variables in the second group (i.e., influencing quality choices) or, equivalently, by adding the household-specific residual to the estimated effect of the first group of variables. Given that residuals are not available for non-consuming households, they are simply assumed to be zero so as to allow estimation of demand relationships over the whole sample. The empirical analysis presented below used the Park and Capps (1997) approach to correct unit values.

Handling of zero-consumption values

The high prevalence of zero consumption observations in microeconomic data sets used to estimate demand systems is very common (Coelho et al., 2010). The fundamental problem that this creates results from the fact that an observation of zero consumption may not indicate that the household does not and will never consume the food concerned, since other possibilities are equally plausible. Zero consumption may be attributable to the infrequency of purchase of some food items, although this is less likely when consumption is recorded over a long period of time, as is the case with consumer panels. In addition to infrequency of purchase, an observation of zero consumption can also reflect a corner solution to the utility maximization problem: given its current income and prevailing prices, the household does not purchase the food item. However, under different economic circumstances, the household may opt to consume the good (Maddala, 1983).

Zero consumption explained by infrequency of purchase or corner solutions implies that the dependent variable, consumption, is censored, which creates an econometric problem particularly difficult to address in the case of multivariate models, such as demand systems. Ignoring censoring by treating zero values as any other value of the consumption variable produces estimates of demand models, and elasticities, which are known to be both biased and inconsistent. The most complete treatment of this issue considers the simultaneous estimation of the decision to consume each good (i.e., a binary problem) and the decision regarding the amount of the good that should be purchased. However, when a system of multiple equations is considered, direct estimation involves the resolution of multiple integrals in the likelihood functions, which proves computationally intensive and often intractable.

Thus, more tractable multi-stage estimation procedures of censored demand models have been developed. Heien and Wessels (1990) (henceforth HS) used the general Heckman procedure to propose an estimation in two simple steps. In the first step, a probit equation is estimated to model the binary decision to consume a food item and, in a second step, the demand equations are augmented by the inverse mills ratios extracted from the first-step regressions. Shonkwiler and Yen (1999) (henceforth SY), however, have demonstrated the inconsistency of the HS estimator before offering a consistent alternative. That procedure is still widely used in empirical demand analysis (e.g., Gustavsen and Rickertsen, 2014) and we adopt it as it represents a good compromise between theoretical soundness and empirical tractability. In a first step, as in the HS framework, the probabilities of consuming positive quantities of any given food item are estimated by probit models. The terms related to the first-stage probit equations are then introduced to correct the bias in the coefficients of the EASI model brought about by censoring. Thus, those corrected coefficients can be used as such in the expressions of the elasticities previously described.

3. Core Data

	France	Finland	
	KANTAR	HBS	NIELSEN
Nature	Consumer panel	Household Budget Survey	Consumer panel
Sample	Fish consumers	All	Fish consumers
# Households	23587	11917	2935
# Transactions	≈ 800000	NA (diary report)	105691
Period of observation	Continuous, year 2012	Two-week periods, years 1998, 2006, 2012	Continuous, year 2014
Fish products	10508	20	1433

Table 1: Overview of the core data used in the study

The empirical analysis relies on a variety of data sources, and the main ones are summarized in Table 1. Fish consumption in France is analysed on the basis of a representative panel of households (Kantar Worldpanel)[4] available for several years, although the demand analysis only uses data from year 2012. Participating households record weekly all their purchases of food, and receive incentives for doing so (points are earned for participating and redeemable to obtain gifts). The information provided includes the characteristics of the purchased product at bar-code level (e.g., brand, size), the quantity purchased as well as related expenditure. KANTAR also provides the main socio-economic characteristics of the panel households, including household size, region of residence and income class. The exact composition of the panel changes over time, with an annual rotation of roughly one third of

[4] Link: http://www.kantarworldpanel.com/global/Sectors. Accessed January 19, 2017

the participants.

In Finland, multiple rounds of the Household Budget Survey (HBS) record the expenditure of a representative sample of households. That data source makes it possible to characterize the allocation of the food budget to fish/seafood in stage 1, but the level of product aggregation (only 20 fish categories) and short period of time over which consumption is recorded (only two weeks) makes it unsatisfactory to refine the analysis to the species level. The demand estimation in stages 2 and 3 was therefore carried out on the basis of consumer panel data purchased from Nielsen[5]. The structure of the data set is very similar to that of the Kantar data.

Table 1 already reveals important characteristics of the consumer panel data and fish & seafood markets in the two countries. Although the French data set features a much larger number of households (23k vs 3k), the relative difference is less than that in population size (65 million vs 5.4 million) so that the Finnish population is in fact a bit better represented than the French one. In the two countries, the number of transactions (e.g., 800k in france) is very large, clearly placing the analysis in the domain of "Big Data". Simple arithmetic further reveals that households in the two consumer panels made, on average, the same number of transaction over the course of year 2012 (34 versus 36 in France and Finland, respectively). The total number of products in the two data sets (10k in France and 1.4k in Finland) confirms the high level of product differentiation that exists in modern fish and seafood markets, but also the a large difference between the two countries.

In addition to those core data, the study uses other publicly available data sources as well as published results from the grey and academic literatures. Stage 1 results are mainly based on previous research (See Irz (2017) for Finland and Caillavet et al. (2017) for France). We report here those results as they provide interesting insights about the place of fish consumption in the whole diet of consumers. Those results will also be used to calibrate the economic model used in Task 4.3.2. Stages 2 and 3 are specifically based on research conducted in the PrimeFish project.

4. Results

4.1. Evolution of fish consumption in the two countries

Figure 2 presents the evolution of average annual fish and seafood consumption per capita in the two countries from 1961 to 2011, using FAOStat data (accessed in December 2016). Heterogeneous products are simply aggregated using their weights, which are very rough, but the graph already reveals similarities in the two countries in terms of consumption levels and consumption growth. In both countries, per capita consumption was less than 20kg/cap/year at the beginning of the period, with a positive secular trend leading to consumption levels worth 35 kg/cap/year at the end of the observation period. The corresponding average growth rate is modest (less than 1.5% annually) and

[5] Consumer Panel Service for the fresh/chilled fish, canned fish and frozen fish categories for the 52 weeks of year 2014 and the Finnish market. Copyright @2016, the Nielsen Company. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible and had no role and was not involved in analyzing and preparing the results reported herein.

Figure 1 also reveals that growth is clearly slowing down. Both countries consume more fish and seafood than the European average, but the gap has increased significantly to reach 13 kg/cap/year.

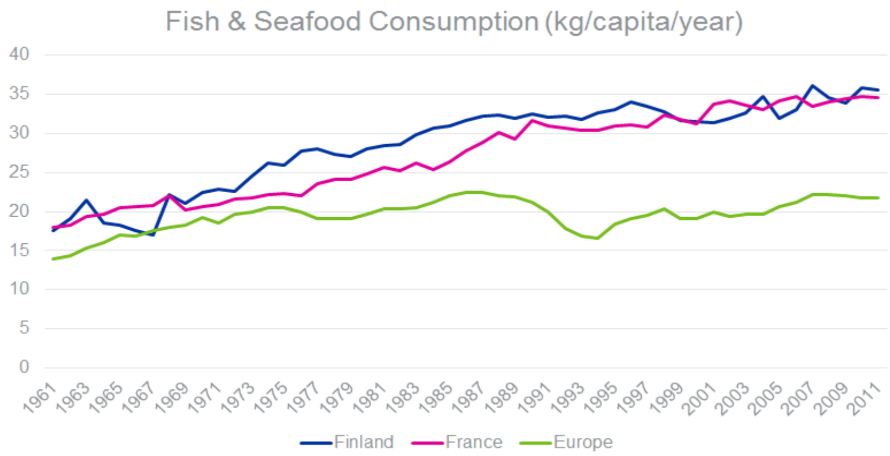


Figure 2: Overall evolution of demand in the two countries

(source: FOASTAT, extracted December 2016)

Main trends in Finland

Figure 3 presents the evolution of the total amount of fish and seafood products available for consumption in Finland as presented in a recent market outlook report (Setälä and Saarni, 2015). The volumes do not correct for the total increase in population size but nonetheless confirm that total consumption of fish has increased in recent decades. More interestingly, the figure demonstrates the major changes in the composition of fish consumption in Finland, with several major phenomena worth highlighting:

- From the early 1990s, a very large expansion of imports of salmonids, the vast majority of which originates from Norway. Thus, Norwegian salmonids now account for more than a third of total Finnish consumption of fish and seafood.
- Parallel to the increase in imports of salmonids, a significant decrease in consumption of salmonids produced domestically (almost exclusively trout). Virtanen et al. (2005) have documented how this evolution can be explained in large part by the liberalization of Finnish trade policies, in particular in relation to the entry of the country into the EU in 1995.
- A large decrease in consumption of herring produced domestically. In just over 30 years, the position of that species in total consumption shifted from being dominant to somewhat marginal.
- A simultaneous decrease in consumption of other domestically produced species, although that decrease is less pronounced than for herring.
- An increase in the importation of non-salmonids, although that increase is quantitatively limited.

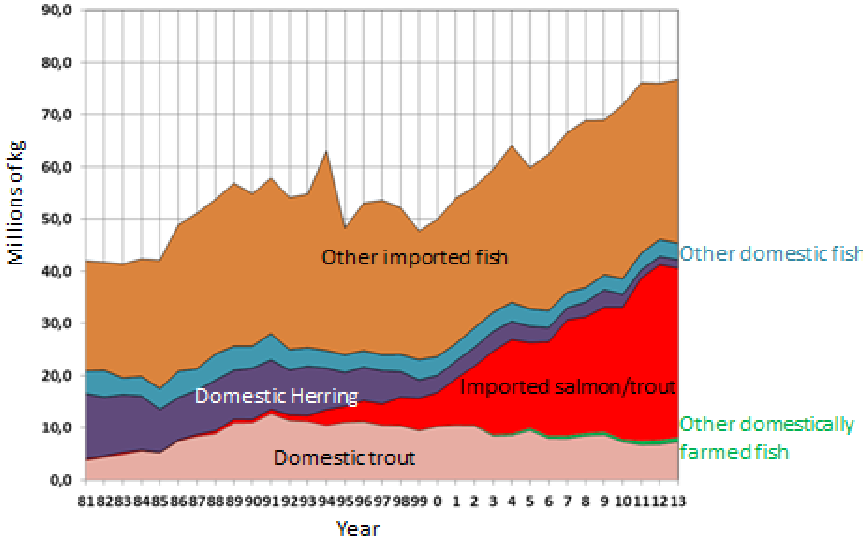


Figure 3: Evolution of fish available for consumption

(reproduced from Setälä and Saarni, 2015)

Table 2 complements the previous graph by summarising the evolution of consumption of fish and seafood in the HBS from 1998 to 2012. The table first shows the limitations of the HBS data in the context of PrimeFish: first, some aggregates (e.g., fish fingers) are not species specific, making it difficult to derive insights for the project's species; second, the product classification changed over time with, for instance, salmon filets only recorded in the last round in the survey; and third, some grouping of products, for instance of fresh and frozen fish, hinders the analysis of consumers'preferences. Nonetheless, the table indicates some important changes in household consumption of fish and seafood:

- For almost all species, a large decrease in consumption of fresh/frozen fish purchased whole, and the concomitant rise in consumption of fish products consumed as fillets. This trend is explained by an increasing demand for convenience and the tightening of the time constraints for many households.
- Development of the lightly processed products, denoted "salted, dried, and smoked" but made up mainly of smoked and marinated fish. Here again, one can speculate that ease of consumption is a key determinant of consumption of that category of fish products.
- A large decrease in consumption of herring, even in fillet form, confirming the trend already noted in relation to Figure 3. The total quantity of herring consumer per household shrank by more than half from 1998 to 2012.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 635761

	Consumption level (kg/year)			% Change
	1998	2006	2012	1998-2012
Fresh, chilled, frozen				
Herring	1.03	0.49	0.56	-46%
Small whitefish	1.80	1.23	1.29	-29%
Salmon	1.38	0.75	0.72	-48%
Rainbow trout	2.81	1.21	0.96	-66%
Other fresh fish	8.41	6.22	6.38	-24%
Coley	1.04	0.66	0.32	-69%
Herring fillets	0.94	0.36	0.36	-62%
				All other
Other fish fillets	1.42	4.24		**(non-**
Fish n. e. c.	0.81	0.41		**176%**
Salmon fish fillets			4.73	NA
Other fish fillets			1.43	NA
Fish n.e.c.			0.90	NA
Other seafood (fresh, chilled, frozen)				
Seafood (shrimps, crabs.)		0.01	0.22	NA
Salted, dried, smoked fish				
Salted fish	0.61	0.52	0.80	32%
Dried or cooked **cod (lutefisk)**	0.23	0.21	0.39	69%
Smoked and grilled fish	1.94	1.94	3.37	73%
Cooked, smoked, etc. seafood	0.38	0.55	0.59	53%
Other preserved/processed fish and fish preparations				
Herring preserved or processed	1.34	0.56	0.69	-49%
Tuna fish preserves	1.37	1.67	2.36	72%
Other fish and seafood preserves	0.43	0.69	0.85	98%
Fish fingers	1.20	1.05	0.98	-19%
Herring casseroles, etc.	0.19	0.23	0.25	29%
Salads and equivalents	0.16	0.42	0.66	302%
Ready-to-eat meals of fish	0.20	0.72	0.72	253%
Fish soups and equivalents	0.41	0.97	1.55	279%
Total	28.12	25.12	31.06	
Average household side	2.55	2.46	2.38	-7%

Table 2: At-home consumption of fish and seafood in Finnish households

Main trends in France

The consumption of seafood products in France at the beginning of the 21th century, despite experiencing positive growth at the end of the 20th century, has been quite stable, oscillating around 35 kg/capita/year. If we look at the volumes, even without correcting for the total increase in population size, the quantity consumed every year has decreased in the last 5 years (7.8% between 2010 and 2014, FranceAgriMer(2015)). Despite that, the total value of the seafood market has increased over the period (+1.25% per year on average between 2006 and 2013) due to an increase in the average price of seafood. At least 70% in volume (and 67% in value) of seafood purchase happened in supermarket and hypermarket stores, and this distribution channel is constantly increasing. Nonetheless, the overall situation hides disparities among seafood categories and species. With regard to the retail network, the crisis of confidence (linked to the "horsegate" in 2013) has resulted in an increase in the market share of specialised retailers, such as fishmongers, thus highlighting the importance of trust for consumer.

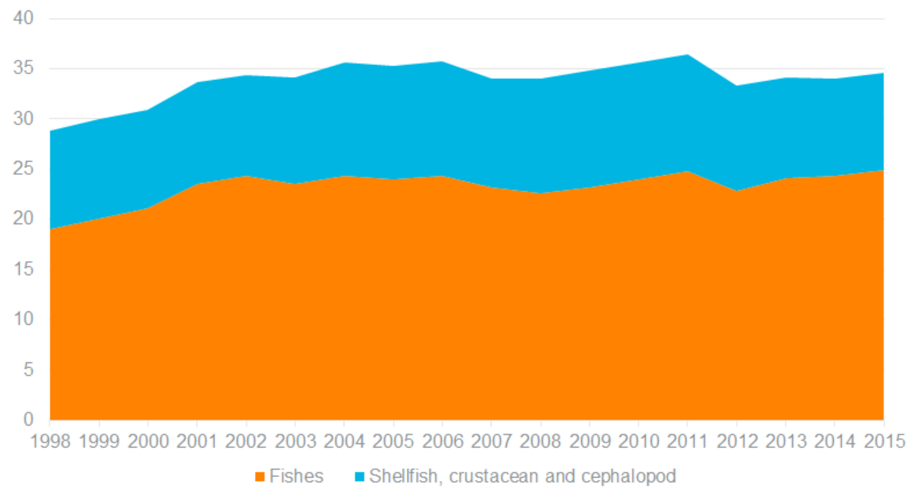


Figure 4: Evolution of seafood consumption in France (kg/capita/year)

(Source: FranceAgriMer – Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture 2015, juillet 2016)

The distribution of seafood consumption between fish and shellfish on the one hand, and crustaceans and cephalopods on the other hand, has been stable (figure 4), but the distribution across seafood categories consumed at home has evolved in the last fifteen years (figure 5). Two important dates can be underlined for the fish sector in France. Social conflicts between fishermen and transporters in May 2008 led to an overall decrease in fresh fish supply; in 2011, a strong increase in international demand led to a rise in overall fish price.

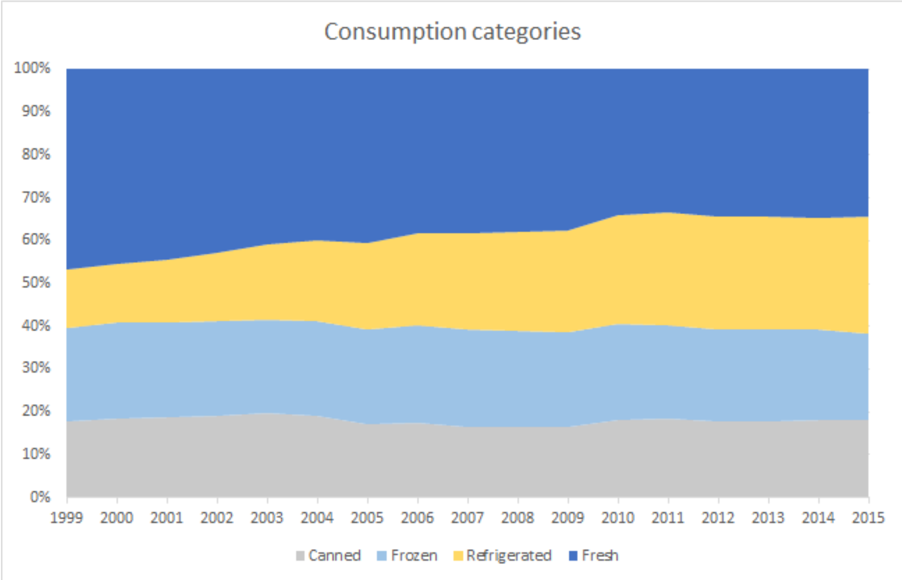
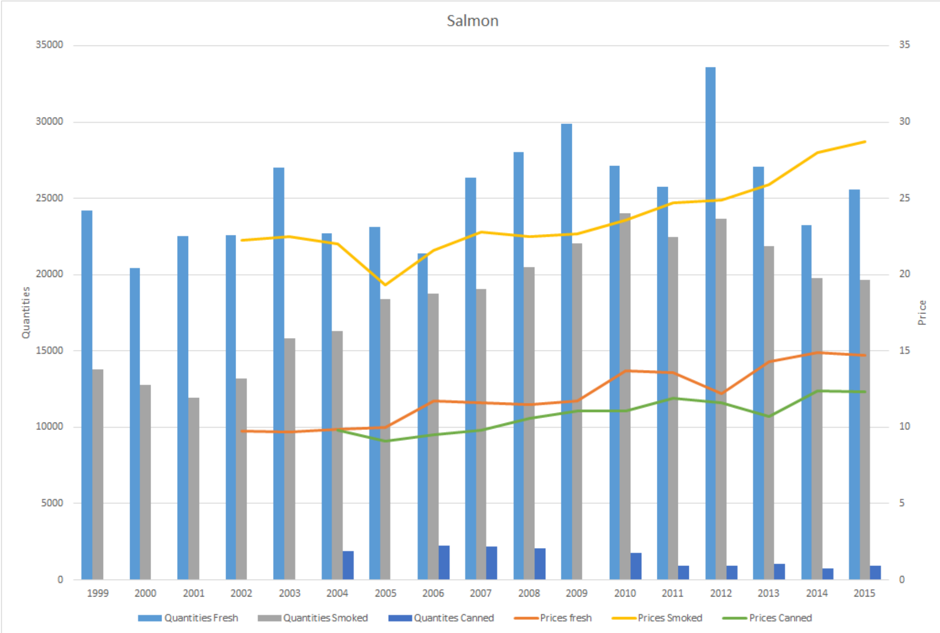


Figure 5: Repartition of seafood consumption at home in France through mean categories (% volume)(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)

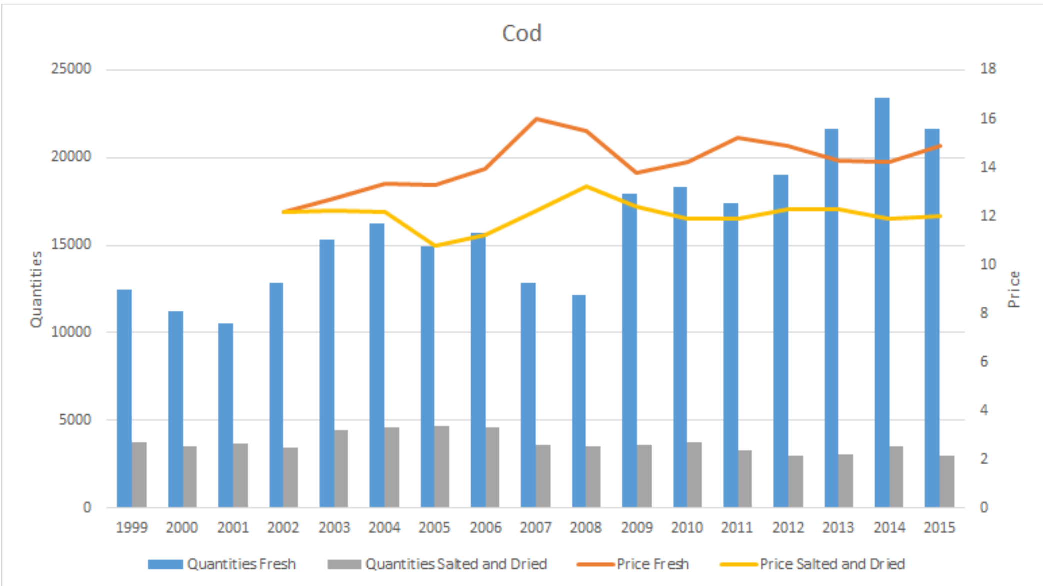
For fresh products, the trend had been continuously downwards between 1999 and 2015, but those products remain the most important fish category (in volume). For fresh fish, market penetration has been around 70% across the period, with a lower rate in 2006 (67.7%) and a higher rate in 2009 (73.5%). In the last fifteen years, market penetration has been either stable or increased, which means that fresh fish continues to attract consumers, but average consumption per buying household is decreasing. The main fish species in the fresh category are salmon and cod, with respectively 44% and 39.2% of market penetration in 2015. The group of pre-packed fresh fishes is worth noting as it has continuously increased over the period, despite a slowdown since 2010.

For fresh salmon, market penetration was 40,9% in 2003, and the volume consumed seems to be linked to price variation as the lowest market penetration (36%) was observed in 2006, which corresponds to a year of strong price increase, while the highest market penetration (48%) was observed in 2012 when price was low (fig 6). Furthermore, the last few years have seen a decrease in salmon consumption, due to a price increase linked to a reduction in supply (increase of international demand) but also bad press for salmon farming following critical documentaries broadcast on French TV. Nonetheless, for fresh products, salmon leads the category and was back in 2015 at the first place of consumed species, in front of cod, which benefited from the salmon situation while its own availability was increasing (rise in cod quota and price decrease since 2007) (figure 7). Market penetration of fresh cod has increased from 28.3% in 2003 to 39.2% in 2015.



<u>Figure 6:</u> <u>Evolution of main salmon based products consumed in France</u>

(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)



<u>Figure 7:</u> <u>Evolution of main cod based products consumed in France</u>

(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)

For others fresh fish species, after several years of decreasing demand (1999 to 2011, figure 8), trout has performed quite well in the last years. The market penetration rate was around 18% in 2015, its highest rate since 2009. Meanwhile, fresh seabass and seabream (figure 9), after ten years of increases in consumption coupled with stable or decreasing prices, have been the subject of increases in price (stronger for seabass) that penalised consumption, leading in particular to a reduction in the number of consumers (lowest market penetration of the last decade in 2015, at 10.4% and 11.3% for seabass and seabream respectively).

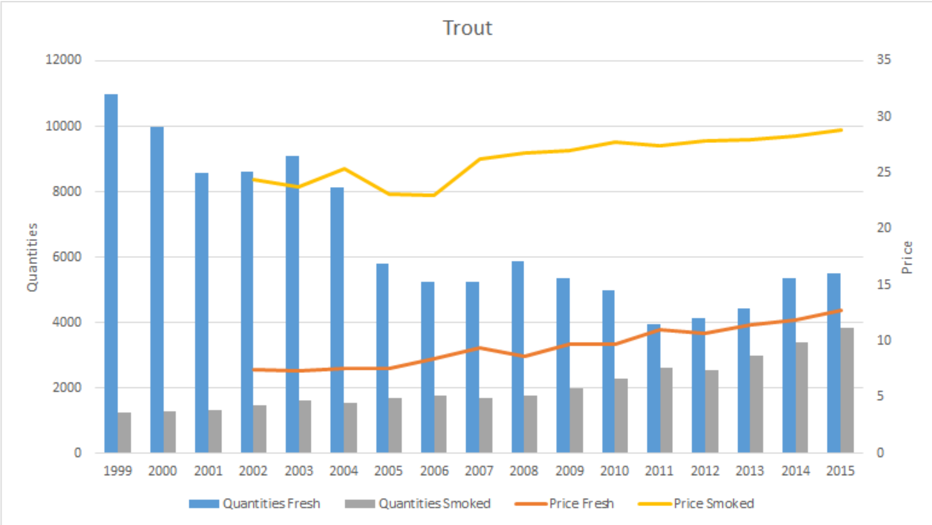


Figure 8: Evolution of main trout based products consumed in France

(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)

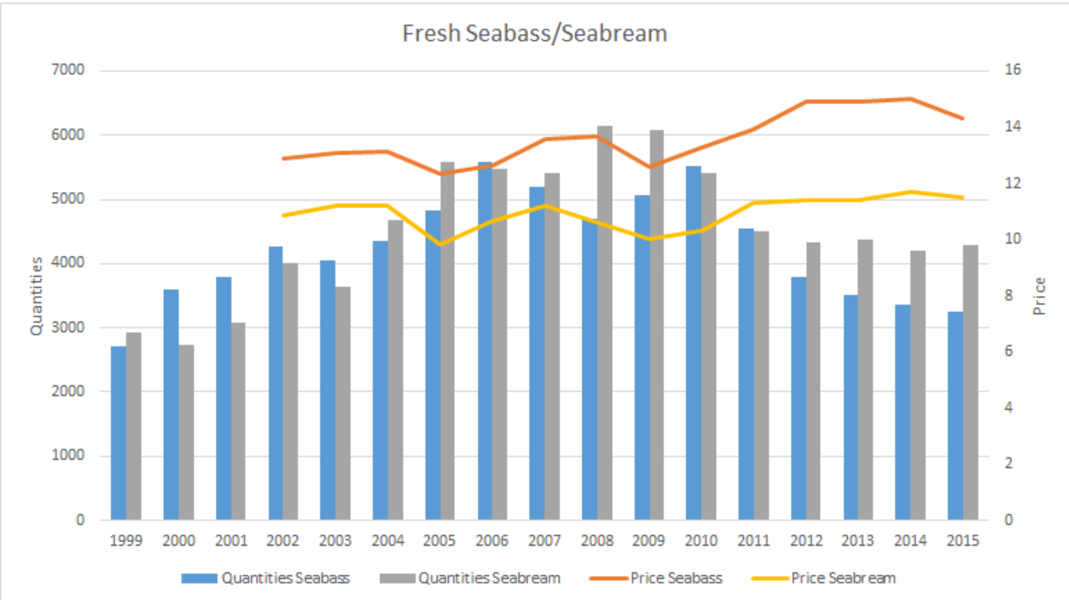


Figure 9: Evolution of main seabass/seabream products consumed in France

(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)

For Pangasius (Figure 10), after growth between 2007 and 2009, the number of households consuming the species as a fresh product has been continuously decreasing, the market penetration rate falling to 4.3% in 2013 (compared to 13.8% in 2009). The negative image of pangasius farming and increase in price are the principal reasons of this weak performance.

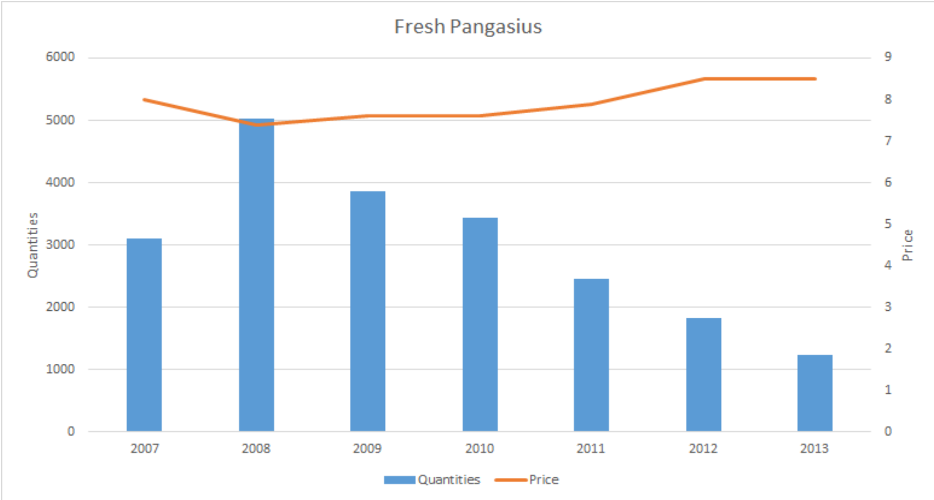


Figure 10: Evolution of main Pangasius products consumed in France

(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)

The refrigerated category has continuously increased in recent year, in volume and value. This dynamism is mainly carried by smoked fishes and cooked shrimps, which are the main subcategories, but also new categories such as raw fish (mostly sushi) and ready-to-eat products. For smoked products, the market penetration rate has been, for all species, higher than 79% since 2010, the main species being salmon. Indeed, despite some scandals in the last three years of the studied period over farmed salmon, which negatively impacted consumption of smoked salmon between 2013 and 2015, the previous period (1999 to 2012) was characterized by an increase in demand despite an increase in price (figure 6). Market penetration for smoked salmon is highest within the category and has exceeded 70% since 2008 (reaching 74.8% in 2010). The second and third most important smoked species in volume are herring and trout, but both have market penetration rates lower than 25.5% for herring and 29.5% for trout. The increasing price of salmon, as well as negative press, have led to a reallocation of smoked fish consumption within the category towards trout (Figure 8), but also to substitutions with non-seafood products (e.g *foie gras*). The market for smoked herring has experience an increase in price but a relatively stable level of market penetration (see appendix 3). Within the refrigerated category, some traditional subcategories decreased or stagnated over the period, for instance market penetration for salted and dried cod (Figure 7) decreased continuously (see appendix 3).

For the frozen fish category, the studied period has been characterized by a decrease in volume and increase in price. This decrease in volume is mainly evident for un-breaded fish, while the fastest growing subcategory has been breaded fish. Indeed, demand for frozen un-breaded fish has been

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 635761

hampered by a price close to that of fresh fish (and even higher in 2009). The market penetration rate for the category is important as around 88% of households bought frozen seafood between 2007 and 2012, but the "horsegate" in 2013 had a particularly large impact on that category of seafood products. This is evident in the decrease in consumption volume in year 2013 despite low prices, and subsequent decreases for all frozen products in terms of quantities sold and number of buying households.

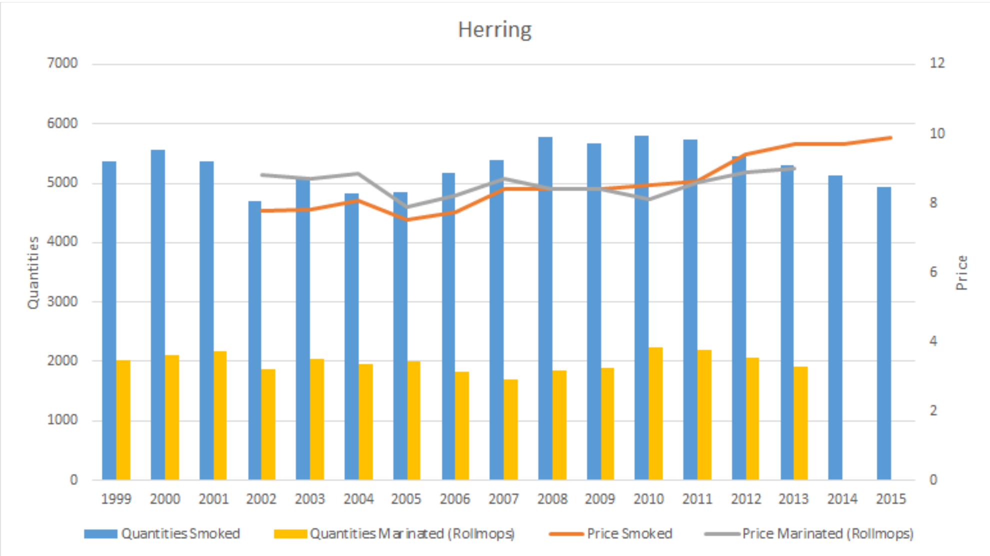


Figure 11: Evolution of main Herring products consumed in France

(Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015)

The last seafood category, canned fish, is the least dynamic and important in volume, but it also has the highest rate of market penetration, as at least 93.6% of households purchased canned seafood (lower penetration rate between 2003 and 2015; highest is 95.3% in 2010 and 2011). The main species in this category is tuna, with higher volume and market penetration. Canned products benefited from the 2008 economic crisis, as many items in the category can be considered cheap products, and we can observe an increase in consumption volume in 2009 and 2010. However, the break in the negative trend for that category was short lived, and due to bad weather (major items in the category are weather dependent, for instance tuna salad, or canned tuna, tend to be consumed more during hot sunny periods), contraction in consumption volume resumed after 2010, except for the spread subcategories. For the project species, only salmon is present in that category and only with a low volume.

4.2 Stage 1: Fish consumption in the whole diet

The demand analysis is organised from the more general level to the more specific one, and in stage 1 we analyse the allocation of the food budget to broad categories of food, including fish and seafood. The analysis of expenditure shares indicates that the relative importance of fish/seafood in food consumption is relatively similar in the two countries in aggregate terms: in France, households allocate 6% of their food budget to fish, as compared to 5% in Finland. We now turn to the discussion of elasticities in Stage 1.

The (conditional) elasticities reported in Figures 12 and 13 are estimated under the assumption of a constant food budget. Thus, the reported elasticity of demand for fish, which is equal to -0.84 in Finland, indicates that a one percent increase in the price of fish would induce a decrease in fish consumption worth 0.84%.

Figures 12 and 13 indicate that all the own-price elasticities for the 19 and 22 food categories included in the Finnish and French diets respectively have the expected negative sign, although four of those elasticities are not statistically significant in the Finnish results. Thus, overall, food demand responds to prices, and this statement also applies to the fish category, with a one percent increase in the price of fish resulting in a 0.8-0.9% decrease in demand in the two countries. When food categories are ranked by magnitude of own-price elasticities (in absolute values), the fish aggregate belongs to the highest tertile, thus already indicating the importance of pricing decisions for the stakeholders of the sector.

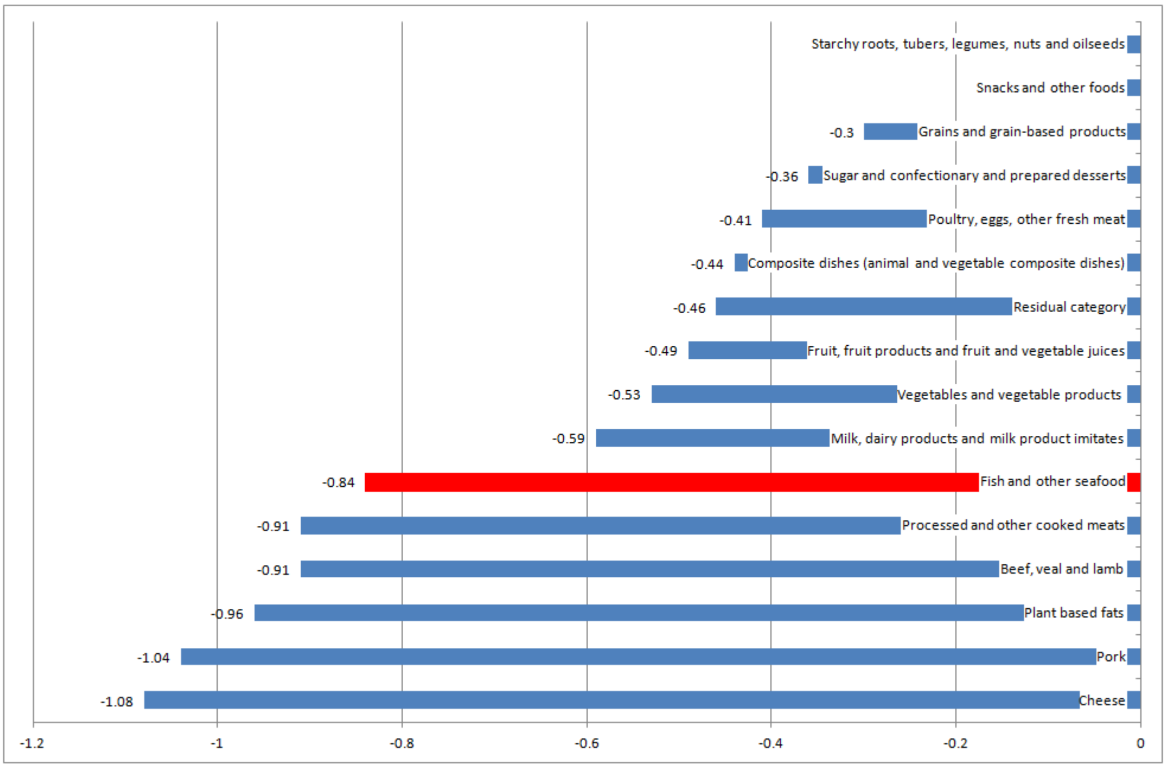


Figure 12: Own-price elasticities of food groups - Finland (Source: Irz, 2017)

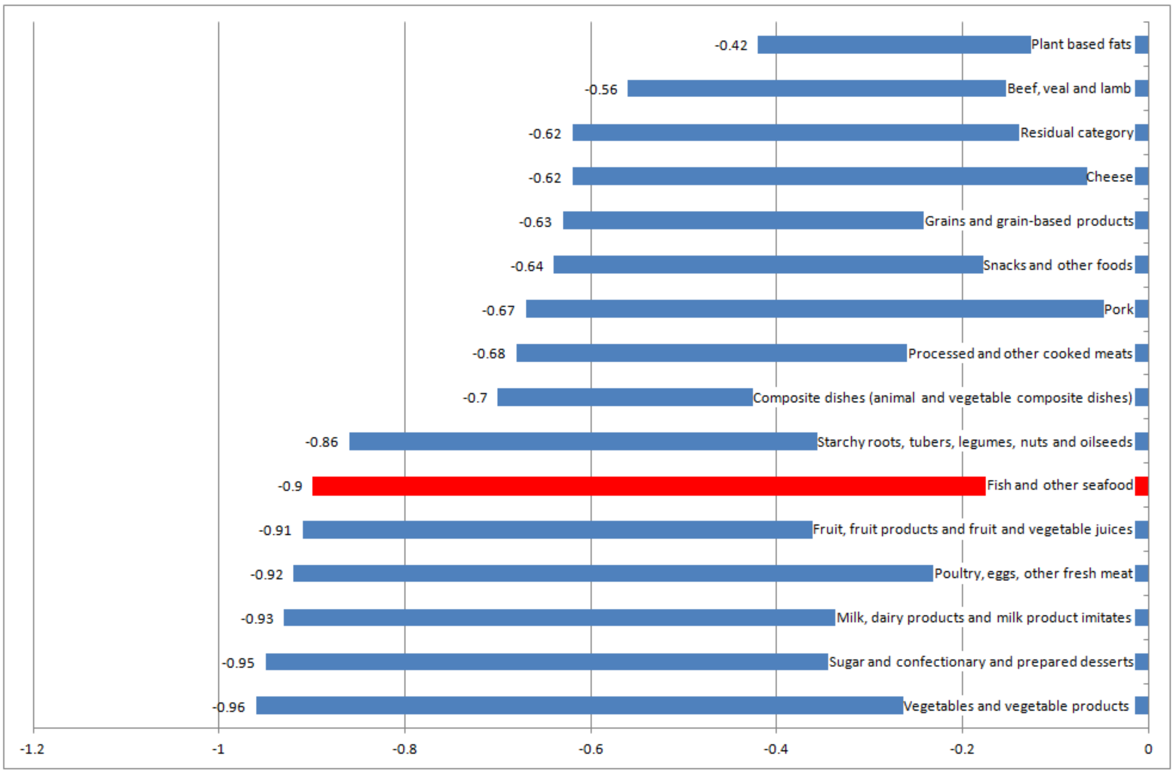


Figure 13: Own-price elasticities of food groups - France (Source: Caillavet et al., 2017)

Cross-price elasticities of demand for fish are depicted in Figures 14 and 15, which indicate how much purchases in each food group are modified when the average price of the fish category increases by 10%. Positive variations indicate products which are substitutes for fish, either because they replace fish consumption in the diet, or because of an income effect; negative variations indicate products which are fish complements. The results indicate that, first, when considering fish as an aggregate category, substitutability and complementary relationships with other foods are rather limited in both countries, with the change in demand exceeding 1% in absolute value for only one group in each country. Second, rather unexpectedly, the analysis does not reveal strong substitutions between fish and meat categories: in Finland, the elasticities of demand for fish with respect to the prices of pork and processed meat are not significant, while those with respect to the prices of red meat (i.e. "ruminant meat" in the table) and poultry are actually negative, indicating complementarity. The main substitute for fish products is the composite dishes group. In France, except for animal fats, consumption of all animal products decreases or remains stable when the price of fish increases. The relationships to other food groups seem to be driven mainly by an income effect, rather than direct substitution.

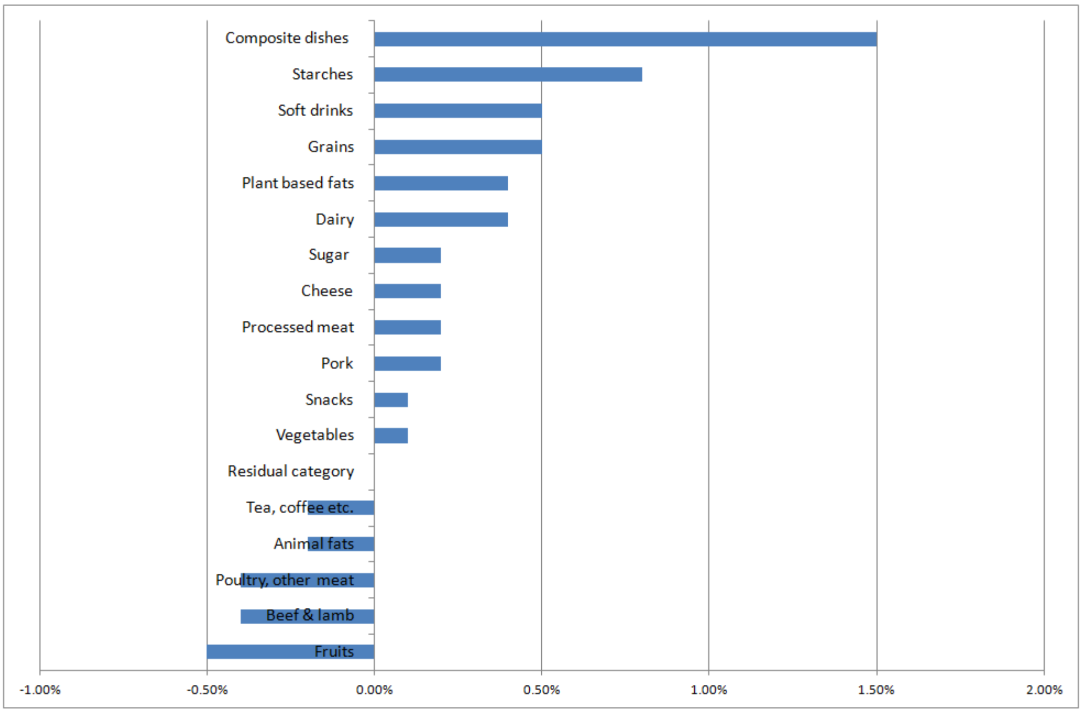


Figure 14: Variations in each food group purchases when the average price of the fish category increases by 10% (Finland)

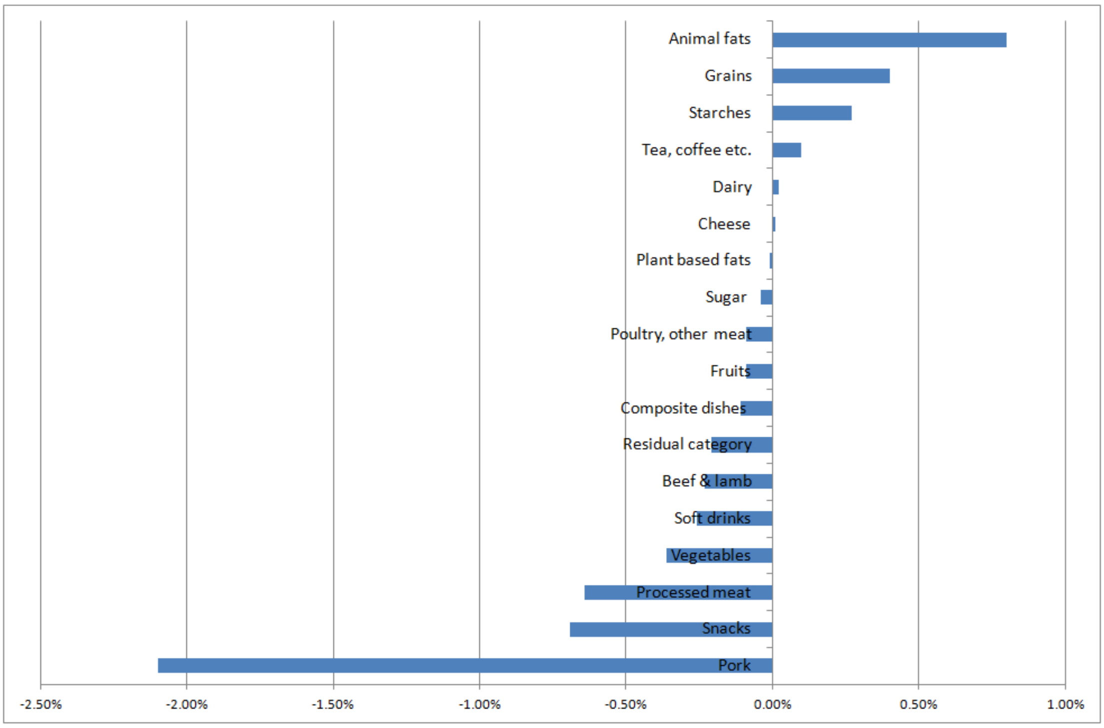


Figure 15: Variations in each food group purchases when the average price of the fish category increases by 10% (France)

4.3 Stage 2: Demand analysis of fish products defined by the type of processing method.

In Stage 2, we consider the demand for fish products defined by the type of processing method. The categorization is given in Table 3 for France and Finland, together with some simple statistics describing purchased quantities and expenditure in the two populations. The data available in Finland covers four types of fish products (fresh, smoked/marinated, canned, and frozen), while the French data is aggregated in six groups (i.e., the same four groups as for Finland plus two additional groups: prepared dishes and other preparations). This explains the gap in the purchased quantities and expenditure between the two countries.

	Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit Value (€/kg)	Budget share (%)	Number of products	Consuming HHs
FR	**ALL FISH**	**8.5**	**89.9**	**10.5**	**-**	**10244**	**-**
	Fresh	2.2	24.8	11.2	28%	2161	69%
	Smoked/marinated	0.5	12.1	22.3	13%	1178	73%
	Canned	1.7	14.3	8.2	16%	1777	86%
	Frozen	1.2	10.4	8.9	12%	1038	68%
	Other preparations	1.8	18.2	10.1	20%	2362	84%
	Prepared dishes	1.9	12.7	6.7	14%	1956	78%
FI	**ALL FISH**	**5.8**	**61.1**	**10.5**	**-**	**1433**	**-**
	Fresh fish	2.7	27.9	10.2	47%	216	75%
	Smoked/marinated	1.0	17.6	16.8	27%	500	70%
	Canned	1.4	11.5	8.5	19%	590	86%
	Frozen	0.7	4.1	6.0	7%	127	60%

Table 3: Structure of fish consumption according to types of processing method

The purchased quantities are in both cases smaller than in data recording quantities available for consumption at national level (e.g. FAO data computed from production, trade and inventory records in food balance sheets). This is explained by a possible under-reporting in consumer panels, but also by the difference between live weight versus final product, and the fact that we only consider here at-home consumption.

It is interesting to note that average prices are similar in both countries. The price hierarchy is also similar with, from the most to the least expensive category: smoked/marinated fish, fresh fish, and a set composed of other preparations, frozen and canned products. In France, composite dishes have the lowest prices.

Regarding budget shares, it turns out that fresh products have the largest share in the two countries, particularly in Finland. The other categories are quite important, except the frozen segment in Finland, because of smaller prices and smaller purchased quantities. Regarding the number of products, if we only consider the four common groups, it turns out that the Finnish market for canned and smoked fish is more diversified than the corresponding French market. Conversely, the fresh fish and frozen fish markets appear to be relatively more diversified in France. Market penetration is rather high in both countries, with 70% to 86% households consuming those fish categories over a one-year period.

	France	Finland
Number products	**6147**	**1433**
Fresh fish	35%	15%
Smoked/ marinated	19%	35%
Canned	29%	41%
Frozen	17%	9%

Table 4: Number of products in 4 fish categories
(Other preparations and other dishes not taken into account)

We now present estimates of the own-price and cross-price elasticities of demand for different categories of fish products as defined by the type of processing method. For both countries, those categories include fresh fish, smoked/marinated fish, canned fish and frozen fish, but the French model also covers two additional categories: fish-based prepared dishes, as well as other fish-based preparations (e.g., seafood spread). As will be the case for the different subsystems in Stage 3, the results are presented as elasticity tables, which are most easily analysed by focusing on different sections:

- The diagonal elements of the table (in bold) are the own-price elasticities, which measure the response of demand for a given fish category to a change in its own price. Those elasticities are expected to take a negative sign and be statistically significant.
- The last column of the table presents the expenditure elasticities measuring how demand for each product category responds to a change in the food budget. Those elasticities are expected to be positive and statistically significant, indicating that greater affluence drives greater consumption for most product categories.
- The non-diagonal elements of the price matrix define the cross-price elasticities and measure the substitutions and complementarities among goods. Positive cross-price elasticity indicates substitutability, and a negative elasticity reveals complementarity between two groups of products. It is difficult to anticipate the signs of those elasticities *a priori,* but one would expect the strength of the substitutability to be stronger among relatively homogeneous products (e.g., canned fish) than across broad food categories (e.g., fish vs meat).

France - The French results are presented in Tables 5 and 6. The expenditure elasticities vary from 0.7 to 1.2 depending on the fish category, which means that demand for each product increases as total fish expenditure grows. However, this effect is stronger for fresh products and smoked products and weaker for frozen products. Thus when total fish expenditure increase, this benefit more to the smoked products (higher quality, and mostly transformed products) and less to the frozen products (perceived as lower quality, less transformed products[6]).

Overall, the Marshallian own-price elasticities vary from -1.2 to -0.7, revealing some differences in price sensitivity of demand across the fish groups (Table 5). The most price-sensitive groups are those corresponding to fresh fish and other fish-based preparations; the least price-sensitive groups correspond to smoked/marinated fish and frozen fish.

	Fresh	Marinated/ Smoked	Canned	Frozen	Prepared dishes	Other preparations	Fish Expenditure
Fresh	**-1.234***** (0.016)	-0.269*** (0.01)	0.125*** (0.009)	0.046*** (0.008)	0.007 (0.008)	0.111*** (0.01)	**1.029***** (0.019)
Marinated/Smoked	-0.433*** (0.019)	**-0.763***** (0.023)	0.137*** (0.014)	0.001 (0.012)	-0.037*** (0.011)	0.169*** (0.013)	**1.188***** (0.015)
Canned	0.343*** (0.015)	0.154*** (0.013)	**-0.968***** (0.016)	-0.042*** (0.01)	-0.021** (0.01)	-0.172*** (0.011)	**0.981***** (0.025)
Frozen	0.146*** (0.014)	-0.005 (0.012)	-0.083*** (0.011)	**-0.891***** (0.014)	-0.029*** (0.01)	-0.106*** (0.011)	**0.741***** (0.018)
Prepared dishes	0.075*** (0.016)	-0.049*** (0.012)	-0.067*** (0.012)	-0.035*** (0.011)	**-0.911***** (0.016)	0.009 (0.014)	**0.936***** (0.02)
Other Preparations	0.193*** (0.013)	0.105*** (0.009)	-0.183*** (0.009)	-0.088*** (0.008)	-0.001 (0.009)	**-1.059***** (0.014)	**0.973***** (0.019)

Table 5: Marshallian elasticities of demand for fish products in France (stage 2)

The Marshallian cross-price elasticities reveal many relationships of substitutability and complementarity between groups. Most elasticities are highly significant, but their values are often relatively small, indicating weak relationships. The strongest substitutions are schematically presented in Figure 16. The highest value is for the fresh/canned relationship: when the price of fresh fish increases by 1%, fresh fish demand decreases by 1.2%, and demand for canned fish increases by 0.3%. There are also relationships of complementary that are worthy of note: when the price of fresh fish increases by 1%, the demand for smoked fish decreases by 0.4%.

It is also interesting to highlight that prepared dishes are weakly related to other fish categories. It is probably due to the fact that the product substitutions within this category are performed with others prepared dishes (based on meat or vegetable) rather than other fish products. Frozen and fresh products, offering similar products (whole or filet), are less related than we first could expect, and if frozen products are weak substitutes for fresh (0.14), the fresh products are almost not impacted by a change in frozen price (0.04). One part of the explanation may be that consumers chose to purchase frozen products with a storage solution in mind (frozen fish products are not necessarily consumed rapidly) and then report their consumption on other frozen species, while 'fresh fish' consumers may

[6] In 2012, 59.1% of frozen products in value were whole or filet fish (breaded or unbreaded) while frozen transformed products represented only 14.5% in value (the rest of frozen category is shellfish, crustacean and cephalopods).

have more a species in mind, and then move to the frozen equivalent if the product is not available or too expensive. This idea will be discussed in stage 3 (demand analysis at the species level).

The Hicksian cross-price elasticities (which are calculated while holding purchasing power constant) in Table 6 are much higher and most of them are positive. For instance, when the price of fresh fish increases by 1%, the purchases of canned, frozen, prepared dishes and other preparations increase by 0.55, 0.43, 0.36, and 0.49% respectively. The fact that the corresponding values of Marshallian cross-price elasticities are smaller reveals a strong income effect. For instance, when the price of fresh fish increases, the consumption of fresh fish decreases, leading to an increase in the consumption of the other groups to maintain a constant level of utility (as shown by the Hicksian values). But as the price of fresh fish increases, total (real) income decreases, which causes a reduction in fish expenditure proportional to expenditure elasticities. This effect weakens the real substitutions (as shown by lower values of Marshallian cross-price elasticities).

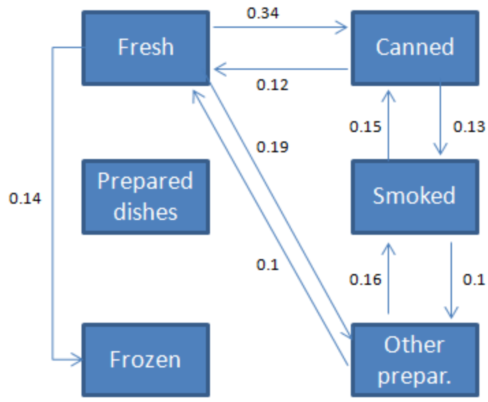


Figure 16: Substitution relationships (only cross price elasticities > 0.1) (France)

	Fresh	Marinated/ Smoked	Canned	Frozen	Prepared dishes	Other preparations
Fresh	**-0.888***** (0.016)	-0.085*** (0.01)	0.328*** (0.009)	0.24*** (0.008)	0.172*** (0.008)	0.371*** (0.01)
Marinated/ Smoked	-0.16*** (0.019)	**-0.619***** (0.023)	0.297*** (0.014)	0.153*** (0.012)	0.092*** (0.011)	0.374*** (0.013)
Canned	0.559*** (0.015)	0.269*** (0.013)	**-0.841***** (0.016)	0.079*** (0.01)	0.082*** (0.01)	-0.009 (0.011)
Frozen	0.429*** (0.014)	0.145*** (0.012)	0.083*** (0.011)	**-0.733***** (0.014)	0.106*** (0.01)	0.107*** (0.011)
Prepared dishes	0.361*** (0.016)	0.103*** (0.012)	0.1*** (0.012)	0.125*** (0.011)	**-0.775***** (0.016)	0.224*** (0.014)
Other Preparations	0.493*** (0.013)	0.264*** (0.009)	-0.007 (0.009)	0.08*** (0.008)	0.142*** (0.009)	**-0.833***** (0.014)

Table 6: Hicksian elasticities of demand for fish products in France (stage 2)

It is also interesting to decompose the price effects for frozen products. As displayed in Table 5, Marshallian elasticities show that frozen products are weakly linked to other products: only an increase of fresh price affects frozen consumption; a variation of frozen products price has a modest impact (all cross elasticities are less than 0.1); and most of them are negative: if the price of frozen products increases, the consumption of canned, prepared dishes and other preparation slightly decreases. If we look at the Hicksian elasticities (Table 6), all elasticities are higher than Marshallian elasticities and positive: all categories are substitute for frozen products. An increase in frozen fish decreases the purchasing power of the consumer, even though it is the smaller for frozen fish: this effect is sufficiently large to nullify the substitution effect, as indicated by the negative cross-price elasticity of Marshallian demand for canned, prepared dishes and other preparation with respect to the price of the frozen category.

Table 7 displays the impact of socio-demographic characteristics of consumers on demand for different groups. It turns out that:

- Age affects positively demand for fresh, canned, and smoked products, and negatively demand for prepared dishes and frozen products. The impact is relatively weak, but reinforces the idea that older people consume more fresh and less ready-to-eat products (as prepared dishes).
- Household size affects positively demand for canned fish, other preparations, and smoked products, and negatively demand for prepared dishes and fresh products. The household size could have two effects: the needed quantity is more important as the household size increases, but the income constraint is more important as well. Thus the consumption of cheaper product in more important quantity is expected, which is confirmed by the important impact of household size on canned products. A stronger negative effect is observed for fresh fish, which is less convenient to cook for numerous family and more expensive.
- Income affects positively demand for other preparations, canned fish, and smoked products, and negatively demand for prepared dishes, fresh fish and frozen products. For fresh products the result is surprising, but it is probably due to species effect that we explore further in the stage 3.
- Education level and presence of child under the age of 16 are not easy to interpreted, probably because of the important number of product in each category, which may be really different in terms of value, but also in terms of positioning. Education affects positively demand for other preparations, canned fish, and smoked products, and negatively demand for prepared dishes, fresh fish and frozen products.
- Presence of a child under the age of 16 affects positively demand for other preparations, frozen fish and canned products, and negatively demand for prepared dishes, fre sh fish and smoked products.
- Holding a freezer is an important and significant household characteristic that affects positively the consumption of frozen and fresh products, and negatively the consumption of canned fish. Canned can be seen as an alternative to frozen products in the conservation at home for seafood products. The influence of freezer possession on frozen seafood consumption was expected, but we can underline that is also an important factor for fresh products, thus we can assumed that people buying fresh fish easily freeze it at home

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themselves.

Variable	Factor level	Fresh		Marinated/ Smoked		Canned		Frozen		Prepared dishes		Other preparations	
		Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age		0.009***	0.001	0.008***	0.001	0.015***	0.001	-0.023***	0.001	-0.037***	0.001	0.012***	0.001
HH size	2	-0.472***	0.025	0.302***	0.033	0.465***	0.03	0.005	0.033	-0.715***	0.042	0.501***	0.032
(ref:1)	3	-0.659***	0.032	0.4***	0.042	0.55***	0.04	-0.053	0.042	-0.055	0.054	0.239***	0.041
	4	-0.769***	0.035	0.427***	0.046	0.896***	0.044	-0.116**	0.046	-0.368***	0.059	0.341***	0.045
	>=5	-0.747***	0.04	0.517***	0.053	0.664***	0.051	0.218***	0.053	-0.017	0.068	-0.041	0.052
Gender of mainpurchase	(ref:Women)	-1.942***	0.033	-0.921***	0.046	1.785***	0.034	-1.154***	0.043	-1.05***	0.056	3.361***	0.045
Socio_economic class	Lower-average	-0.325***	0.022	0.081***	0.031	0.722***	0.026	-0.673***	0.03	-0.588***	0.038	0.685***	0.028
(ref : Modest)	Upper-average	-0.267***	0.025	0.369***	0.034	0.979***	0.031	-1.244***	0.033	-0.778***	0.043	0.747***	0.032
	Well-off	-0.078**	0.033	0.564***	0.043	1.095***	0.043	-1.857***	0.042	-0.86***	0.056	0.776***	0.042
Region	Centre-East	-0.899***	0.033	-0.683***	0.043	0.616***	0.041	0.681***	0.042	-1.316***	0.055	1.524***	0.044
(ref:Paris)	Centre-West	-0.951***	0.031	-0.579***	0.041	0.863***	0.04	0.261***	0.04	-1.268***	0.052	1.608***	0.039
	East	-1.338***	0.036	-0.637***	0.048	0.967***	0.044	0.142***	0.047	-0.919***	0.062	1.949***	0.049
	South-West	-0.577***	0.036	-0.648***	0.049	-0.18***	0.044	1.03***	0.047	-0.232***	0.061	0.746***	0.045
	North	-1.376***	0.035	-0.387***	0.045	1.446***	0.045	-0.933***	0.044	-0.616***	0.059	2.059***	0.048
	West	0.073**	0.03	-0.404***	0.041	-1.062***	0.038	1.297***	0.039	0.785***	0.052	-0.445***	0.037
	South-East	-0.832***	0.034	-0.624***	0.047	0.007	0.044	1.374***	0.045	-0.35***	0.058	0.741***	0.045
Education	Between Bac and Bac +5	-0.432***	0.018	0.11***	0.025	0.53***	0.023	-0.299***	0.024	-0.545***	0.031	0.651***	0.024
ref(<= Bac)	> Bac +5	-0.18***	0.035	0.258***	0.045	0.232***	0.047	-0.006	0.045	-0.209***	0.059	0.013	0.043
Owns a freezer (Ref: none)		0.465***	0.018	0.153***	0.024	-0.686***	0.022	0.472***	0.023	0.39***	0.03	-0.789***	0.023
Child <=16 (Ref: none)		-0.6***	0.027	-0.408***	0.036	0.693***	0.035	0.145***	0.036	-1.154***	0.045	1.169***	0.035

Table 7: Influence of socio-demographic variables on fish consumption in France

Finland - The Finnish results (Table 8) are presented in a similar manner. The expenditure elasticities (last column) indicate that demand for each of the four product categories increases with the total fish budget, but that the relationship is much stronger for fresh products than for frozen products. This confirms the view of frozen products in Finland as necessities of relatively low quality, which account for a decreasing share of the fish budget as households allocate more resources to the purchase of fish/seafood.

	Fresh	Smoked/marinated	Canned	Frozen	Fish Expenditure
Fresh	**0.921*****	-0.118***	-0.13***	-0.09***	**1.233*** **
	(0.032)	(0.028)	(0.021)	(0.019)	(0.018)
Smoked/marinated	-0.092*	**-1.795*****	0.782***	0.075**	**1.027*****
	(0.047)	(0.062)	(0.041)	(0.033)	(0.034)
Canned	-0.084	1.297***	**-1.554*****	-0.369***	**0.739*****
	(0.053)	(0.064)	(0.077)	(0.046)	(0.055)
Frozen	0.044	0.431***	-0.592***	**-0.111**	**0.304*****
	(0.09)	(0.095)	(0.084)	(0.097)	(0.07)

Table 8: Marshallian elasticities of demand for fish in Finland (Stage 2)

All own-price elasticities are negative, but demand for frozen fish stands out as being particularly inelastic, and smoked/marinated as well as canned products as being particularly elastic. Several cross-price elasticities are positive, significant and large, hence confirming the substitutability of fish products across large categories. The strongest substitutions occur between the smoked/marinated and canned categories, as well as between the frozen and smoked categories. The fresh product category in Finland does not compete directly with other fish product categories, a result that seems surprising and that we seek to explain further by presenting the Hicksian elasticities of demand in Table 9. By contrast to the Marshallian elasticities in Table 8, those elasticities are calculated while holding purchasing power (i.e. real fish expenditure, or utility), as opposed to nominal fish expenditure, constant. In that setting, we observe much stronger substitutability among the fish product categories, with only one pair of product categories (i.e., that corresponding to canned and frozen products) not characterized as substitutes. The Hicksian elasticities also show strong substitutions between the fresh products and all other categories, with the strength of the substitution largest with the smoked/marinated category. The large differences between the two sets of elasticities demonstrate the importance of the income effect already mentioned in the methodology section but that we can now illustrate with reference to demand for fresh fish products. Thus, when the price of smoked fish increases, two opposite phenomena occur:

- Smoked fish becomes more expensive and, as a result, consumers turn towards substitutes, including fresh fish, as indicated by the positive Hicksian elasticities between the two product categories. This defines the substitution effect of the price change.
- The purchasing power of the consumer decreases: with a given level of nominal fish expenditure, he/she can afford less fish. This income effect affects demand for each category of products in relation to its expenditure elasticity (Table 8). Fresh fish having a large expenditure elasticity, this effect is sufficiently large to nullify the substitution effect, as indicated by the negative cross-price elasticity of Marshallian demand for fresh fish with respect to the price of the smoked/marinated category.

Our results indicate that those income effects are often quantitatively large for fish products and accounts for a large share of the behavioural adjustments measured by the Marshallian elasticities.

	Fresh	Smoked/marinated	Canned	Frozen
Fresh	**-0.3*****	0.256***	0.112***	0.042**
	(0.032)	(0.028)	(0.021)	(0.019)
Smoked/marinated	0.426***	**-1.483*****	0.983***	0.184***
	(0.047)	(0.062)	(0.041)	(0.033)
Canned	0.288***	1.521***	**-1.409*****	-0.29***
	(0.053)	(0.064)	(0.077)	(0.046)
Frozen	0.198**	0.523***	-0.532***	**-0.078**
	(0.09)	(0.095)	(0.084)	(0.097)

Table 9: Hicksian elasticities of demand for fish in Finland (Stage 2)

We now turn to the analysis of the influence of socio-demographic variables on fish demand in Finland, as summarized in Table 10.

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Variable	Factor level	Fresh Fish Estimate	SE	Smoked/marinated Estimate	SE	Canned fish Estimate	SE	Frozen fish Estimate	SE
Age		0.007***	0.001	0.008***	0.001	0.043***	0.002	-0.133***	0.002
HH size		0.103***	0.011	-0.247***	0.022	0.112***	0.036	0.007	0.044
Child<=16 (ref.=none)		0.182***	0.039	-1.071***	0.075	0.832***	0.123	0.655***	0.155
Social clas	C1	-0.01	0.031	-0.97***	0.061	1.267***	0.096	0.477***	0.125
(ref. =AB)	C2	0.004	0.023	-1.268***	0.046	1.285***	0.073	1.226***	0.095
	DE	-0.043	0.029	-0.986***	0.057	0.21**	0.09	2.613***	0.118

Table 10: Influence of socio-demographic variables on fish consumption in Finland

The Finnish results first show that a majority of coefficients are strongly statistically significant, which demonstrates that fish preferences vary systematically with observed socio-demographics within the population, hence opening the door for segmentation strategies and targeted marketing campaigns. The second general observation that can be made is that the nature of the relationship between fish consumption and a given socio-economic variable depends on the type of fish category that is considered, as no variable influences demand in the same direction across all four categories. Turning to the effect of each socio-economic variable, we find that older households consume significantly more fresh, smoked/marinated and canned fish but also less frozen fish. Household size influences consumption of smoked/marinated fish negatively, and that of fresh and canned fish positively. The presence of children has been found in the literature to influence fish consumption negatively (Verbeke and Vackier, 2005) but the Finnish results show a different picture: a child under the age of 16 in the household reduces consumption of smoked/marinated fish but raises significantly consumption of the other fish categories. The strong effect on frozen fish consumption may be related to the popularity of fish fingers among children. Finally, Table 10 also reveals strong socio-economic gradients in fish consumption, with lower classes (D, E) strongly favouring consumption of frozen fish, with the highest class (A, B) favouring consumption of smoked/marinated products. Consumption of fresh fish products appears relatively class-neutral, while canned fish is favoured by all but the highest social class.

4.4 Stage 3: Demand analysis at the species level

For each category of fish products defined on the basis of processing method in Stage 2, we now extend the analysis of demand to differentiate products on the basis of species. The primary focus lies with the six PrimeFish species, but we also include other species or groups of other species (e.g., lean white fish) to understand competition among species more broadly.

Stage 3.1: Analysis of demand for fresh fish

Table 10 presents some descriptive statistics about consumption of fresh fish in France and Finland. The composition of that consumption differs markedly between the two countries. In France, consumption of four project species (salmon, cod, seabass/seabream and trout) is quantitatively significant, but salmon is the main species. In Finland, consumption of salmonids (salmon, but also trout) accounts for the bulk of fresh fish consumption (87% in physical weight and 82% in value). Among the other Primefish species, consumption of cod and pangasius is marginal in Finland, while that of seabass/bream appears non-existent. The unit values for the different species in the two countries show great variability, but herring is clearly a low-value species, while seabass and cod are high-price species. Apart from salmon in Finland, market penetration for any given project species is low, since a majority of sample households do not record any consumption over a one-year period.

	Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit Value (€/kg)	Budget share (%)	Number of products	Share of consuming households
FR	**Fresh fish**	2.22	24.8	11.2	28%	2161	69%
	Salmon	0.36	4.7	12.9	19%	182	31%
	Cod	0.19	2.8	14.6	11%	113	20%
	Trout	0.03	0.3	9.7	1%	12	5%
	Seabass/bream	0.07	0.9	12.6	3%	73	6%
	Crustacean	0.79	7.2	9.1	29%	664	52%
	Fat Fish	0.14	1.1	8.4	5%	200	12%
	Lean/White Fish	0.46	5.6	12.3	23%	614	26%
	Others	0.17	2.1	12.2	8%	303	25%
FI	**All fresh fish**	2.73	27.9	10.2	47%	216	75%
	Salmon	1.53	15.4	10.1	55%	79	60%
	Trout	0.68	6.6	9.7	24%	59	45%
	Herring	0.16	1.0	5.9	3%	15	18%
	Cod	0.004	0.1	17.5	0%	1	2%
	Pangasius	0.001	0.0	2.5	0%	1	0.1 %
	Seabass/bream	-	-	-	-	-	-
	White Fish	0.05	0.8	17.7	3%	4	8%
	Vendace	0.13	0.9	7.0	3%	23	14%
	Pike-perch	0.04	0.9	24.4	3%	9	7%
	Other	0.13	2.2	16.2	8%	25	18%

Table 10: Structure of fresh fish consumption in France and Finland according to species (Stage 3.1)

France - Marshallian elasticities of demand for fresh fish are displayed in Table 11. The expenditure elasticities do not vary a lot across species, all values being around 1. The composition of the fresh fish basket does not seem to strongly change when total expenditure on fresh fish increases. We can underline that the most important *(weak)* substitution is between cod and salmon, the two main species consumed in fresh in France, which is in line with others studies (e.g. Singh et al. 2014 for the U.S.). Surprisingly, they is little competition between fresh salmon and fresh trout, as the substitutability between the two species is close to zero.

Marshallian cross-price elasticities are very small and not significant. It would mean that species do not compete strongly with each other. However, Hicksian cross-price elasticities are stronger and significant in many cases (Table 12). This suggests that the interactions between species are likely linked to the income effect, rather than a direct substitution/complementarity effect. One explanation of this weak competition between fresh species is likely linked to consumer habits. Indeed, consumers have limited knowledge about proposed species in fresh fish counters in stores, and tend to be reinsured by well-known species (Fasquel et al. 2014). This 'habit' effect limits the willingness to switch from one species to another.

	Salmon	Cod	Trout	Seabass/ Bream	Crustacean	Fat Fish	Lean/white Fish	Other	Fish Expenditure
Salmon	**-0.999*****	0.018**	0.001	-0.005	0	-0.002	-0.006	0.006	**0.991*****
	(0.007)	(0.007)	(0.008)	(0.008)	(0.003)	(0.006)	(0.006)	(0.006)	(0.005)
Cod	0.019*	**-1.006*****	-0.016	0.009	-0.018***	-0.01	0.005	-0.016	**1.021*****
	(0.011)	(0.019)	(0.015)	(0.015)	(0.006)	(0.012)	(0.013)	(0.011)	(0.009)
Trout	0.009	-0.037	**-0.962*****	-0.024	-0.012	-0.02	0.05	0.036	**0.975*****
	(0.032)	(0.042)	(0.059)	(0.053)	(0.019)	(0.033)	(0.033)	(0.034)	(0.025)
Seabass/Bream	-0.025	0.012	-0.017	**-0.988*****	0.009	0.023	-0.038*	-0.03*	**1.034*****
	(0.02)	(0.023)	(0.029)	(0.035)	(0.012)	(0.02)	(0.019)	(0.018)	(0.015)
Crustacean	-0.004	-0.007**	-0.004	0.007	**-1.001*****	-0.001	0.003	0.001	**1.004*****
	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Fat Fish	0.002	-0.009	-0.014	0.037	0.008	**-1.017*****	0.026	0.015	**0.97*****
	(0.018)	(0.022)	(0.023)	(0.025)	(0.011)	(0.026)	(0.021)	(0.017)	(0.016)
Lean/white Fish	-0.007	0.008	0.01	-0.01	0.006	0.006	**-1.002*****	-0.002	**0.995*****
	(0.006)	(0.008)	(0.007)	(0.008)	(0.004)	(0.007)	(0.009)	(0.005)	(0.005)
Other	0.01	-0.014	0.014	-0.018	0.005	0.006	-0.004	**-0.99*****	**0.995*****
	(0.01)	(0.012)	(0.014)	(0.013)	(0.006)	(0.01)	(0.01)	(0.013)	(0.01)

Table 11: Marshallian elasticities of demand for fresh fish in France (Stage 3.1)

	Salmon	Cod	Trout	Seabass/ Bream	Crustacean	Fat Fish	Lean/white Fish	Other
Salmon	**-0.717*****	0.204***	0.067***	0.113***	0.337***	0.094***	0.291***	0.166***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.003)	(0.006)	(0.006)	(0.006)
Cod	0.31***	**-0.814*****	0.051***	0.132***	0.329***	0.089***	0.311***	0.148***
	(0.011)	(0.019)	(0.015)	(0.015)	(0.006)	(0.012)	(0.013)	(0.011)
Trout	0.287***	0.145***	**-0.898*****	0.093*	0.319***	0.074**	0.342***	0.193***
	(0.032)	(0.042)	(0.059)	(0.053)	(0.019)	(0.033)	(0.033)	(0.034)
Seabass/Bream	0.27***	0.206***	0.052*	**-0.864*****	0.36***	0.123***	0.273***	0.136***
	(0.02)	(0.023)	(0.029)	(0.035)	(0.012)	(0.02)	(0.019)	(0.018)
Crustacean	0.282***	0.181***	0.062***	0.127***	**-0.659*****	0.096***	0.304***	0.162***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)
Fat Fish	0.278***	0.172***	0.051**	0.153***	0.337***	**-0.923*****	0.317***	0.171***
	(0.018)	(0.022)	(0.023)	(0.025)	(0.011)	(0.026)	(0.021)	(0.017)
Lean/white Fish	0.277***	0.195***	0.076***	0.109***	0.344***	0.102***	**-0.704*****	0.158***
	(0.006)	(0.008)	(0.007)	(0.008)	(0.004)	(0.007)	(0.009)	(0.005)
Other	0.294***	0.173***	0.08***	0.101***	0.343***	0.102***	0.294***	**-0.83*****
	(0.01)	(0.012)	(0.014)	(0.013)	(0.006)	(0.01)	(0.01)	(0.013)

Table 12: Hicksian elasticities of demand for fresh fish in France (Stage 3.1)

Regarding the influence of socio-demographic variables (Table 13), it turns out that most variables have strong effects on demand:

- Household size affects positively demand for salmon as well as, to a lesser extent, cod, and negatively demand for trout as well as, to a lesser extent, seabass. The effect is more ambiguous for others species. Trout and seabass, in 2012 are mainly issues from aquaculture (100% for trout and 56% for seabass; FranceAgriMer 2013) and consumed whole as "trout ration" or "seabass ration" calibrated to fit for two people. This could explain the negative impact of household size on this species. Conversely, a larger household size favours the consumption of cod and salmon, probably because these species are sold in pieces and easier to calibrate with household size (more than 92% of fresh cod and 86% fresh salmon are sold cut, while only 31% of seabass and 49% of trout).
- Presence of a child under the age of 16 affects positively demand for cod and seabass, and negatively demand for salmon, trout, and fat fish. Cod is a fish commonly used to be breaded which is appreciated by children.
- The effect of income and education are more disparate across species. Income affects positively demand for salmon, trout and cod, and negatively demand for the other species, while education level affects positively demand for seabass, white fish and 'other' fish, and negatively that for other species. This heterogeneity of preferences is complicated to interpret.

		Salmon	Cod	Trout	Seabass/ Bream	Crustacean	Fat Fish	Lean/white Fish	Other
Variable	**Factor level**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Age		0.028***	0.003***	-0.033***	-0.044***	0.021***	-0.023***	0.023***	-0.08***
HH size	2	0.403***	0.275***	-1.609***	-0.012	0.058***	-0.259***	0.236***	-0.771***
(ref:1)	3	0.499***	0.927***	-1.632***	-0.617***	-0.02**	-0.003	-0.065***	-0.67***
	4	0.428***	1.654***	-2.018***	-0.685***	0.009	-0.018	-0.391***	-0.625***
	>=5	0.58***	1.283***	-2.603***	-0.7***	0.122***	0.289***	-0.231***	-0.93***
Gender of mainpurchase	(ref:Women)	-0.046***	-0.177***	-3.61***	0.276***	-0.087***	0.192***	0.683***	0.365***
Socio_economic class	Lower-average	0.229***	0.035	1.973***	-0.018	0.073***	-0.537***	-0.257***	-0.597***
(ref : Modest)	Upper-average	0.435***	0.539***	2.281***	-0.174***	0.086***	-0.71***	-0.565***	-0.91***
	Well-off	0.582***	0.838***	0.877***	-0.042	-0.053***	-0.526***	-0.478***	-1.018***
Region	Centre-East	0.022	-0.259***	1.426***	-1.136***	0.015	-0.247***	0.215***	0.239***
(ref:Paris)	Centre-West	0.114***	-0.352***	0.748***	-1.052***	0.01	-0.1*	0.432***	-0.082***
	East	-0.1***	-0.825***	6.114***	-1.378***	0.291***	-0.931***	-0.088***	-0.244***
	South-West	0.233***	-0.554***	-0.066	-1.015***	0.136***	0.027	0.549***	-0.311***
	North	-0.078***	-0.468***	5.486***	-1.385***	0.267***	-0.497***	-0.274***	-0.298***
	West	0.098***	-0.505***	3.868***	-1.314***	0.217***	-1.341***	0.374***	-0.551***
	South-East	0.092***	-1.042***	-1.209***	-0.778***	-0.171***	0.158**	1.12***	0.307***
Education	Between Bac and Bac +5	-0.109***	0.143***	-0.102**	0.219***	-0.105***	-0.087***	-0.019**	0.217***
ref(<= Bac)	> Bac +5	-0.089***	-0.616***	-1.406***	0.679***	-0.25***	-0.346***	0.772***	0.245***
Owns a freezer (Ref: none)		0.04***	0.077***	0.008	-0.132***	0.06***	-0.333***	-0.066***	0.132***
Child <=16 (Ref: none)		-0.171***	0.291***	-0.684***	0.572***	-0.04***	-0.345***	0.024*	0.067***

Table 13: Influence of socio-demographic variables on fresh fish consumption in France (Stage 3.1)

Note that age plays a role in determining the composition of the fresh fish basket: older people tend to consume more salmon, crustacean and lean/white fish, and less trout, seabass and fat fish. But the coefficients are small, meaning a modest impact of this variable.

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If we look more closely at the socio-demographic of fresh salmon and trout consumers, we can observe strong differences that can explain the weak competition between the two species in the fresh market. In France, trout and salmon consumers are not identical. While trout is more consumed by younger and small households located in the East, West and North of France (compared to Paris), salmon is consumed by older consumers, in larger households and located in the South-West and Middle West of France (compared to Paris). However both consumers of trout and salmon are less likely to have a high education and a child under 16 at home; they are more likely to be well-off.

Finland - The Marshallian elasticities of demand for fresh fish are presented in Table 14, and the last column shows that the expenditure elasticities vary widely across species, from a maximum of 1.8 for the "Other" aggregate to a minimum of 0.67 for salmon, with trout also characterised by a relatively small expenditure elasticity. Thus, as the fresh fish budget of Finnish consumers expands, the share of that budget allocated to salmonids decreases. One may hypothesize that the high expenditure elasticity of demand for the "Other" species reflects a desire for more variety in fresh fish consumption (e.g., inclusion of exotic imported species) as Finnish households become more prosperous. The own-price elasticities indicate that demand for fresh trout is relatively inelastic, while demand for the "Domestic, fresh water" aggregate (which includes mainly whitefish (*Coregonus lavaretus),* vendace and pike-perch) is particularly elastic. We must acknowledge that the own-price elasticity of demand for herring, which is both strongly positive and significant, appears anomalous. The result could be caused by the fact that herring is often consumed during festive times (e.g., Christmas and mid summer), hence explaining the positive association between prices and demand, but that explanation is not entirely satisfactory. More interestingly, the cross-price elasticities indicate that salmon competes with most other species except herring, which is expected given the major share of the fresh fish market that salmon occupies in Finland. As expected, salmon represents the main competitor of trout in the fresh fish market.

	Salmon	Trout	Herring	Domestic, fresh	Other	Fish Expenditure
Salmon	**-1.001*****	0.187***	-0.353***	0.259***	0.355***	**0.671*****
	(0.063)	(0.048)	(0.04)	(0.032)	(0.037)	(0.034)
Trout	0.201**	**-0.743*****	-0.191***	-0.087	-0.049	**0.903*****
	(0.086)	(0.105)	(0.072)	(0.055)	(0.064)	(0.06)
Herring	-2.828***	-0.83***	**3.016*****	0.417**	-0.88***	**1.077*****
	(0.296)	(0.294)	(0.373)	(0.19)	(0.223)	(0.206)
Domestic, fresh water	0.407***	-0.303***	0.156*	**-1.618*****	-0.142*	**1.368*****
	(0.101)	(0.096)	(0.082)	(0.099)	(0.082)	(0.1)
Other	0.487***	-0.399***	-0.462***	-0.24***	**-1.543*****	**1.851*****
	(0.123)	(0.117)	(0.101)	(0.087)	(0.138)	(0.118)

Table 14: Marshallian elasticities of demand for fresh fish in Finland (Stage 3.1)

Table 15 presents the influence of socio-demographic variables on consumption of fresh fish in Finland. Age effects are significant, with older households favouring herring and salmon consumption but consuming less "Other" species, which may result from a greater attachment to the consumption of

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traditional species by those older households. Households with children tend to consume more salmon, which may be explained by a strong preference for boneless filets by children, but presence of a child also influences consumption of the "other" aggregate negatively, possibly because of the aversion of children towards novel foods. Socio-economic gradients are present for consumption of all species, but the magnitude of the gradient is strongest for herring and the "Other" aggregate. Clearly, lower socio-demographic classes have strong preferences for herring, but consume less "Other" species than higher classes.

		Salmon		Trout		Herring		Domestic, fresh water		Other	
Variable	Factor level	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age		0.02***	0.001	-0.008***	0.002	0.039***	0.006	-0.001	0.003	-0.068***	0.003
HH size		-0.019	0.021	0.06*	0.036	-0.593***	0.136	0.054	0.067	0.165**	0.077
Child<=16		0.785***	0.076	0.153	0.133	0.415	0.565	-0.173	0.269	-2.899***	0.302
Social class	C1	0.569***	0.061	0.267**	0.105	1.302***	0.325	-0.707***	0.159	-2.23***	0.192
(ref. =AB)	C2	0.623***	0.045	0.377***	0.08	1.611***	0.263	-0.443***	0.131	-3.032***	0.159
	DE	0.436***	0.056	0.582***	0.094	2.193***	0.288	0.243	0.147	-3.774***	0.191

Table 15: Influence of socio-demographic variables on fresh fish consumption in Finland (Stage 3.1)

Stage 3.2: Analysis of demand for smoked/marinated fish

The average structure of consumption of smoked and marinated fish in France and Finland is presented in Table 16. For this market segment, the PrimeFish species account for the bulk of consumption (97% in France and 87% in Finland), but there are cross-country differences in the relative importance of each species. In France, 80% of the smoked fish consumed is salmon, with trout and herring capturing only 10% and 7% of the market respectively, while consumption of cod in this category (salted and dried) is minimal. In Finland, salmon and trout are almost equally important in terms of value, while herring and cod account for small but not insignificant market shares. The unit values for those products are high, reflecting the value added by processing, but we note that herring is much more affordable than the other species. Almost three quarters of the households ate some smoked fish over the one-year period over which the data was collected. In France, smoked fish used to be a luxury product consumed only occasionally by a few people, but Table 16 demonstrates that it is no longer the case. While the number of smoked products is larger in the French market than the Finnish one, the ratio of about two is much smaller than for other market segments (e.g., fresh fish, where that ratio was 10). This reflects cultural and historical differences between the two countries, smoked fish being a much more traditional part of the diet in Northern Europe than in France.

	Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit Value (€/kg)	Budget share (%)	Number of products	Share of consuming households
FR	**All smoked fish**	0.6	12.3	22.3	14%	1178	73%
	Salmon	0.4	9.9	24.9	80%	846	67%
	Trout	0.04	1.2	28.0	10%	99	18%
	Herring	0.09	0.9	9.2	7%	128	19%
	Fat fish	0.01	0.1	20.4	1%	30	3%
	Lean/White fish	0.0	0.1	19.5	1%	31	2%
	Other	0.01	0.1	20.9	1%	44	2%
FI	**All smoked fish**	1.0	17.6	16.8	27%	500	70%
	Salmon	0.36	7.1	19.6	40%	141	46%
	Trout	0.43	7.4	17.2	42%	206	52%
	Herring	0.1	0.6	10.3	3%	26	10%
	Cod	0.04	0.3	7.7	2%	17	5%
	Pangasius	-	-	-	-	-	-
	Seabass/bream	-	-	-	-	-	-
	White Fish	0.1	1.1	12.9	6%	40	14%
	Vendace	0.02	0.3	14.2	2%	25	8%
	Pike-perch	0.004	0.1	21.1	1%	13	1%
	Other	0.04	0.6	15.3	4%	32	10%

Table 16: Structure of smoked/marinated fish consumption in France and Finland according to species (Stage 3.2)

France - Marshallian elasticities are displayed in Table 17. Given the very small market shares of fat fish, lean/white fish and other, we only consider here salmon, trout and herring. The own-price elasticities vary from -0.6 (herring) to -1.6 (trout). Thus, purchases of herring seem to be much less price-sensitive than purchases of salmon and trout. Regarding cross-price elasticities, it turns out that they are significant but moderate. The main substitute of salmon is trout; the main substitute of trout is herring; and the main substitute of herring is trout. But, if we look at the hicksian elasticity (appendix 2, table 46) we can see that this weak substitutability is partially attributable to strong income effects, since the Hicksian cross-price elasticities are significant at the one percent level and larger. If the salmon price increases, the substitution effect plays in favour of herring, as indicated by the positive Hicksian elasticities between the two species. But with the price increase the power of purchase decrease and the income effect is sufficiently large to nullify the substitution effect, as indicated by the negative cross-price elasticity of Marshallian demand for smoked herring with respect to the price of the smoked salmon.

	Salmon	Trout	Herring	Fat Fish	Lean/whiteFish	Other	Fish Expenditure
Salmon	**-1.008***** (0.001)	0.032*** (0.005)	-0.044*** (0.002)	-0.277*** (0.008)	-0.054*** (0.008)	0.33*** (0.008)	**1.012***** (0.002)
Trout	0.24*** (0.015)	**-1.63***** (0.062)	0.187*** (0.022)	3.443*** (0.107)	0.498*** (0.104)	-3.479*** (0.104)	**0.849***** (0.025)
Herring	-0.155*** (0.007)	0.236*** (0.031)	**-0.644***** (0.024)	0.19*** (0.067)	0.219*** (0.063)	-0.776*** (0.065)	**0.959***** (0.012)
Fat Fish	-2.706*** (0.052)	6.513*** (0.213)	0.046 (0.095)	**-13.744***** (0.705)	2.36*** (0.497)	4.555*** (0.55)	**2.147***** (0.148)
Lean/white Fish	0.018 (0.042)	0.829*** (0.164)	0.297*** (0.069)	2.056*** (0.392)	**-5.674***** (0.471)	2.044*** (0.368)	**0.669***** (0.102)
Other	2.496*** (0.051)	-6.911*** (0.208)	-1.026*** (0.092)	4.809*** (0.555)	2.638*** (0.471)	**-2.228***** (0.634)	**0.547***** (0.139)

Table 17: Marshallian elasticities of demand for smoked fish in France (Stage 3.2)

If we look more precisely at the competition between species, we can underline that trout if a substitute for salmon more than salmon is a substitute for trout and the main competitor in this category are in fact trout and herring.

Regarding the socio-demographic characteristics of consumers (Table 18), it turns out that:

- Even if many coefficients are significant, purchases of smoked salmon do not seem to be very sensitive to age, household size, socio-economic class, and education.

- Conversely, consumption of trout and herring is negatively affected by household size and the presence of a child under the age of 16, and positively affected by income and education level. Thus it seems that consumer of trout and herring are more similar compare to consumer of smoked salmon, which could explain the stronger competition between trout and herring market compare to the smoked salmon market.

		Salmon	Trout	Herring	Fat Fish	Lean/white Fish	Other
Age		0.006***	-0.054***	0.015***	0.022***	0.003	0.019***
HH size	2	0.025***	-0.589***	-0.283***	-1.161***	1.14***	1.136***
(ref:1)	3	0.048***	-0.824***	-0.275***	-0.612***	1.022***	1.047***
	4	-0.004	-0.474***	-0.466***	-0.786***	1.513***	0.498**
	>=5	0.013***	-1.522***	-0.985***	1.22***	1.803***	0.835***
Gender of mainpurchase	(ref:Women)	0.264***	-3.051***	-0.194***	0.465*	1.861***	1.865***
Socio_economic class	Lower-average	0.002	0.269***	0.268***	0.271	0.406**	-1.731***
(ref : Modest)	Upper-average	-0.039***	0.949***	0.385***	-0.181	0.031	-2.063***
	Well-off	-0.061***	1.39***	0.409***	-0.48*	-0.658***	-1.655***
Region	Centre-East	0.071***	-0.675***	0.478***	-0.484	3.54***	-3.826***
(ref:Paris)	Centre-West	0.076***	-0.671***	0.366***	-0.96***	1.415***	-0.504**
	East	0.049***	-0.436***	0.308***	-2.557***	1.896***	0.28
	South-West	0.112***	-1.241***	0.379***	-1.559***	3.062***	-1.105***
	North	0.109***	-1.652***	-0.439***	-0.611**	2.12***	1.148***
	West	0.1***	-0.434***	0.832***	-1.281***	1.946***	-2.148***
	South-East	0.075***	-1.652***	-0.217***	0.734**	3.359***	-1.895***
Education	Between Bac and Bac +5	-0.045***	0.79***	0.023	-0.57***	-0.193**	-0.512***
ref(<= Bac)	> Bac +5	-0.023***	0.927***	0.308***	-0.71***	-0.524***	-0.764***
Owns a freezer (Ref: none)		0.026***	-0.151***	0.316***	-0.407***	0.155*	-0.098
Child <=16 (Ref: none)		0.051***	-0.591***	-0.61***	0.758***	0.928***	-0.228

Table 18: Influence of socio-demographic variables on smoked/marinated fish consumption in France

Finland - The expenditure elasticities of demand for smoked fish in Finland (Table 19) show large variations across species. Consumption of herring and cod responds particularly little to group expenditure, which allows us to anticipate further decline in the market shares of those species in the medium to long-run as the result of economic growth. The estimation results also reveal that demand for salmon is significantly more expenditure elastic than demand for trout. Demand for non-project species is characterised by particularly high expenditure elasticities, possibly indicating a growing taste for diversity in the consumption of smoked fish products as consumers become relatively better off. All own-prices elasticities display the expected negative sign and a satisfactory level of significance. In addition, those elasticities are large in absolute value, the smallest one, for cod, being equal to 0.96 and hence close to unity. Demands for trout and salmon are close to being price iso-elastic. The results also reveal very strong levels of price responsiveness of demand for herring, Finnish freshwater species (whitefish, vendace, pike-perch) as well as the "other" aggregate. Together with the stage 2 results, which indicated that "smoked fish" in aggregate was itself price elastic, those results point to the particular importance of prices in that market segment, which may be related to the high prices of most smoked products.

Inspection of the cross-price elasticities indicates that PrimeFish species do not compete strongly with each other on that market segment, with the exception of salmon and herring. There is significant substitution between trout and salmon, but the magnitude of the cross-price elasticity is surprisingly small (0.1) given the apparent organoleptic similarities between the two species. The Hicksian elasticities reported in the Appendix 2 (Table 45) show, however, that this phenomenon is entirely attributable to strong income effects, since the Hicksian cross-price elasticities are significant at the one percent level and large (>0.5). The importance of the income effects related to the prices of trout and salmon, in turn, are explained by the large shares of group expenditure that those two categories absorb (descriptive Table 16). Hence, salmon's share of the smoked fish budget being 40%, when the price of that species increases by one percent, real expenditure allocated to smoked fish declines by 0.4% and the resulting decrease in consumption of all smoked fish categories often nullifies the substitution effects. Going back to the Marshallian elasticities, Table 19 shows that all PrimeFish species are in strong competition with the species of the "Domestic fresh water" group.

	Salmon	Trout	Herring	Cod	Domestic, fresh	Other	Group Expenditure
Salmon	**-1.098*****	0.021	0.142***	-0.169**	0.119**	-0.142**	**1.081*** **
	(0.063)	(0.051)	(0.051)	(0.069)	(0.06)	(0.068)	(0.038)
Trout	0.099*	**-0.979*** **	-0.193***	-0.287***	0.173***	0.321***	**0.915*** **
	(0.049)	(0.048)	(0.045)	(0.064)	(0.052)	(0.061)	(0.03)
Herring	0.754***	-0.673***	**-2.907*** **	0.312	1.376***	0.653**	**0.671*** **
	(0.203)	(0.183)	(0.302)	(0.324)	(0.27)	(0.314)	(0.206)
Cod	-0.297	-0.786***	0.269	**-0.959***	0.934***	0.54	**0.552*** **
	(0.224)	(0.215)	(0.265)	(0.515)	(0.315)	(0.429)	(0.207)
Domestic, fresh water	0.253	0.316**	0.789***	0.615***	**-2.669*** **	-0.557**	**1.161*** **
	(0.147)	(0.131)	(0.166)	(0.238)	(0.269)	(0.229)	(0.14)
Other	-0.701***	0.811***	0.452*	0.418	-0.846***	**-1.992*** **	**1.549*** **
	(0.228)	(0.212)	(0.268)	(0.447)	(0.317)	(0.515)	(0.224)

Table 19: Marshallian elasticities of demand for smoked fish in Finland (Stage 3.2)

The effects of socio-demographic variables on demand for smoked fish are reported in Table 20. Lower socio-economic classes (C1, C2, DE) consume relatively less smoked salmon but relatively more smoked trout than the higher reference class (AB), while for the other species the influence of that socio-economic status on demand is less clear. The presence of a child diminishes consumption of smoked salmon, raises that of cod and has a strong negative influence on the consumption of the "other" aggregate (as was also the case for the fresh fish category). Age effects are present, with older households tending to consume more of all categories of smoked fish except for the "Other" aggregate.

	Factor	Salmon		Trout		Herring		Cod		Domestic, fresh water		Other	
Variable	level	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age		0.017***	0.001	0	0.001	0.057***	0.006	0.033***	0.006	0.037***	0.004	-0.192**	0.007
HH size		0.162***	0.023	-0.108***	0.018	0.969***	0.141	-0.673***	0.125	0.395***	0.088	-0.838**	0.141
Child<=16		-0.366***	0.079	0.081	0.059	0.883	0.661	2.242***	0.657	0.537	0.326	-2.886**	0.622
Social class	C1	-0.184***	0.061	0.219***	0.049	0.723**	0.311	-2.246***	0.305	-0.046	0.206	1.643***	0.334
(ref. =AB)	C2	-0.197***	0.046	0.322***	0.037	0.584**	0.239	0.11	0.244	-0.707***	0.169	-0.096	0.267
	DE	-0.211***	0.056	0.421***	0.045	-0.066	0.279	0.883***	0.277	-1.483***	0.217	0.424	0.306

Table 20: Influence of socio-demographic variables on smoked fish consumption in Finland (Stage 3.2)

Stage 3.3: Analysis of demand for canned fish

Table 21 presents some descriptive statistics about the consumption of canned fish in the two countries. In France, this represents a market segment where the PrimeFish species are almost non-existent: salmon is the most consumed species in value terms but its market share barely exceeds one percent. This market segment is dominated in France by tuna, which concentrates more than half of household expenditure allocated to canned fish and is consumed by three quarters of households in the sample. The other two significant species in that market are mackerel and sardines, and in all cases we note that the species most consumed in canned form are very affordable (i.e., unit value in the €7-9 range). Salmon, while much cheaper in cans than in its fresh or smoked versions, appears to be still too expensive to compete on that market. The Finnish market for canned fish looks rather different from the French one. While tuna is also the leading species with a market share of almost one half, consumption of herring is important (> half a kilogram/cap/year and 38% expenditure share), and anchovies are the only other species attracting a non-negligible share of household expenditure. Given the popularity of salmonids consumed as fresh and smoked products in Finland, it is noticeable that consumption of canned salmon/trout in that country is even more marginal than in France. In the two countries, market penetration, at 86%, is higher than in any of the other stage 3 sub-markets, which may be explained by the ease of preparation of many canned products.

	Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit Value (€/kg)	Budget share (%)	Number of products	% consum. HHs
FR	**Canned fish**	1.8	14.5	8.2	16%	1777	86%
	Salmon	0.02	0.20	10.64	1%	51	5%
	Crustaceans	0.06	0.85	15.29	6%	149	17%
	Lean/White Fish	0.02	0.40	19.13	3%	118	12%
	Tuna	1.07	7.86	7.37	54%	646	77%
	Sardine	0.24	2.28	9.52	16%	425	40%
	Mackerel	0.31	2.51	8.00	17%	302	39%
	Other	0.04	0.39	8.93	3%	86	10%
FI	**Canned fish**	1.4	11.5	8.5	19%	590	86%
	Salmon	0.003	0.03	10.3	0%	6	1%
	Trout	0.0002	0.02	76.9	0%	6	0%
	Herring	0.5	4.4	8.0	38%	229	56%
	Cod	0.0003	0.005	15.8	0%	4	0%
	Pangasius	-	-	-	-	-	-
	Seabass/bream	-	-	-	-	-	-
	Tuna	0.7	5.5	8.1	48%	126	63%
	Anchovies	0.03	0.5	16.3	4%	15	14%
	Sardines	0.02	0.2	11.0	1%	26	7%
	Mackerel	0.024	0.2	8.8	2%	22	5%
	Other	0.05	0.7	13.2	6%	156	14%

Table 21: Structure of consumption of canned fish in France and Finland according to species (Stage 3.3)

France - Marshallian elasticities are displayed in Table 22. Given the very small market shares of salmon, crustaceans, lean/white fish and other, we only consider here tuna, sardine and mackerel.

For the 3 species, own-price elasticity of demand is around -0.9, and expenditure elasticities is the higher for Mackerel (1.35). Most cross-price elasticities are significant but quite small. An exception is related to the variation of mackerel demand when tuna price is modified, which shows a relative complementarity between the two canned species. However, Hicksian cross-price elasticities are much higher (see Table 22) and reveal important substitution effects among the three species, main substitute of sardine is mackerel and main substitute of mackerel is sardine, which is logical as the two species are really closed in terms of presentation (whole without the head, with oil, with a large range of spices) and use.

	Salmon	Crustacean	Lean/White Fish	Tuna	Sardine	Mackerel	Other	Fish Expenditure
Salmon	**-1.118***** (0.088)	-0.291*** (0.043)	0.349*** (0.056)	0.19*** (0.02)	0.125*** (0.041)	0.073 (0.052)	0.217** (0.085)	**0.684***** (0.057)
Crustacean	-0.278*** (0.026)	**-0.502***** (0.027)	-0.346*** (0.019)	-0.499*** (0.007)	-0.124*** (0.014)	0.182*** (0.018)	-0.238*** (0.027)	**1.467***** (0.031)
Lean/White Fish	0.378*** (0.06)	-0.436*** (0.035)	**-0.685***** (0.077)	1.114*** (0.022)	-0.248*** (0.037)	-1.098*** (0.053)	0.594*** (0.064)	**0.641***** (0.046)
Tuna	0.013*** (0.005)	-0.062*** (0.003)	0.202*** (0.005)	**-0.913***** (0.002)	0.016*** (0.003)	-0.047*** (0.005)	-0.048*** (0.005)	**0.907***** (0.003)
Sardine	0.037 (0.024)	-0.007 (0.013)	-0.176*** (0.02)	0.014 (0.007)	**-0.985***** (0.017)	0.062*** (0.02)	0.135*** (0.025)	**0.954***** (0.017)
Mackerel	-0.055** (0.025)	0.174*** (0.014)	-0.59*** (0.024)	-0.37*** (0.01)	-0.041** (0.016)	**-0.834***** (0.03)	0.103*** (0.028)	**1.356***** (0.018)
Other	0.22*** (0.083)	-0.204*** (0.045)	0.547*** (0.059)	-0.045 (0.022)	0.299*** (0.042)	0.407*** (0.057)	**-1.59***** (0.107)	**0.632***** (0.06)

Table 22: Marshallian elasticities of demand for canned fish in France (Stage 3.3)

Regarding socio-demographic characteristics of consumers (Table 23), it turns out that:

- Effect of age is relatively weak for the composition of canned basket, and effect of household size is negative for the main species of the category (tuna, sardine and mackerel) despite a positive impact of household size on the overall canned products.
- Consumption of tuna is positively affected by income level and education while consumption of mackerel is negatively affected by those variables.
- Tuna is less consumed in Paris, and more consumed in the South-East, while Sardine and mackerel are more consumed in Paris (and relatively to other part of France in the west and south-west). This repartition of sardine and mackerel consumption, more consumed in the west part of France, can be explain by the important development of canning industry, first for

sardine, in Brittany at the beginning of the XXe century, and even if the canned industry declined in Brittany there is still a strong traditional attachment to this industry.

- Consumers of sardine and tuna are quite similar in terms of socio-demographic characteristics (age, HH size, education) but the income level and the household location differ.

For the other species, Table 23 shows that salmon consumption is positively affected by household size, income and education, and negatively affected by the presence of child under the age of 16. Lean and white fish consumption is positively affected by household size, the presence of child under the age of 16, and to a lesser extent by income, and negatively affected by education.

	Salmon	Crustacean	Lean/White Fish	Tuna	Sardine	Mackerel	Other
Salmon	**-1.027*** (0.088)**	-0.137*** (0.043)	0.435*** (0.056)	0.598*** (0.02)	0.281*** (0.041)	0.261*** (0.052)	0.31*** (0.085)
Crustacean	-0.081*** (0.026)	**-0.171*** (0.027)**	-0.162*** (0.019)	0.376*** (0.007)	0.21*** (0.014)	0.587*** (0.018)	-0.037 (0.027)
Lean/White Fish	0.464*** (0.06)	-0.291*** (0.035)	**-0.604*** (0.077)**	1.496*** (0.022)	-0.103*** (0.037)	-0.922*** (0.053)	0.681*** (0.064)
Tuna	0.134*** (0.005)	0.142*** (0.003)	0.316*** (0.005)	**-0.372*** (0.002)**	0.223*** (0.003)	0.203*** (0.005)	0.076*** (0.005)
Sardine	0.165*** (0.024)	0.208*** (0.013)	-0.057*** (0.02)	0.582*** (0.007)	**-0.768*** (0.017)**	0.325*** (0.02)	0.266*** (0.025)
Mackerel	0.127*** (0.025)	0.481*** (0.014)	-0.42*** (0.024)	0.438*** (0.01)	0.268*** (0.016)	**-0.46*** (0.03)**	0.288*** (0.028)
Other	0.304*** (0.083)	-0.061 (0.045)	0.627*** (0.059)	0.332*** (0.022)	0.443*** (0.042)	0.581*** (0.057)	**-1.504*** (0.107)**

Table 22. Hicksian elasticities of demand for canned fish in France (Stage 3.3)

		Salmon	Crustacean	Lean/White Fish	Tuna	Sardine	Mackerel	Other
Variable	**Factor level**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**	**Estimate**
Age		-0.051***	-0.036***	0.062***	0.015***	0.02***	-0.026***	0.007***
HH size	2	-0.258***	-0.374***	0.453***	0.101***	0.078***	-0.439***	0.77***
(ref:1)	3	0.637***	-0.414***	0.759***	-0.043***	-0.272***	-0.263***	0.531***
	4	0.64***	-0.229***	0.991***	-0.062***	-0.025	-0.36***	-0.119
	>=5	1.485***	-0.321***	0.78***	-0.13***	-0.48***	-0.308***	0.348**
Gender of mainpurchase	(ref:Women)	-4.276***	-0.559***	2.706***	0.357***	1.009***	-0.326***	0.046
Socio_economic class	Lower-average	0.4***	-0.717***	0.992***	0.135***	0.024	-0.52***	0.3***
(ref : Modest)	Upper-average	0.901***	-0.903***	0.778***	0.169***	0.032	-0.834***	0.792***
	Well-off	2.171***	-1.313***	0.119	0.221***	-0.141***	-0.875***	0.972***
Region	Centre-East	0.466***	-0.57***	3.725***	0.406***	-0.567***	-2.115***	0.506***
(ref:Paris)	Centre-West	-1.194***	-0.888***	4.288***	0.384***	-0.075**	-1.849***	0.882***
	East	1.078***	-0.689***	3.824***	0.509***	-0.483***	-3.089***	1.39***
	South-West	0.531***	-0.566***	3.184***	0.479***	-0.413***	-2.518***	1.17***
	North	0.73***	-0.03	4.647***	0.374***	-1.016***	-2.971***	1.122***
	West	-1.91***	-0.794***	5.154***	0.305***	-0.063*	-1.169***	-0.419***
	South-East	3.478***	-0.812***	2.04***	0.556***	-1.153***	-3.039***	1.69***
Education	Between Bac and Bac +5	1.616***	-0.976***	-0.641***	0.161***	0.031	-0.698***	1.273***
ref(<= Bac)	> Bac +5	2.088***	-1.957***	-1.418***	0.322***	0.28***	-0.942***	2.524***
Owns a freezer (Ref: none)		-1.075***	0.719***	0.56***	-0.075***	0.162***	0.31***	-1.219***
Child <=16 (Ref: none)		-0.474***	-1.028***	1.202***	0.21***	0.066**	-0.516***	1.078***

Table 23: Influence of socio-demographic variables on canned fish consumption in France (Stage 3.3)

Finland - The cross-price elasticities of demand for canned fish presented in Table 24 reveal strong substitutability among species and other consumption aggregates. Focusing first on the only PrimeFish species represented in the table, we note that herring does not compete with tuna (i.e., the other main species consumed canned). This can be explained in part by differences in processing methods: herring is usually sold in chilled cans kept in the refrigerator and typically consumed cold without any additional preparation. Tuna is most commonly offered as shelf-stable cans that are often used as an ingredient in a recipe (e.g., tuna pasta). The analysis, however, identifies mackerel as the main product competing with herring on the Finnish market for canned fish. For non-PrimeFish species, we note the strong substitutability among fat fish species, i.e mackerel and sardines, anchovies and sardines, which makes intuitive sense, but tuna and anchovies also appear to compete with each other.

The own-price elasticities are all negative, statistically significant, and relatively large in absolute value. In particular, a 10% increase in the price of canned herring results in a 9.2% decline in demand for that product. The own-price elasticities of demand for sardines and, to a lesser extent, mackerel and anchovies appear even implausibly large. This can be explained by the difficulty for the econometric model to measure demand relationships for some products with great accuracy when the majority of households do not consume those products at all, as is the case for those three species (Table 21). At a more technical level, the fact that the expenditure shares form the denominators of the own-price elasticity formulae (equation A1.16 in the Appendix 1) implies that any inaccuracy in the measurement of the price coefficients of the EASI model (equation (6)) are greatly amplified in the estimation of own-price elasticities for those relatively minor products. Finally, the expenditure elasticities indicate that, as more resources are allocated to the purchase of canned fish product, the consumption shares of herring declines marginally while that of tuna remains more or less constant. Sardine is the only species for which the expenditure elasticity differs significantly from unity.

	Herring	Tuna	Anchovies	Sardines	Mackerel	Other	Group Expenditure
Herring	**-0.924*****	-0.024**	-0.264***	-0.107***	0.226***	0.14***	**0.974*****
	(0.009)	(0.007)	(0.026)	(0.03)	(0.032)	(0.015)	(0.013)
Tuna	-0.033***	**-1.067*****	0.553***	0.004	-0.339***	-0.123***	**1.002*****
	(0.005)	(0.007)	(0.02)	(0.02)	(0.022)	(0.01)	(0.006)
Anchovies	-0.844***	2.24***	**-3.214*****	1.583***	-0.177	-0.57***	**0.989*****
	(0.082)	(0.079)	(0.379)	(0.373)	(0.389)	(0.153)	(0.14)
Sardines	-0.338	0.298	2.577***	**-7.694*****	5.266***	-0.34	**0.561***
	(0.152)	(0.131)	(0.591)	(1.14)	(0.981)	(0.34)	(0.292)
Mackerel	0.649***	-1.298***	-0.172	3.081***	**-3.502*****	0.202	**1.022*****
	(0.095)	(0.085)	(0.366)	(0.583)	(0.642)	(0.187)	(0.157)
Other	0.175***	-0.477***	-0.424***	-0.211	0.112	**-0.578*****	**1.23*****
	(0.032)	(0.026)	(0.104)	(0.145)	(0.135)	(0.124)	(0.095)

Table 24: Marshallian elasticities of demand for canned fish in Finland (Stage 3.3)

Table 25 presents the elasticities of demand for canned fish with respect to socio-demographic variables. For the only PrimeFish species in the table, herring, it is evident that preferences vary within the population along systematic socio-demographic lines, hence opening the way to segmentation strategies in marketing. Given a constant economic environment, demand for herring rises with age and decreases with the presence of a child under the age of 16 as well as household size, hence pointing to the influence of stages of life variables on consumption of that product. The results also show a significant socio-economic gradient in consumption of herring, which is favoured by households in the highest A category. We explain the insignificance of the coefficient associated with the DE dummy by the fact that that socio-economic category is rather heterogenous and includes many pensioners. Together with the large decrease in demand reported in section 4.1, those elements suggest that there may be inter-generational changes in preferences for herring: the species remains popular with older generations but has difficulty attracting younger consumers. Testing that hypothesis rigorously would require, however, household-level consumption data over multiple years, which is unfortunately not available in Finland.

	Factor	Herring		Tuna		Anchovies		Sardines		Mackerel		Other	
Variable	level	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age		0.01***	0.001	0.009***	0.001	0.04***	0.007	-0.128***	0.017	-0.051***	0.009	0.018***	0.005
HH size		-0.094***	0.009	0.121***	0.004	0.054	0.09	0.152	0.225	0.066	0.099	-0.279**	0.062
Child<=16		-0.126*	0.075	-0.375***	0.036	2.302***	0.618	4.727***	1.275	-3.32***	0.703	0.107	0.362
Social clas	C1	-0.192***	0.019	0.204***	0.008	-0.115	0.181	1.11***	0.385	0.245	0.217	-0.719**	0.132
(ref. =AB)	C2	-0.165***	0.014	0.151***	0.007	0.659***	0.139	0.994***	0.314	0.03	0.183	-0.953**	0.113
	DE	0.01	0.016	0.146***	0.009	-0.107	0.165	-1.189***	0.35	2.259***	0.204	-1.468**	0.144

Table 25: Influence of socio-demographic variables on canned fish consumption in Finland (Stage 3.3)

Stage 3.4: Analysis of demand for frozen fish

Table 26 presents some average statistics describing the structure of frozen fish consumption in the two countries. The project species account for a much smaller share of the market than was the case for fresh fish and smoked fish. In France, consumers allocate on average 19% of their frozen fish budget to cod, and 10% to salmon, but the other PrimeFish species are quantitatively insignificant in that market, which is dominated by the consumption of lean/white fish other than cod. The salmon dominate this category in volume and value (FranceAgriMer, 2013), beside *low* choice of products (only 65 products versus 153 for cod). The average unit values of frozen cod and salmon are almost double that of the "lean/white fish" aggregate, and it is clear that the PrimeFish species are therefore not competing on prices in that particular segment of the French fish market. Market penetration of the PrimeFish species in France is also low, only 4.2% for frozen pangasius in 2012, beside 27.4% and 21.4¨% for Salmon and Cod respectively, other PrimeFish species are not bought enough to be analysed separately (FranceAgriMer, 2013)

The structure of the Finnish market for frozen fish is particularly simple, with one species, pollock, accounting for 80% of the market in terms of weight and 75% in terms of value. According to the data, less than 1% of Finnish households consumed pangasius in 2014 but, more surprisingly, cod consumption also appears quantitatively insignificant. Of all the project species, only salmon accounts for a non-trivial share of the frozen fish market in Finland (9%). The popularity of frozen pollock in Finland can be linked to its affordability, with an average unit value (€5.5) less than half of that of cod. As already indicated by the low expenditure elasticity of demand for frozen fish in stage 2, Finnish consumers seem to consider the frozen fish segment to be a low-quality segment and Table 26 suggests that, in that market, competition occurs mainly on prices. While Pangasius was still marginal in 2014, one can postulate that the importance of price competition in the Finnish market for frozen products could contribute to the growth in Pangasius consumption in the future.

	Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit Value (€/kg)	Budget share (%)	Number of products	Share of consuming households
FR	**All frozen fish**	1.18	10.5	8.9	12%	1038	68%
	Salmon	0.07	1.1	14.5	10%	65	13%
	Cod	0.16	2.0	12.6	19%	153	20%
	Crustacean	0.17	2.1	12.5	20%	241	26%
	Lean/White Fish	0.55	3.7	6.7	35%	344	46%
	Others	0.23	1.6	7.2	16%	235	29%
FI	**All frozen fish**	0.68	4.1	6.0	7%	127	60%
	Salmon	0.03	0.4	12.4	9%	15	8%
	Trout	0.000	0.0	5.7	0%	1	0.1 %
	Herring	0.01	0.1	6.5	1%	3	2%
	Cod	0.003	0.0	11.4	1%	6	1%
	Pangasius	0.005	0.0	5.6	1%	7	0.6 %
	Pollock	0.55	3.1	5.5	75%	59	54%
	Plaice	0.01	0.1	11.3	3%	7	4%
	Other	0.03	0.2	7.4	6%	16	9%
	Unknown	0.04	0.2	3.8	4%	13	9%

Table 26: Structure of frozen fish consumption in France and Finland (Stage 3.4)

France - Table 27 presents the Marshallian price elasticities for the frozen fish category. Expenditure elasticities strongly vary, from 0.2 for salmon to 1.6 for cod. This means that an increase in total fish expenditure results in an increase in the relative consumption share of cod, crustaceans and other fish. Conversely, it causes a decrease in the consumption share of salmon and lean/white fish. The own price elasticities are all significant and are between -1.75 for cod and -0.65 for salmon, which is in line with the literature, with salmon own-elasticity lower than cod one's (e.g Singh et al. 2012 for the US).

Cross-price elasticities reveal important substitutions between species. It is interesting to note that cross-price elasticities of salmon are higher in the frozen category than in the fresh category, me aning that frozen salmon competes more strongly with others species that fresh salmon. This result supports the previous results related to the relationship between fresh and frozen fish, and those related to the weak relationship between fresh salmon / cod and other species. Indeed, if a fresh species is not available, the consumer moves to the frozen equivalent species, leading to a weak competition between species in the fresh market. In addition, this explains the higher competition between the same species in the frozen market, as substitutions of frozen products by fresh ones seem to be less frequent (see stage2). As frozen product are mostly cut (95% of frozen fish in 2012, FranceAgriMer, 2013) it is easier for consumers to switch species. If we look at the compensated elasticities (appendix 2, table 48), we can underline that all the species are strongly in competition, except salmon with "other" were we find some complementarity. This may be partially due to the success of new food as sushi/sashimi, very popular in France and mostly based on salmon and tuna.

	Salmon	Cod	Crustacean	Lean/white Fish	Other	Fish Expenditure
Salmon	**-0.656*** (0.042)**	0.417*** (0.045)	0.178*** (0.02)	0.632*** (0.02)	-0.103*** (0.021)	**0.2*** (0.034)**
Cod	-0.09** (0.038)	**-1.759*** (0.051)**	-0.084*** (0.021)	-0.272*** (0.018)	0.082*** (0.019)	**1.612*** (0.03)**
Crustacean	-0.144*** (0.016)	0.102*** (0.02)	**-1.093*** (0.016)**	-0.129*** (0.01)	0.043*** (0.011)	**1.121*** (0.023)**
Lean/white Fish	0.312*** (0.013)	0.159*** (0.015)	0.097*** (0.008)	**-0.735*** (0.009)**	-0.077*** (0.009)	**0.588*** (0.016)**
Other	-0.525*** (0.021)	0.126*** (0.023)	-0.108*** (0.014)	-0.549*** (0.013)	**-0.933*** (0.018)**	**1.539*** (0.029)**

Table 27: Marshallian elasticities of demand for frozen fish in France (Stage 3.4)

Socio-demographic characteristics of consumers are given in Table 28. All variables are significant:

- While the frozen category is appreciated by young consumers, we find some differences across the category, as salmon and lean/white fish are more consumed by older people.
- Salmon consumption is negatively affected by household size; it is the only one in this category. This can be due to the fact that large households, while buying frozen products, choose less expensive species due to budget constraints (salmon is the most expensive species in the frozen category).
- Cod consumption is positively affected by the household size (it is one of the least expensive species in the frozen market) and negatively affected by education and the presence of a child under the age of 16. Despite a competition in frozen category, especially between salmon and cod, consumers of cod and salmon differ in their socio-demographic characteristics (older, smaller household, women shopper and higher education for salmon, with regional disparity).
- Lean and white fish consumption is positively affected by income, education and the presence of a child under the age of 16. Lean and whitefish are less expensive and more often consumed breaded, which responds to child demand for fish.

		Salmon	Cod	Crustacean	Lean/Withe Fish	Other
Age		0.024***	-0.007***	-0.005***	0.048***	-0.081***
HH size	2	-1.13***	0.153***	0.42***	0.655***	-0.531***
(ref:1)	3	-0.389***	-0.121**	0.276***	0.069**	0.093
	4	-1.342***	0.358***	0.355***	0.007	0.483***
	>=5	-1.661***	0.263***	0.395***	0.107***	0.722***
Gender of mainpurchase	(ref:Women)	0.156**	-0.738***	-0.312***	1.153***	-0.592***
Socio_economic class	Lower-average	1.772***	-0.617***	-0.256***	0.625***	-1.672***
(ref : Modest)	Upper-average	0.278***	-0.113**	-0.058*	1.511***	-2.319***
	Well-off	-0.651***	0.619***	0.081*	2.117***	-3.326***
Region	Centre-East	3.887***	-2.038***	-1.09***	0.879***	-1.448***
(ref:Paris)	Centre-West	3.91***	-1.865***	-1.165***	1.444***	-2.423***
	East	4.742***	-2.293***	-1.411***	0.943***	-1.705***
	South-West	4.212***	-2.441***	-0.711***	1.298***	-2.392***
	North	2.595***	-1.766***	-1.088***	1.909***	-1.989***
	West	4.584***	-2.11***	-1.418***	1.5***	-2.582***
	South-East	3.249***	-2.001***	-0.47***	1.019***	-1.827***
Education	Between Bac and Bac +5	0.283***	-0.114***	-0.108***	0.586***	-0.885***
ref(<= Bac)	> Bac +5	0.515***	0.061	-0.103**	0.635***	-1.411***
Owns a freezer (Ref: none)		-0.183***	-0.212***	0.286***	-0.223***	0.413***
Child <=16 (Ref: none)		-0.043	-0.469***	-0.194***	0.24***	0.496***

Table 28: Influence of socio-demographic variables on frozen fish consumption in France (Stage 3.4)

Finland - Table 29 presents the Marshallian elasticities of demand for frozen fish in Finland. The products were aggregated into only three categories because, as evident from Table 26, with the exceptions of pollock and salmon, individual species account for very small shares of the market and are purchased by only a tiny proportion of consumers. Although the expenditure elasticity for the whole group (i.e., in stage 2) was particularly low, the corresponding elasticities for individual species are close to unity. This means that while the share of the total fish budget allocated to frozen fish tends to decrease, in relative terms, as households become more prosperous, the distribution of expenditure within the frozen fish group does not vary much across species, although there is a small reallocation towards the "Other" aggregate and away from salmon. The own-price elasticities show strong statistical significance as well as the expected negative sign, but demand for pollock appears particularly inelastic, maybe reflecting that that species is already significantly cheaper than many of its competitors (e.g., cod) so that small price variations have little influence on demand. By contrast, demand for frozen salmon, a category that fetches higher prices, responds much more vigorously to prices. The cross-price Marshallian elasticities reveal that, on the whole, salmon only competes with the "Other" aggregate, but not pollock, in the frozen fish market. This could indicate that pollock is typically an entry-level product while salmon competes with species much higher on the quality ladder.

	Salmon	Pollock	Other	Group Expenditure
Salmon	**-1.747*** **	-0.034	0.866***	**0.943*** **
	(0.068)	(0.027)	(0.086)	(0.08)
Pollock	-0.027*	**-1.048*** **	0.119***	**0.97*** **
	(0.013)	(0.009)	(0.016)	(0.015)
Other	0.9***	0.151	**-2.25*** **	**1.133*** **
	(0.097)	(0.037)	(0.129)	(0.122)

Table 29: Marshallian elasticities of demand for frozen fish in Finland (Stage 3.4)

The socio-economic variables are found to have a strong influence on demand for frozen fish but, once again, the effect of a given variable clearly varies across species. Further, the magnitude of the coefficients reveals that the main effects relate to social class and the presence of a child under the age of 16: households in the higher social classes (AB) with children tend to favour consumption of salmon, while they consume relatively less of the "Other" aggregate than other households. For pollock, those two variables have little effect on demand. Table 30 also indicates that larger and older households have stronger preferences for pollock, while the relationship is opposite for the other two species aggregates (i.e., salmon and "other").

		Salmon		Pollock		Other	
Variable	**Factor level**	Estimate	SE	Estimate	SE	Estimate	SE
Age		-0.006**	0.003	0.008***	0.001	-0.012***	0.004
HH size		-0.124***	0.032	0.166***	0.007	-0.25***	0.048
Child<=16		0.502***	0.107	0.029	0.022	-0.631***	0.165
Social class	C1	-0.288**	0.127	-0.096***	0.022	0.548***	0.187
(ref. =AB)	C2	-0.188**	0.088	0.01	0.016	0.189	0.131
	DE	-0.459***	0.103	-0.164***	0.021	0.899***	0.159

Table 30: Effect of socio-demographic variables on demand for frozen fish in Finland

Stage 3.5: Analysis of demand for prepared dishes

France. Table 31 displays the structure of prepared dishes consumption in France. Prepared dishes bring all dishes together, that doesn't need anything to be the main course, as pizza, lasagna, cooked rice, pasta, and so on. The main category is the 'others' group in which species are not salmon, tuna or crustacean, but individually is not significant; or sometimes only fish or seafood is specified on the product. The importance of this subcategory underline the diversity of species used in prepared dishes, but only few are significant. The second group is composed of prepared dishes with tuna. Salmon and crustacean-based products account for around 10% and 14% of quantities respectively, and 11 and 21% of market shares respectively. The penetration rate varies from 19% for salmon group to 49% for 'others' group. Even for a named species, the variety of products in this category is really important (can be pizza with salmon as well as salmon lasagna). In this category, fish or seafood may not be the main ingredient.

Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit value (€/kg)	Budget share (%)	Share of consumtiong HHs	Number of products
Dishes	1.02	9.41	9.25	10%		1434
Salmon	0.10	1.02	10.01	11%	19%	149
Crustacean	0.14	1.93	13.63	21%	24%	310
Tuna	0.23	1.46	6.45	16%	29%	323
Others	0.55	5.00	9.14	53%	49%	652

Table 31: Structure of prepared dishes consumption in France (Stage 3.5)

Table 32 presents the Marshallian elasticities of demand for prepared dishes. Expenditure elasticities strongly vary by species from 0.5 for tuna to 1.6 for crustaceans. This means that an increase in total fish expenditure induces an increase in the consumption share of crustaceans and a decrease in that of tuna.

Own-price elasticities vary from -0.9 ('other' group) to -1.5 for crustaceans. Salmon, crustaceans and tuna consumption seem to be quite price-sensitive in this category. Indeed, seafood products are an alternative to other products based on meat or vegetable, thus it can explained the strong price elasticities. For salmon it is the most important own price elasticity across all the category, thus prepared dishes based on salmon are price sensitive. But it is also the higher expenditure elasticity, meaning that salmon based prepared dishes are viewed as higher quality compared to other categories.

Cross-price elasticities reveal important substitutions between species: tuna is the main substitute for salmon, crustaceans and 'other'. Salmon is the main substitute for tuna. But in this category it would be interesting to compare seafood products to other prepared dishes non-based on seafood products.

	Salmon	Crustacean	Tuna	Other	Fish Expenditure
Salmon	**-1.415***** (0.04)	0.132*** (0.03)	0.304*** (0.04)	-0.107*** (0.013)	**1.055***** (0.033)
Crustacean	0.003 (0.02)	**-1.502***** (0.028)	0.063** (0.025)	-0.19*** (0.009)	**1.401***** (0.027)
Tuna	0.385*** (0.034)	0.398*** (0.031)	**-1.364***** (0.05)	0.303*** (0.014)	**0.537***** (0.031)
Other	-0.019*** (0.005)	0.052*** (0.005)	0.015** (0.007)	**-0.99***** (0.003)	**0.963***** (0.006)

Table 32: Marshallian elasticities of demand for prepared dishes in France (stage 3.5)

Regarding the socio-demographic variables, it has to be reminded the very strong variability of available products in this category. Nonetheless, Table 33 shows that:

- Income affects positively demand for tuna and the 'other' aggregate, and negatively consumption of salmon and crustaceans.
- Education affects positively consumption of salmon, tuna and 'other' fish, and negatively consumption of crustaceans.
- The presence of a child under the age of 16 affects positively demand for tuna and 'other' fish, and negatively that for salmon and crustaceans.

		Salmon	Crustacean	Tuna	Other
Age		-0.083***	-0.039***	0.064***	0.026***
HH size	2	-0.854***	-0.885***	1.891***	-0.039***
(ref:1)	3	0.945***	-0.388***	0.887***	-0.566***
	4	0.085	-0.385***	1.119***	-0.337***
	>=5	2.06***	0.155*	-0.128	-0.845***
Gender of mainpurchase	(ref:Women)	0.821***	-1.194***	1.325***	-0.255***
Socio_economic class	Lower-average	-0.505***	-1.37***	1.012***	0.52***
(ref : Modest)	Upper-average	-1.371***	-1.369***	1.333***	0.711***
	Well-off	-1.595***	-1.481***	1.273***	0.893***
Region	Centre-East	-0.48***	-2.452***	4.046***	-0.292***
(ref:Paris)	Centre-West	-1.392***	-2.233***	3.792***	0.062***
	East	-0.116	-2.452***	4.257***	-0.535***
	South-West	-0.795***	-2.557***	4.295***	-0.223***
	North	0.52***	-1.389***	2.434***	-0.546***
	West	-1.802***	-2.155***	4.125***	0.022*
	South-East	-0.824***	-3.051***	5.254***	-0.376***
Education	Between Bac and Bac +5	0.184***	-1.605***	1.671***	0.072***
ref(<= Bac)	> Bac +5	0.861***	-2.17***	1.754***	0.095***
Owns a freezer (Ref: none)		-0.723***	0.285***	-0.15***	0.191***
Child <=16 (Ref: none)		-1.29***	-1.272***	1.871***	0.368***

Table 33: Effect of socio-demographic variables on demand for prepared dishes in France(stage 3.5)

Stage 3.6: Analysis of demand for other groups

France. This group is mainly composed of ready-to-eat products, as spread and surimi. As for the previous category, it is composed of very different products, with different positioning and use.

The budget share of crustacean products accounts for 57% within this category, mostly composed of cooked shrimps or mussels, while salmon, lean and other fish only account for around 10%. The penetration rate of crustacean products is quite high (73%).

Product categories	Quantities (Kg/cap/year)	Expenditure (€/cap/year)	Unit value (€/kg)	Budget share (%)	Share of consumtiong HHs	Number of products
Other	1.82	18.48	10.16	21%	84%	2656
Salmon	0.16	2.42	15.53	13%	34%	345
Cod	0.04	0.62	14.24	3%	6%	356
Hereng	0.02	0.20	9.38	1%	5%	60
Crustacean	1.18	10.47	8.87	57%	73%	978
Fat FIsh	0.09	1.29	14.94	7%	30%	253
Lean/White FIsh	0.17	1.66	9.55	9%	30%	356
Others	0.16	1.82	11.58	10%	25%	308

Table 34: Structure of 'other' group consumption in France (Stage 3.6).

Table 35 presents the Marshallian price elasticities for the residual 'other' group. Expenditure elasticities are quite homogeneous and around unity, suggesting that the share of each species is not really modified in this category when fish expenditure varies. Own-price elasticities do not vary a lot either within this category, and are around -1. Marshallian cross-price elasticities are generally significant but low and do not reveal important substitutions between species. Higher Hicksian cross-price elasticities suggest that substitutions are mainly driven by an income effect.

	Salmon	Cod	Herring	Crustacean	Fat Fish	Lean/white Fish	Other	Fish expenditure
Salmon	**-0.984*****	0.009	0.004	-0.003	-0.035***	0.002	-0.016*	**1.014*****
	(0.011)	(0.014)	(0.011)	(0.004)	(0.013)	(0.01)	(0.009)	(0.01)
Cod	0.033**	**-0.942*****	-0.031	0.061***	0.088***	-0.013	-0.037*	**0.905*****
	(0.014)	(0.05)	(0.043)	(0.008)	(0.02)	(0.02)	(0.021)	(0.015)
Herring	0.006	-0.086	**-1.045*****	-0.076***	0.052	-0.054	0.167***	**1.021*****
	(0.022)	(0.084)	(0.081)	(0.012)	(0.034)	(0.033)	(0.033)	(0.023)
Crustacean	0.006***	0.005*	-0.01***	**-0.996*****	0.023***	-0.01***	0.011***	**0.984*****
	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Fat Fish	-0.058***	0.115***	0.043	0.075***	**-1.163*****	0.07***	-0.119***	**1.022*****
	(0.021)	(0.033)	(0.028)	(0.01)	(0.038)	(0.024)	(0.02)	(0.023)
Lean/white Fish	-0.002	-0.046*	-0.038*	-0.068***	0.055***	**-1.012*****	0.053***	**1.034*****
	(0.013)	(0.026)	(0.022)	(0.006)	(0.02)	(0.022)	(0.015)	(0.015)
Other	-0.035***	-0.083***	0.091***	-0.029***	-0.095***	0.038***	**-1.034*****	**1.087*****
	(0.011)	(0.024)	(0.019)	(0.005)	(0.015)	(0.013)	(0.018)	(0.011)

Table 35: Marshallian elasticities of demand for 'other' fish in France (stage 3.6)

Table 36 shows that socio-demographic variables are highly significant. :

- Household size affects consumption of salmon and herring negatively, and consumption of cod, crustaceans, lean fish and other fish positively.
- Income affects positively consumption of fat fish, lean fish and 'other' fish, but negatively consumption of salmon and cod.
- Education affects positively demand for salmon, herring, lean fish and 'other' fish, but negatively demand for fat fish and cod.
- The presence of a child younger than 16 in the household affects positively consumption of cod and herring, but negatively that of fat fish, lean fish and 'other' fish.

		Salmon	Cod	Herring	Crustacean	Fat Fish	Lean/white Fish	Other
Age		-0.05***	0.02***	-0.044***	0.016***	-0.039***	0.014***	0.025***
HH size	2	-0.825***	0.168***	-1.185***	0.104***	0.173***	0.328***	0.712***
(ref:1)	3	-1.243***	0.995***	-1.945***	0.185***	-0.18**	0.431***	0.597***
	4	-1.397***	1.068***	-1.39***	0.214***	-0.274***	0.515***	0.264***
	>=5	-2.08***	1.813***	-3.395***	0.273***	0.24***	0.557***	0.782***
Gender of mainpurchase	(ref:Women)	-0.167***	2.289***	-0.738***	0.368***	-1.966***	-0.767***	-1.072***
Socio_economic class	Lower-average	-0.423***	-0.547***	0.739***	0.075***	-0.254***	0.192***	0.455***
(ref : Modest)	Upper-average	-0.763***	-1.202***	0.461***	0.038***	0.413***	0.354***	1.257***
	Well-off	-0.62***	-1.338***	-0.267***	-0.051***	0.809***	0.629***	1.432***
Region	Centre-East	-0.471***	-0.17**	4.441***	0.281***	-1.108***	0.43***	-2.353***
(ref:Paris)	Centre-West	0.067**	0.909***	0.38***	0.146***	-0.661***	0.496***	-1.768***
	East	0.324***	-3.024***	9.218***	0.157***	-0.986***	-0.288***	-1.871***
	South-West	-0.36***	0.632***	6.211***	0.479***	-1.644***	-0.084	-4.232***
	North	-0.376***	-1.267***	7.309***	0.233***	-1.032***	-0.208***	-2.235***
	West	0.193***	0.775***	1.07***	-0.039***	0.359***	0.425***	-2.254***
	South-East	-0.762***	0.427***	5.834***	0.474***	-1.634***	0.101*	-3.467***
Education	Between Bac and Bac +5	-0.271***	-0.588***	0.04	-0.004	-0.072*	0.656***	0.45***
ref(<= Bac)	> Bac +5	0.207***	-0.668***	0.299***	0.021***	-0.913***	0.254***	0.719***
Owns a freezer (Ref: none)		-0.403***	0.512***	-0.008	0.106***	-0.218***	0.249***	-0.519***
Child <=16 (Ref: none)		0.074***	0.643***	0.813***	0.054***	-0.468***	-0.302***	-0.871***

Table 36: Effect of socio-demographic variables on demand for 'other' fish in France (stage 3.6)

5. Synthesis

5.1 Socio-demographic drivers of fish consumption

As previously indicated, socio-demographic variables taken into account in this study are highly significant in most cases, in Finland as well as in France. Age, income, education, household size, and the presence of young children often affect the decision to consume fish products and the trade-offs between fish categories defined by the type of processing method (frozen, canned, fresh…), and between species within each of these categories. This statement may justify implementing differentiation strategies by targeting various consumer segments. However, it is difficult to identify simple targets, as the socio-economic drivers of consumption vary depending on the product category, the species and the country. The fish market appears to be very complex as no variable influences demand in the same direction across all categories.

- Age

Age is often a significant variable in both countries. However, the coefficients are generally small, meaning that other socio-demographic variables influence more strongly fish consumption. It turns out that, in France as well as in Finland, age favours the consumption of fresh, smoked and canned products. Conversely, age reduces the probability to consume frozen products in both countries (and prepared dishes in France).

In France, age affects the fresh fish market by favouring salmon, cod, crustacean, and lean fish consumption and by disfavouring trout, seabass, fat fish and 'other' consumption. It affects the smoked fish market by favouring herring and fat fish consumption, and disfavouring trout consumption. It affects canned fish market, by favouring lean fish, tuna, sardine consumption and disfavouring crustacean and mackerel consumption. It affects the frozen market by favouring salmon and lean fish consumption.

In Finland, age also moderately influences consumption across the different categories of fish products. In the fresh market, older people tend to consume more salmon and herring and less 'other' products. In the smoked market, older people tend to consume more salmon, herring, cod, and domestic fish, and less 'other' group. In the canned market, older people tend to consume more herring, anchovies, and less sardines and mackerel. In the frozen market, older people tend to consume more pollock and less salmon.

- Economic and social characteristics of households

Economic and social characteristics of households have significant impact on fish consumption in France and Finland. But the direction is not always the same in both countries and the effect is not always correlated to product prices. Note also that income and education do not always affect consumption in the same direction.

In some cases, higher income increases the probability to consume a fish category whose price is not necessarily the highest. In that case, the effect is likely related to preference issues rather than to budgetary constraints of households. Higher income and education level favour the consumption of smoked products in Finland and France, which can be understood as salmon price is the highest across processing types. In France, they also favour consumption of canned fish and other preparations and disfavour consumption of fresh, frozen and prepared dishes. Higher social class in Finland decreases the probability to consume more fresh, canned and frozen products.

In France, higher income increases the probability to consume more fresh salmon, trout and cod, more smoked trout and herring, more canned tuna and salmon, more frozen lean fish, and more prepared dishes based on crustacean products. Conversely, higher income decreases the probability to consume seabass, fat fish, lean fish and 'other' in the fresh market, smoked fat fish, and canned mackerel.

In Finland, upper social class tends to consume more fresh salmon, trout and 'other', and less herring. Note that fresh herring price is the lowest price in the fresh category. Upper social class consumes also more smoked, frozen and canned salmon, and less smoked trout, canned tuna.

- Structure of the household (size, and presence of young children

The structure of the households affects in many cases fish consumption. The size of the family may influence consumption through budgetary or time constraints for cooking. The presence of children under the age of 16 may affect fish consumption in relation to preference and convenience issues.

In France, household size increases the probability to consume more smoked and canned fish, and less fresh and prepared dishes. The presence of young children favours the consumption of canned and frozen fish, and disfavours the consumption of fresh and smoked fish. In Finland, this variable tends to favour the consumption of canned, frozen and fresh fish, and disfavour smoked fish consumption. Household size increases the consumption of fresh and canned fish and decreases smoked fish consumption.

In Finland, the presence of young children tends to increase the consumption of fresh salmon, herring and trout, smoked cod, canned anchovies and sardines, and frozen salmon. It tends to decrease the consumption of fresh domestic fish, smoked salmon, canned tuna and mackerel. Household size favours the consumption of canned tuna and frozen pollock, and disfavours the consumption of fresh and canned herring, and frozen salmon.

- Region

In France, the regions in which people live have often very strong impact on fish consumption. It is well known about fresh fish, with higher consumption levels in Paris and the West region, and to a lesser extent in the South-West region. But this variable also affects the other markets. Interestingly, canned fish and prepared dishes consumption is symmetrically lower in Paris, West and South-West regions. Smoked products are much more consumed in Paris than elsewhere in France. These results confirm the existence of different patterns (and habits) of fish consumption across French regions.

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	France						Finland				
		Age	Household size	Income	Education	Child under 16		Age	Household size	Social class	Child under 16
Stage 2	**Fresh**	(+)	-	-	-	-	**Fresh**	(+)	+	(-)	+
	Marinated/ smoked	(+)	+	+	+	-	**Marinated/ smoked**	(+)	-	+	-
	Canned	(+)	+	+	+	+	**Canned**	(+)	+	-	+
	Frozen	(-)		-	-	+	**Frozen**	(-)			+
	Prepared dishes	(-)	-	-	-	-					
	Other preparation		+	+	+	+					
Stage 3.1 Fresh fish	**Salmon**	(+)	+	+	-	-	**Salmon**	(+)		+	+
	Trout	(-)	-	+	-	-	**Trout**			+	+
	Cod	(+)	+	+	-	+	**Herring**	(+)	-	-	+
	Seabass/ Bream	(-)	-	-	+	+	**Domestic, fresh water**				-
	Crustacean	(+)			-		**Other**	(-)	+	+	-
	Fat fish	(-)		-	-	-					
	Lean/white fish	(+)		-	+						
	Other	(-)		-	+						
Stage 3.2 Marinated/ smoked fish	**Salmon**			(-)	(-)	(+)	**Salmon**	(+)		+	-
	Trout	(-)	-	+	+	-	**Trout**			-	
	Herring	(+)	(-)	+	+	-	**Herring**	(+)			
	Fat fish	(+)	-		-	+	**Cod**	(+)			+
	Lean/white fish		+	(+)	-	+	**Domestic, fresh water**	(+)			
	Other	(+)	+	(-)	-	-	**Other**	(-)			-

Table 37a: Influence of socio-demographic variables on fish consumption

France		Age	Household size	Income	Education	Child under 16
Stage 3.3 Canned fish	Salmon	(-)	+	+	+	-
	Crustacean	(-)				
	Lean/white fish	(+)	+	(+)	(+)	-
	Tuna	(+)	-	+	+	
	Sardine	(+)	-		+	
	Mackerel	(-)	-	-	-	
	Other					
Stage 3.4 Frozen fish	Salmon	(+)	-	(+/-)	+	
	Cod		+	(-/+)		-
	Crustacean		+	(-/+)	-	-
	Lean/white fish	(+)	+	+	+	+
	Other		+	-	-	+
Stage 3.5 Prepared dishes	Salmon	(-)		-		-
	Tuna	(-)	+	-	+	-
	Crustacean	(+)	-	+	-	+
	Other	(+)	-	+		+
Stage 3.6 Other	Salmon	(-)	-	-		
	Cod	(+)	+	-	-	+
	Herring	(-)	-		+	+
	Crustacean	(+)	+			
	Fat fish	(-)		-	-	-
	Lean/white fish	(+)	+	-/+	+	-
	Others	(+)	+	-/+	+	-

Finland		Age	Household size	Social class	Child under 16
Stage 3.3 Canned fish	Herring	(+)	-	+	
	Tuna		+	-	-
	Anchovies	(+)			+
	Sardines	(-)			+
	Mackerel	(-)			-
	Other	(+)	-	+	
Stage 3.4 Frozen fish	Salmon		-	+	+
	Pollock		+	+	
	Other		-		-

Table 37b: Influence of socio-demographic variables on fish consumption

5.2 Economic drivers of fish consumption: unconditional elasticities and simulations of scenarios at the level of species

While the analysis of the conditional elasticities at each stage helps understand the relationships of substitution and complementarity among relatively similar products, it has been noted already in the methodology section that real-world consumers do not impose upon themselves artificial constraints regarding how they may allocate their budget (e.g., by fixing a fresh fish budget for instance). To address this issue, we now present the unconditional elasticities of demand for fish products. In the Finnish case, those elasticities are calculated by assuming that only total consumption expenditure (i.e., food and non-food expenditure) satisfies a fixed budget constraint, while in the French case fixity of the food budget is assumed. Our results are then summarized by identifying for each type of processing method and each PrimeFish species, the main products competing for the consumer's resources. Finally, some simple price and revenue simulations are used to derive the implications of changes in the economics for demand for PrimeFish species.

Finland - Table 38 presents the results obtained by application of the formulae proposed by Carpentier and Guyomard (2001). The highlighted areas of the price matrix give the substitutions within the stage-3 groups, modified to take account of the possibility that the total food budget, fish budget, and stage-3 budgets may now vary. On the whole, the unconditional own-price elasticities do not differ too drastically from their conditional counterparts. The two sets of elasticities are very close to each other for most product categories, with exceptions for the products that account for a large expenditure share in stage 3. For instance, the own-price elasticity of demand for Pollock is -1.04 in its conditional form but only -0.39 in its unconditional form. Because that species accounts for 75% of expenditure of frozen fish, consumers respond to an increase in its price by raising their frozen fish budget, hence limiting the decrease calculated while assuming constancy of that budget. The same type of phenomenon is observed for the within-group cross-price elasticities: those are similar to their conditional counterparts except for those species accounting for a large share of the stage 3 budget, e.g., pollock in the frozen category, salmon in the fresh category, tuna and herring in the canned category, and salmon and trout in the smoked category. We note in particular that the unconditional elasticities, as compared to the conditional ones, depict stronger substitutability between salmon and trout in the fresh fish category, but weaker substitutability between those same two species in the smoked fish category.

The completely new elements in Table 38 are the cross-price elasticities of demand for pairs of goods belonging to different stage-3 groups (i.e., the parts of the price matrix in Table 38 that are not shaded). Those elasticities reveal little substitution between fresh fish products and non-fresh fish products, but for the other stage-3 groups cross-category substitutions are observed. The large cross-price elasticities (i.e., >0.1) affecting demand for Primefish species appear in red in the table, which allows us to identify five new important relationships of substitutability:

- Demands for smoked salmon, trout and herring respond strongly to the prices of canned herring and canned tuna.
- Demand for canned herring responds strongly to the price of smoked salmon and trout.
- Demand for frozen salmon responds strongly to the prices of smoked trout and salmon.

% Δ Quantity		1% Δ Price	Fresh					Smoked/marinated						Canned						Frozen			1% Δ expend.
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
Fresh	**Salmon**	(1)	**-0.86**	0.21	-0.35	0.24	0.32	-0.02	-0.02	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.65
	Trout	(2)	0.38	**-0.71**	-0.19	-0.11	-0.10	-0.03	-0.03	0.00	0.00	-0.01	0.00	-0.01	-0.02	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.88
	Herring	(3)	-2.61	-0.79	**3.02**	0.39	-0.94	-0.03	-0.03	0.00	0.00	-0.01	0.00	-0.02	-0.02	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	1.05
	Domestic, FW	(4)	0.69	-0.25	0.16	**-1.66**	-0.22	-0.04	-0.04	0.00	0.00	-0.01	-0.01	-0.02	-0.03	0.00	0.00	0.00	0.00	0.00	-0.02	-0.01	1.33
	Other	(5)	0.86	-0.33	-0.46	-0.29	**-1.65**	-0.06	-0.05	0.00	0.00	-0.01	-0.01	-0.03	-0.04	0.00	0.00	0.00	-0.01	0.00	-0.03	-0.01	1.80
Smoked	**Salmon**	(6)	-0.04	-0.03	0.00	-0.02	-0.02	**-1.49**	-0.26	0.14	-0.17	0.02	-0.21	**0.33**	**0.47**	0.03	0.01	0.01	0.07	0.01	**0.10**	0.02	0.88
	Trout	(7)	-0.04	-0.02	0.00	-0.01	-0.01	-0.23	**-1.22**	-0.20	-0.29	0.09	0.26	**0.28**	**0.40**	0.03	0.01	0.01	0.06	0.01	0.09	0.02	0.74
	Herring	(8)	-0.03	-0.02	0.00	-0.01	-0.01	0.51	-0.85	**-2.91**	0.31	1.31	0.61	**0.20**	**0.29**	0.02	0.00	0.01	0.04	0.01	0.06	0.02	0.54
	Cod	(9)	-0.02	-0.01	0.00	-0.01	-0.01	-0.50	-0.93	0.27	**-0.96**	0.88	0.51	0.17	0.24	0.02	0.00	0.01	0.03	0.01	0.05	0.01	0.45
	Domestic, FW	(10)	-0.05	-0.03	0.00	-0.02	-0.02	-0.17	0.02	0.78	0.62	**-2.78**	-0.63	0.35	0.51	0.04	0.01	0.02	0.07	0.01	0.11	0.03	0.94
	Other	(11)	-0.06	-0.04	-0.01	-0.02	-0.02	-1.26	0.41	0.44	0.42	-0.99	**-2.09**	0.47	0.68	0.05	0.01	0.02	0.10	0.02	0.14	0.04	1.26
Canned	**Herring**	(12)	-0.04	-0.02	0.00	-0.01	-0.01	**0.56**	**0.50**	0.03	0.01	0.13	0.07	**-1.09**	-0.28	-0.28	-0.11	0.22	0.09	-0.03	-0.23	-0.06	0.57
	Tuna	(13)	-0.04	-0.02	0.00	-0.01	-0.01	0.57	0.52	0.03	0.01	0.14	0.07	-0.20	**-1.33**	0.54	0.01	-0.35	-0.17	-0.03	-0.24	-0.06	0.59
	Anchovies	(14)	-0.04	-0.02	0.00	-0.01	-0.01	0.57	0.51	0.03	0.01	0.14	0.07	-1.01	1.98	**-3.23**	1.59	-0.18	-0.62	-0.03	-0.24	-0.06	0.58
	Sardines	(15)	-0.02	-0.01	0.00	-0.01	-0.01	0.32	0.29	0.02	0.01	0.08	0.04	-0.43	0.15	2.57	**-7.69**	5.26	-0.37	-0.02	-0.13	-0.03	0.33
	Mackerel	(16)	-0.04	-0.02	0.00	-0.01	-0.01	0.59	0.53	0.03	0.01	0.14	0.08	0.48	-1.56	-0.19	3.08	**-3.51**	0.15	-0.03	-0.25	-0.06	0.60
	Other	(17)	-0.04	-0.03	0.00	-0.02	-0.02	0.71	0.64	0.03	0.02	0.17	0.09	-0.03	-0.80	-0.45	-0.21	0.10	**-0.64**	-0.04	-0.30	-0.07	0.72
Frozen	**Salmon**	(18)	0.01	0.01	0.00	0.00	0.01	**0.18**	**0.16**	0.01	0.00	0.04	0.02	-0.19	-0.28	-0.02	0.00	-0.01	-0.04	**-1.67**	0.61	1.00	0.23
	Pollock	(19)	0.01	0.01	0.00	0.00	0.01	0.19	0.17	0.01	0.00	0.04	0.02	-0.20	-0.28	-0.02	0.00	-0.01	-0.04	0.06	**-0.39**	0.25	0.23
	Other	(20)	0.02	0.01	0.00	0.01	0.01	0.22	0.20	0.01	0.00	0.05	0.03	-0.23	-0.33	-0.02	0.00	-0.01	-0.05	1.00	0.92	**-2.09**	0.27

Table 38: Unconditional Marshallian elasticities of demand for fish products in Finland

Altogether, the analysis of substitutability among the 19 product categories considered in Stage 3 allows us to identify the main competitors of PrimeFish species, differentiated by processing method (Table 39). That table, which summarises qualitatively the analysis of demand, generates general insights that complement the specific results presented in previous sections. It is first evident that, unsurprisingly, all nine fish products based on PrimeFish species have competitors. However, which species compete with each other usually depends on the processing method. Thus, while salmon is the main species competing with trout in the chilled market, it is herring, both smoked and canned, that substitutes most strongly for smoked trout. The analysis also reveals that, although the Primefish species account for the bulk of total fish consumption in Finland, competition with other non-PrimeFish species is quantitatively significant. In particular, the domestically produced fresh water species including pike-perch, whitefish and vendace, compete strongly with PrimeFish species in three of the four market segments (the exception being the market for frozen fish).

	PrimeFish Species	**Fresh**			**Smoked**				**Canned**	**Frozen**
Main competitors		Salmon	Trout	Herring	Salmon	Trout	Herring	Cod	Herring	Salmon
Fresh	Salmon		X							
	Trout	X								
	Herring									
	Domestic, FW	X		X						
	Other	X								
Smoked	Salmon						X		X	X
	Trout								X	X
	Herring				X			X		
	Cod						X			
	Domestic, FW						X	X	X	
	Other					X	X	X		
Canned	Herring				X	X	X	X		
	Tuna				X	X	X	X		
	Anchovies									
	Sardines									
	Mackerel								X	
	Other									
Frozen	Salmon									
	Pollock				X					X
	Other									X

Table 39: Main competitors of PrimeFish species, by market segments defined on the basis of processing method (Finland)

In order to derive general quantitative results at the species level regardless of processing method, which may be more useful for primary producers, we now turn to some simple simulations of price increases and expenditure growth based on two strong simplifying assumptions: 1- That in the species-specific price scenarios, all products derived from the species whose price increases undergo the same relative price variation (i.e., in the "Salmon Price +10%" scenario, both the price of fresh salmon and that of smoked salmon rise by 10%); 2- That all products within a species can be aggregated by adding up physical units. Under those assumptions, the results are presented in Table 40. Focusing first on the last two columns of the table, we observe that a 10% increase in total consumption expenditure (i.e., expenditure allocated to food and non-food consumption) results in a 7.1% increase in demand for fish, but that the allocation of that increase varies markedly across species. Among PrimeFish species, trout consumption increases the most in relative terms, while cod and herring consumption increases the least. Thus, the relative decline in herring consumption presented previously may at least in part be related to the growing income of Finnish households. The species whose consumption expands the most are, however, not those forming the primary focus of PrimeFish, as they correspond to the "Domestic, FW" aggregate including pike-perch, whitefish and vendace. Although those domestically produced species still account for a limited market share, they are thus expected to grow in importance in the future. This contrasts sharply with other non-PrimeFish species such as pollock whose demand appears to respond very little to total consumption expenditure.

The price scenarios consider increases in the prices of the three main PrimeFish species in Finland as well as the main competing species of quantitative significance ("Domestic FW" aggregate, tuna, pollock). Investigating the table horizontally generates some general conclusions regarding demand for those three main PrimeFish species in Finland:

- Demand for salmon is almost price iso-elastic since, overall, a 10% increase in its price results in a 10.1% decrease in consumption. Finnish consumers can therefore be described as price sensitive as far as that species is concerned. Trout is an important competitor, but the cross-price effect is small: a 10% increase in the price of trout results in a limited 1% increase in the demand for salmon. The analysis identifies, instead, the domestically produced fresh water species as the main species competing with salmon in the final consumer market: a 10% decrease in the price of those species results in an almost 2% decline in consumption of salmon.
- Demand for trout is also relatively price elastic, a 10% increase in its price resulting in a 9.3% decrease in its demand. The analysis identifies salmon but also tuna as the main competitors of trout, although the levels of substitutability remain in both cases limited.
- Demand for herring, unlike demand for salmonids, is particularly inelastic, which indicates that, as a group, an increase in price of that species would raise revenue from its sale. This may also indicate that Finnish consumers rank non-price attributes over price attributes when purchasing herring. Salmon, but also the domestically produced fresh water species, represent the main competing species.

Given that consumption of cod and pangasius is highly marginal in Finland, and that the data set upon which the estimates are based contained only few transactions involving those species, the results with respect to cod and pangasius should be treated with caution. With that caveat in mind, Table 40 identifies herring and the domestically produced freshwater species as the main species competing with cod for consumers' budgets, while pangasius competes primarily with salmon but also pollock.

Demand \ Scenarios	Salmon Price +10%		Trout Price +10%		Herring Price +10%		Domestic FW pr. +10%		Tuna price +10%		Pollock Price + 10%		Expenditure +10%	
	ΔQ (kg/cap/year)	% ΔQ	ΔQ (kg/cap/year)	% ΔQ	ΔQ (kg/cap/year)	% ΔQ	ΔQ (kg/cap/year)	% ΔQ	ΔQ (kg/cap/year)	% ΔQ	ΔQ (kg/cap/year)	% ΔQ	ΔQ (kg/cap/year)	% ΔQ
All fish	-0.11	-1.9 %	-0.04	-0.6 %	-0.09	-1.5 %	-0.01	-0.2 %	-0.09	-1.5 %	-0.04	-0.6 %	0.41	7.1 %
By species														
Salmon	-0.20	**-10.1 %**	0.02	1.0 %	-0.04	-2.1 %	0.04	1.9 %	0.01	0.7 %	0.00	0.2 %	0.13	6.9 %
Trout	0.01	1.2 %	-0.10	**-9.3 %**	-0.01	-1.0 %	0.00	-0.4 %	0.02	1.4 %	0.00	0.2 %	0.09	8.3 %
Herring	-0.01	-1.6 %	0.01	1.1 %	-0.02	**-3.2 %**	0.02	2.6 %	-0.01	-1.8 %	-0.01	-1.5 %	0.05	6.7 %
Cod	0.00	-3.9 %	0.00	-8.8 %	0.00	3.4 %	0.00	7.6 %	0.00	2.1 %	0.00	0.4 %	0.00	5.7 %
Pangasius	0.001	11.7 %	0.000	1.2 %	0.000	-2.6 %	0.00	0.1 %	0.00	-2.9 %	0.00	7.8 %	0.00	4.9 %
Seabass/bream	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Domestic FW	0.01	3.5 %	-0.01	-1.9 %	0.02	4.8 %	-0.07	**-20.6 %**	0.01	1.6 %	0.00	0.2 %	0.04	12.0 %
Pollock	0.01	2.6 %	0.01	1.8 %	-0.01	-1.9 %	0.00	0.5 %	-0.02	-2.8 %	-0.02	**-3.9 %**	0.01	2.3 %
Tuna	0.03	5.1 %	0.03	5.0 %	-0.01	-1.8 %	0.01	1.2 %	-0.09	**-13.3 %**	-0.02	-2.4 %	0.04	5.9 %
Other	0.02	5.8 %	0.00	1.2 %	-0.01	-1.8 %	-0.01	-1.6 %	0.00	-0.7 %	0.00	1.3 %	0.04	10.3 %
By processing type														
Fresh	-0.13	-4.7 %	-0.05	-1.7 %	-0.02	-0.9 %	-0.01	-0.2 %	-0.01	-0.2 %	0.00	-0.2 %	0.23	8.5 %
Smoked/mar.	-0.07	-7.0 %	-0.07	-6.8 %	0.02	2.3 %	-0.02	-2.2 %	0.05	4.4 %	0.01	0.9 %	0.08	8.1 %
Canned	0.07	5.1 %	0.07	4.9 %	-0.07	-5.3 %	0.02	1.2 %	-0.11	-8.0 %	-0.03	-2.4 %	0.08	5.8 %
Frozen	0.02	3.2 %	0.01	1.8 %	-0.01	-1.9 %	0.00	-0.5 %	-0.02	-2.9 %	-0.01	-1.5 %	0.02	2.4 %

Table 40: Impact of exogenous changes in prices and consumption expenditure on demand for PrimeFish and other species in Finland

France - The French results are organised in three tables similar in their structure to those presented above for Finland. Table 41 first presents the matrix of unconditional (Marshallian) price elasticities for the 26 fish product categories considered in Stage 3. Here again, within groups defined by level of processing and corresponding to the shaded areas of the table, the unconditional elasticities do not differ drastically from their conditional counterparts discussed in previous sections. Thus, the table confirms that there is little substitution among fresh fish species, but that demands for the different types of fresh fish are rather responsive to their own prices. This suggests that there is little to gain for retailers and other stakeholders by modifying the prices of their products, or in other words that pricing strategies adopted to date have been near optimal (at least at an aggregated level).

In the case of smoked fish, however, the large share of one species, salmon, in the category causes noticeable differences between conditional and unconditional elasticities of demand for salmon and its main substitutes. In the more realistic setting in which the smoked fish budget is now allowed to vary, we note that the own-price elasticity of demand for salmon becomes very small (again due to a large income effect), which we interpret as indicating that smoked salmon may still be viewed by French consumers as a form of luxury good, despite important communication effort from the industry to change consumers perception, and make smoked salmon become a weakly product. The cross-price elasticities with respect to the price of salmon also indicate strong substitutability with other smoked species, including trout, herring, lean white fish and other fish. Similarly in the canned fish market, where tuna accounts for a relatively large budget share, we note that the unconditional elasticities, when compared with their conditional counterparts, reveal stronger competition between tuna and its main substitutes, particularly salmon but also mackerel, sardines and lean/white fish. For the frozen fish market, relaxation of the stage-3 budget constraint does not put to light any new important relationship of substitutability among species, except between salmon and lean/white fish and between cod and salmon, hence confirming that cod has few competitors on that market.

The new sections of the table of unconditional elasticities (non-shaded areas) reveal few substitutions between products belonging to different stage-3 groups except for canned tuna and different species of fresh fish, as well as between several types of smoked fish and crustaceans. Substitutions between fresh salmon and a set of smoked products (salmon, trout, herring, and fat fish) can be also identified but the coefficients are small (below 0.1). This reveals that substitution between fresh and frozen fish, as developed in the previous stage, may not be very strong, even if they still existing and is higher for fresh products substitution than for frozen. Apart the exceptions related to the substitutions crustaceans/smoked products, fresh salmon / smoked products and canned tuna/fresh fish, this suggests that the different markets (fresh, smoked, canned, frozen) are quite separated and that consumers do not switch a lot from one market to another by comparing prices. The reason is likely that each market responds to specific consumer expectations.

It is interesting to note that the exceptions, namely the substitution crustacean / smoked fish as well as the substitution canned tuna / fresh fish, can be understood as these products may have the same role in the meal. It is also interesting to note that the relation is not symmetrical: if canned tuna price increases, fresh fish consumption increases, but when fresh fish price increases, canned tuna consumption does not increase.

We then pursue the synthesis in Table 42, which summarizes qualitatively the main competitors of PrimeFish species, differentiated by processing method. The analysis identifies for all PrimeFish products some competitors. In most cases, competitors are in the same market. Within the fresh fish group, the strongest substitutions actually occur with a non-fresh product, namely smoked fish, but they are small and below 0.1 and there is no evidence of significant competition among PrimeFish species. For the three other stage-3 groups, the situation is different since we find strong within-group competition, notably among PrimeFish species for smoked products, but few significant cross-group substitutions.

Finally, Table 43 summarizes the analysis by simulating the effect of simple price and expenditure scenarios on demand for PrimeFish species, using the same simplifying assumptions as in the Finnish case. Starting from the last column, we note that demand for all PrimeFish species, but particularly cod as well as seabass, responds strongly to an increase in food expenditure, and significantly more so than demand for other fish (considered as an aggregate category). Thus, one can anticipate that PrimeFish species will occupy a rising market share of food expenditure as French households become more prosperous in the future, even in the case of herring (although the relative share of expenditure on herring in total fish expenditure should remain fairly stable). In that expenditure dimension, the prospects of demand for PrimeFish species therefore look brighter in France than in Finland. [7]

Turning to the price scenarios, and focusing on demand for the five PrimeFish species of interest (shaded area), several results stand out. Overall (i.e., considering all processing methods), demand for salmon is rather price inelastic and responds little to the prices of other species, although some limited substitutions occur with trout, cod, and other lean-white fish. However, salmon prices have a strong influence on demand for trout but also herring, and those results taken together illustrate that relationships of substitutability are often asymmetric. In this case, the price of the species that occupies a large market (share) has a strong influence on demand for more minor species (trout), but the reverse is not true. This preference for salmon in France is important, as it allow this sector to be stronger in case of negative shock. Indeed, diffusion of a critical documentaries broadcast on French TV on salmon farming, impacted salmon consumption on the end of 2013 right after the diffusion, and penalised sales in 2014 but the consumption of salmon restarted in 2015 and meet level reached prior to the crisis.

Trout and herring are clear substitutes and often display similar patterns of substitutability with other species; in particular demand for both species responds significantly to the prices of fat fish and lean white fish. The last two PrimeFish species (cod and seabass) display no substitutability with any Primefish species, and little with non-PrimeFish species, the only substitution of note taking place with canned tuna.

Altogether, those price simulations give a picture of the French fish market where salmon dominates in the sense that its demand is mainly driven by its own price, but its price influences demand for many other species. By contrast, while demands for herring and trout respond to own-prices, they are also

[7] Note that French results are given holding the food expenditure constant, while Finnish results are given holding the total expenditure constant.

strongly influenced by salmon prices, each other's prices, as well as other prices. Cod and seabass, meanwhile, appear to form a separate market segment where little substitution with other species takes place, maybe because those fishes lie higher up on the quality ladder.

		1% Δ Price	Fresh								Smoked						Canned							Frozen					1% Δ
% Δ Quantity			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Expend.
Fresh	**Salmon**	1	**-1.03**	-0.03	0.00	-0.02	-0.07	-0.03	-0.02	-0.03	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	**0.10**	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.65
	Trout	3	-0.01	-0.08	**-0.95**	-0.05	-0.05	-0.10	0.09	-0.05	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	**0.10**	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.63
	Cod	2	-0.05	**-1.02**	-0.02	0.01	-0.08	-0.01	-0.06	-0.02	-0.20	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	**0.10**	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.69
	Seabass/Bream	4	-0.07	0.00	-0.03	**-0.96**	-0.07	0.03	-0.12	-0.01	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	**0.10**	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.68
	Crustacean	5	-0.04	-0.03	0.00	-0.01	**-1.07**	-0.02	-0.03	-0.02	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.67
	Fat Fish	6	-0.04	0.00	-0.03	0.03	-0.06	**-1.02**	-0.04	-0.03	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.62
	Lean/white Fish	7	-0.03	-0.05	0.03	-0.06	-0.07	-0.04	**-0.99**	-0.03	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.68
	Other	8	-0.06	-0.02	-0.02	0.00	-0.06	-0.04	-0.03	**-1.00**	-0.19	-0.02	-0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.03	0.05	0.00	0.00	0.02	0.02	0.01	0.02	1.66
Smoked	**salmon**	9	0.07	0.04	0.00	0.01	**0.11**	0.04	0.04	0.03	**-0.03**	0.14	0.03	-0.23	-0.01	0.28	-0.01	-0.07	-0.02	-0.48	-0.13	-0.22	-0.01	0.00	0.00	0.00	-0.01	0.00	1.33
	Trout	10	0.06	0.03	0.00	0.01	**0.09**	0.04	0.04	0.03	1.05	**-1.46**	0.25	3.11	0.15	-2.84	-0.01	-0.06	-0.01	-0.40	-0.11	-0.18	-0.01	0.00	0.00	0.00	0.00	0.00	1.12
	Herring	11	0.07	0.04	0.00	0.01	**0.10**	0.04	0.04	0.03	0.77	0.34	**-0.56**	0.11	0.14	-0.59	-0.01	-0.07	-0.01	-0.45	-0.12	-0.20	-0.01	0.00	0.00	0.00	-0.01	0.00	1.26
	Fat Fish	12	0.14	0.08	0.01	0.02	0.22	0.09	0.09	0.07	-0.45	6.09	0.08	**-13.14**	3.22	3.80	-0.02	-0.15	-0.03	-0.99	-0.26	-0.44	-0.03	0.00	-0.01	-0.01	-0.01	-0.01	2.74
	Lean/white Fish	13	0.04	0.02	0.00	0.01	0.06	0.03	0.03	0.02	0.82	0.35	0.26	2.72	**-5.33**	1.59	0.00	-0.04	-0.01	-0.27	-0.07	-0.12	-0.01	0.00	0.00	0.00	0.00	0.00	0.75
	Other	14	0.05	0.03	0.00	0.01	0.08	0.03	0.03	0.02	2.58	-5.41	-0.72	3.85	1.93	**-1.90**	-0.01	-0.05	-0.01	-0.34	-0.09	-0.15	-0.01	0.00	0.00	0.00	0.00	0.00	0.94
Canned	**salmon**	15	-0.06	-0.03	0.00	-0.01	-0.09	-0.04	-0.04	-0.03	-0.42	-0.04	-0.03	-0.01	0.00	0.00	**-1.11**	-0.24	0.37	0.64	0.24	0.22	0.23	0.00	0.00	0.00	0.00	0.00	0.71
	Crustacean	16	-0.12	-0.07	-0.01	-0.02	-0.19	-0.08	-0.08	-0.06	-0.90	-0.09	-0.07	-0.02	-0.01	-0.01	-0.26	**-0.40**	-0.30	0.47	0.12	0.50	-0.20	0.00	0.01	0.01	0.00	0.01	1.52
	Lean/white Fish	17	-0.05	-0.03	0.00	-0.01	-0.08	-0.03	-0.03	-0.03	-0.39	-0.04	-0.03	-0.01	0.00	0.00	0.39	-0.39	**-0.67**	1.54	-0.14	-0.96	0.61	0.00	0.00	0.00	0.00	0.00	0.66
	Tuna	18	-0.08	-0.04	0.00	-0.01	-0.12	-0.05	-0.05	-0.04	-0.55	-0.05	-0.04	-0.01	0.00	0.00	0.03	0.00	0.23	**-0.31**	0.17	0.15	-0.02	0.00	0.01	0.00	0.00	0.00	0.94
	Sardine	19	-0.08	-0.05	0.00	-0.01	-0.12	-0.05	-0.05	-0.04	-0.58	-0.06	-0.04	-0.01	0.00	0.00	0.05	0.06	-0.15	0.64	**-0.82**	0.27	0.16	0.00	0.01	0.00	0.00	0.00	0.99
	Mackerel	20	-0.11	-0.07	-0.01	-0.02	-0.17	-0.07	-0.07	-0.05	-0.83	-0.08	-0.06	-0.02	-0.01	-0.01	-0.04	0.27	-0.55	0.53	0.19	**-0.54**	0.14	0.00	0.01	0.01	0.00	0.01	1.41
	Other	21	-0.05	-0.03	0.00	-0.01	-0.08	-0.03	-0.03	-0.02	-0.39	-0.04	-0.03	-0.01	0.00	0.00	0.23	-0.16	0.57	0.37	0.41	0.54	**-1.57**	0.00	0.00	0.00	0.00	0.00	0.66
Frozen	**Salmon**	22	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.64**	0.40	0.18	0.67	-0.11	0.27
	Cod	23	0.05	0.03	0.00	0.01	0.07	0.03	0.03	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.01	-0.01	0.00	0.04	**-1.88**	-0.07	0.01	0.00	2.20
	Crustacean	24	0.03	0.02	0.00	0.01	0.05	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	-0.01	0.00	-0.05	0.02	**-1.09**	0.07	-0.01	1.53
	Lean/white Fish	25	0.02	0.01	0.00	0.00	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.36	0.12	0.10	**-0.63**	-0.11	0.80
	Other	26	0.05	0.03	0.00	0.01	0.07	0.03	0.03	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.01	-0.01	0.00	-0.40	0.01	-0.10	-0.28	**-1.01**	2.10

Table 41: Unconditional Marshallian elasticities of demand for fish products in France

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Species	PrimeFish Main	Fresh Salmon	Fresh Cod	Fresh Trout	Fresh Seabass	Smoked Salmon	Smoked Trout	Smoked Herring	Canned Salmon	Frozen Salmon	Frozen Cod
Fresh	Salmon										
	Cod										
	Trout										
	Seabass/bream										
	Crustaceans										
	Fat Fish										
	Lean/white fish										
	Other										
Smoked	Salmon	(X)					X				
	Trout	(X)				X		X			
	Herring	(X)				X	X				
	Fat Fish	(X)	(X)				X	X			
	Lean/white fish					X	X	X			
	Other					X					
Canned	salmon										
	Crustaceans										
	Lean/white fish								X		
	Tuna										
	Sardine										
	Mackerel										
	Other								X		
Frozen	Salmon										X
	Cod										
	Crustaceans										
	Lean/white fish									X	X
	Other										

Table 42: Main competitors of PrimeFish species, by market segments defined on the basis of processing methods (France) (only cross-price elasticities >0.1).

Demand \ Scenarios	Salmon Price +10%		Trout Price +10%		Herring Price +10%		Cod price +10%		Seabass price +10%		Tuna Price + 10%		Fat Fish Price + 10%		Lean Fish Price + 10%		Expenditure +10%	
	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/ye	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ	ΔQ (kg/ cap/year)	% ΔQ
All fish	**-0.17**	**-2.9 %**	-0.01	-0.3 %	**-0.01**	**-0.2 %**	**-0.04**	**-0.8 %**	**-0.01**	**-0.2 %**	**0.00**	**0.0 %**	**-0.03**	**-0.5 %**	**-0.08**	**-1.3 %**	**0.73**	**12.8 %**
By species																		
Salmon	-0.05	**-6.4 %**	0.01	0.6 %	0.00	0.1 %	0.004	0.5 %	0.000	0.0 %	-0.014	-1.7 %	-0.009	-1.0 %	0.006	0.7 %	0.12	13.6 %
Trout	0.00	4.8 %	-0.01	**-12.4 %**	0.00	1.3 %	0.00	-0.1 %	0.00	-0.2 %	0.00	-1.8 %	0.01	17.0 %	0.00	1.4 %	0.01	13.5 %
Herring	0.01	7.0 %	0.00	3.4 %	-0.01	**-5.6 %**	0.00	0.3 %	0.00	0.1 %	0.00	-4.5 %	0.00	1.5 %	0.00	1.6 %	0.01	12.6 %
Cod	0.00	-0.7 %	0.00	-0.2 %	0.00	-0.1 %	-0.05	**-13.8 %**	0.00	0.1 %	0.00	0.5 %	0.00	0.1 %	0.00	-0.1 %	0.07	19.2 %
Seabass	0.00	-2.4 %	0.00	-0.5 %	0.00	-0.1 %	0.00	0.2 %	-0.01	**-9.6 %**	0.00	1.0 %	0.00	0.2 %	0.00	-1.1 %	0.01	16.8 %
Tuna	-0.05	-4.4 %	-0.01	-0.6 %	0.00	-0.4 %	0.00	-0.4 %	0.00	-0.1 %	-0.03	**-3.1 %**	-0.01	-0.6 %	0.02	1.8 %	0.10	9.4 %
Sardine	-0.03	-14.4 %	0.00	-0.6 %	0.00	-0.4 %	0.00	-0.4 %	0.00	-0.1 %	0.02	6.4 %	0.00	-0.6 %	0.00	-2.0 %	0.02	9.9 %
mackerel	-0.02	-7.9 %	0.00	-0.9 %	0.00	-0.6 %	0.00	-0.6 %	0.00	-0.2 %	0.02	5.3 %	0.00	-0.9 %	-0.02	-6.3 %	0.04	14.1 %
Crustacean	-0.02	-2.3 %	0.00	-0.2 %	0.00	-0.1 %	0.00	0.0 %	0.00	-0.1 %	0.01	1.0 %	0.00	-0.2 %	0.00	-0.2 %	0.17	16.4 %
Other Lean/Wh.	0.01	1.3 %	0.00	0.1 %	0.00	0.0 %	0.01	0.6 %	0.00	-0.2 %	0.00	0.5 %	0.00	0.0 %	-0.08	**-7.8 %**	0.12	11.8 %
Other Fat Fish	0.00	-2.2 %	0.00	2.0 %	0.00	-0.1 %	0.00	0.2 %	0.00	0.3 %	0.00	0.5 %	-0.02	**-15.1 %**	0.00	1.1 %	0.02	16.7 %
Other	-0.01	-2.0 %	0.00	-0.8 %	0.00	-0.2 %	0.00	0.2 %	0.00	0.0 %	0.00	0.6 %	0.00	0.4 %	0.00	-0.6 %	0.08	17.8 %
By processing type																		
Fresh	-0.08	-3.7 %	-0.01	-0.3 %	0.00	-0.1 %	-0.02	-0.9 %	-0.01	-0.5 %	0.02	1.0 %	-0.02	-0.9 %	-0.05	-2.1 %	0.37	16.7 %
Smoked	0.01	1.5 %	0.00	0.7 %	0.00	-0.6 %	0.00	0.4 %	0.00	0.1 %	-0.03	-4.7 %	0.00	0.7 %	0.00	0.3 %	0.07	13.0 %
Canned	-0.11	-6.4 %	-0.01	-0.7 %	-0.01	-0.4 %	-0.01	-0.4 %	0.00	-0.1 %	0.00	0.3 %	-0.01	-0.7 %	0.00	-0.2 %	0.18	10.4 %
Frozen	0.02	1.6 %	0.00	0.0 %	0.00	0.0 %	-0.02	-1.6 %	0.00	0.0 %	0.00	-0.1 %	0.00	0.1 %	-0.03	-2.3 %	0.11	9.0 %

Table 43: Impact of exogenous changes in prices and consumption expenditure on demand for PrimeFish and other species in France

6. Conclusion

In this deliverable, we proposed an analysis of demand for fish in France and Finland, with a special focus on PrimeFish species. Those two countries have relatively high levels of fish consumption by European standards, and have experienced significant growth in fish consumption over the last 40 years, although the level of consumption appears to have plateaued since the start of the century.

To better understand the demand for fish, we applied a quantitative methodology by using purchases data collected in large samples of consumers in both countries. The econometric analysis aimed (i) to identify the economic and socio-demographic drivers of household-level fish consumption, defined in terms of both species and processing method, and (ii) estimate the degree of substitution among potentially competing products. The simulation of simple scenarios of changes in the economic environment, using the empirically estimated demand systems, then provided a quantitative summary of our analysis at the level of PrimeFish species.

This study provided many insights regarding the fish market at a very detailed level of analysis in the two countries. Indeed it was possible to analyse the socioeconomic drivers and the competition between products at different level of aggregation, by considering:

- the place of fish products within the whole diets of consumers,
- the place of product categories identified by their processing type (fresh, frozen, smoked…) within the fish market,
- the place of different species (salmon, cod, seabass…) within the different fish markets defined by their processing type.

In general terms, the main conclusions are the following:

- The overview of consumption trends and structures in the two countries sheds light on important changes and differences. Thus, among PrimeFish species, growth in consumer expenditure is particularly favourable to consumption of cod and seabass in France, as well as trout in Finland. In the French fish market, salmon occupies a special place in the sense that its demand is mainly driven by its own price, but its price has a strong influence on demand for other species, including trout and herring. Cod and seabass, meanwhile, appear to form a separate market segment where little substitution with other species takes place, maybe because those fishes lie higher up on the quality ladder.

- The results demonstrate that, while the main competition among species often occurs within a market segment (e.g., between trout and salmon among smoked products in France), substitutions also take place much more broadly. For instance, canned tuna is an important substitute for all PrimeFish species in the French fresh fish market, and smoked products are important substitutes to crustaceans. However, aside from these exceptions, the different markets defined by the processing type (fresh, smoked, canned, frozen) appear to be quite separated, suggesting that consumers do not switch a lot from one market to another by comparing prices. The reason is likely that each market responds to specific consumer expectations.

- The analysis of the influence of households' socio-demographic characteristics on fish preferences and consumption reveals a high level of heterogeneity among consumers, hence suggesting the need for segmentation of the market and targeted marketing strategies. However, few relationships between socio-demographics and consumption hold across all PrimeFish species and product groups. This is illustrated by the result that, in both countries, while consumption of fresh fish tends to increase with the age of the household head, the relationship applies to salmon but not trout. Thus, market segmentation needs to be adapted to each product defined in terms of species and processing method.

Other results will be proposed in the next report (task 4.3.2) as the elasticities of demand for fish reported in this report will be used further to simulate the sustainability effects of raising fish consumption.

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Appendix 1 – Elasticity Formulae

Semi-elasticities of budget shares

Lewbel and Pendakur (2009) only provide the semi-elasticities of the budget shares for the full EASI model with interactions, so we need first to derive the expressions of the semi-elasticities for the approximate model. The second issue is to derive the elasticities of quantities (rather than semi-elasticities of budget shares). The *Hicksian* share equations are given by equations (2) and (5), and the derivatives of those equations with respect to exogenous price, real income, and sociodemographic variables give the Hicksian semi-elasticities:

$$\frac{\partial \boldsymbol{\omega}^i}{\partial \ln p^j} = a^{ij} \;\; \forall i, \; \forall j \qquad \text{(A1.1)}$$

$$\frac{\partial \boldsymbol{\omega}^j(p, y, z, \boldsymbol{\varepsilon})}{\partial y} = \sum_{r=1}^{R} b_r^j r y^{r-1} \qquad \text{(A1.2)}$$

$$\frac{\partial \boldsymbol{\omega}^i}{\partial z_t} = g_t^i \;\; \forall i, \; \forall t \geq 1 \qquad \text{(A1.3)}$$

The approximate model defined in terms of the *Marshallian* budget shares, as specified above, is:

$$w^j = \sum_{r=1}^{R} b_r^j (\hat{y})^r + \sum_{t=0}^{T} g_t^j z_t + \sum_{k=1}^{J} a^{jk} \ln p^k + \varepsilon^j, \; j = 1, \ldots, J$$

$$\hat{y} = \ln(x) - \sum_{k=1}^{J} \overline{w}^k \ln p^k \qquad \text{(A1.4-5)}$$

This results in the following Marshallian semi-elasticities:

$$\frac{\partial w^j(p, \hat{y}, z, \boldsymbol{\varepsilon})}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^j r \left(\hat{y} \right)^{r-1} \right) \frac{\partial \hat{y}}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^j r \left(\hat{y} \right)^{r-1} \right) \qquad \text{(A1.6)}$$

$$\frac{\partial w^i}{\partial \ln p^j} = a^{ij} - \bar{w}^j \left(\sum_{r=1}^{R} b_r^j r \left(\hat{y} \right)^{r-1} \right) \; \forall i, \forall j \qquad \text{(A1.7)}$$

$$\frac{\partial w^i}{\partial z_t} = g_t^i \;\; \forall i, \; \forall t \geq 1 \qquad \text{(A1.8)}$$

The Hicksian semi-elasticities with respect to prices (9) and real income (10) can also be inferred by removing the interaction terms from the corresponding expressions for the full EASI model (i.e., equations (12) and (13) in reference Lewbel and Pendakur (2009)). The expenditure semi-elasticity (14), however, differs from that of the full model because the approximation used to calculate real income (i.e., equation (14)) does not allow the budget shares $\overline{w}^k$ to depend on total expenditure *x*. If, following Zhen et al. (2013), one restores that dependence by calculating real expenditure as nominal expenditure deflated by the Stone price index, i.e. $\ln x - \sum_{j=1}^{J} w^j \ln p^j$, the expenditure semi-elasticity of budget share *j* becomes:

$$\frac{\partial w^j(p, y(x), z, \boldsymbol{\varepsilon})}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^j r(y)^{r-1}\right)\left(1 - \sum_{k=1}^{J} \frac{\partial w^k}{\partial \ln x} \ln p^k\right) \tag{A1.9}$$

This linear system of *J* equations is then solved using matrix algebra, leading to:

$$\frac{\partial w}{\partial \ln x} = \left(I_J + BP'\right)^{-1} B \tag{A1.10}$$

where *B* is the *Jx1* vector whose *j-th* element is $\sum_{r=1}^{R} b_r^j r y^{r-1}$, and *P* is the *J*-vector of log prices.

Elasticities of demand

The relationship between the semi-elasticities of budget shares and the elasticities of quantities can be derived in general terms. Starting with *Hicksian* demands, we have $\boldsymbol{\omega}^i(p, u = y) = p^i q^i(p,u) / x(p,u)$ from which it follows that: $q^i(p,u,z) = \boldsymbol{\omega}^i(p, u = y, z).x(p,u,z) / p^i$. Thus

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{\partial \ln \boldsymbol{\omega}^i}{\partial \ln p^j} + \frac{\partial \ln x(p,u,z)}{\partial \ln p_j} \text{ -}\boldsymbol{\delta}_{ij} \tag{A1.11}$$

where $\delta_{ij} = 1$ if $i = j$ and 0 otherwise. Using (9) and the expression for approximate real income (13), we obtain the Hicksian price elasticities:

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{a^{ij}}{w^i} + \overline{w}^j - \boldsymbol{\delta}_{ij} \tag{A1.12}$$

In a Marshallian framework, demand for good *i* is $q^i = q^i(p,x)$, where total expenditure *x* is assumed exogenous. Each Marshallian budget share is: $w^i(p,x) = p^i q^i(p,x) / x$, from which it follows that $q^i(p,x) = w^i(p,x).x / p^i$. Log-differentiating this expression gives the Marshallian expenditure elasticities:

$$\frac{\partial \ln q^i}{\partial \ln x} = \frac{\partial \ln w^i}{\partial \ln x} + 1 = \frac{1}{w^i} \cdot \frac{\partial w^i}{\partial \ln x} + 1 \qquad \text{(A1.13)}$$

Plugging back the expression of the expenditure semi-elasticity of Marshallian shares (14) gives the complete formula as a function of the estimated parameters:

$$\frac{\partial \ln q^i}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^i r \left(\hat{y} \right)^{r-1} \right) \frac{1}{w^i} + 1 \qquad \text{(A1.14)}$$

The Marshallian price elasticities of quantities are then most easily obtained by application of the Slutsky equation, using equations (20) and (22):

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{a^{ij}}{w^i} + \overline{w}^j - \delta_{ij} - w^j \left[\left(\sum_{r=1}^{R} b_r^i r \left(\hat{y} \right)^{r-1} \right) \frac{1}{w^i} + 1 \right] \qquad \text{(A1.15)}$$

Estimated at the sample mean, this becomes:

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{a^{ij}}{\overline{\overline{w^i}}} - \delta_{ij} - \frac{\overline{w^j}}{\overline{\overline{w^i}}} \left(\sum_{r=1}^{R} b_r^i r \left(\overline{\hat{y}} \right)^{r-1} \right) \qquad \text{(A1.16)}$$

For the socio-demographic variables we have in a Marshallian context:

$$\frac{\partial \ln q^i}{\partial \ln z^j} = \frac{\partial \ln w^i}{\partial \ln z^j} = \frac{1}{w^i} \cdot \frac{\partial w^i}{\partial \ln z^j} = \frac{z^j}{w^i} \cdot \frac{\partial w^i}{\partial z^j} \qquad \text{(A1.17)}$$

Or for a dummy variable:

$$\frac{\partial \ln q^i}{\partial D^j} = \frac{\partial \ln w^i}{\partial D^j} = \frac{1}{w^i} \cdot \frac{\partial w^i}{\partial D^j} \qquad \text{(A1.18)}$$

Appendix 2 – Additional elasticity tables

	Salmon	Trout	Herring	Domestic, fresh water	Other
Salmon	**-0.606***** (0.063)	0.405*** (0.048)	-0.299*** (0.04)	0.385*** (0.032)	0.474*** (0.037)
Trout	0.733*** (0.086)	**-0.449***** (0.105)	-0.118 (0.072)	0.082 (0.055)	0.111* (0.064)
Herring	-2.193*** (0.296)	-0.479 (0.294)	**3.103***** (0.373)	0.618*** (0.19)	-0.69*** (0.223)
Domestic, fresh water	1.213*** (0.101)	0.143 (0.096)	0.266*** (0.082)	**-1.363***** (0.099)	0.1 (0.082)
Other	1.578*** (0.123)	0.204* (0.117)	-0.313*** (0.101)	0.106 (0.087)	**-1.215***** (0.138)

Table 44: Hicksian elasticities of demand for fresh fish in Finland (Stage 3.1)

	Salmon	Trout	Herring	Cod	Domestic, fresh water	Other
Salmon	**-0.586***** (0.063)	0.553*** (0.051)	0.271*** (0.051)	-0.011 (0.069)	0.329*** (0.06)	0.01 (0.068)
Trout	0.532*** (0.049)	**-0.53***** (0.048)	-0.084* (0.045)	-0.153** (0.064)	0.351*** (0.052)	0.449*** (0.061)
Herring	1.072*** (0.203)	-0.343* (0.183)	**-2.826***** (0.302)	0.41 (0.324)	1.506*** (0.27)	0.747** (0.314)
Cod	-0.036 (0.224)	-0.515** (0.215)	0.335 (0.265)	**-0.878*** (0.515)	1.041*** (0.315)	0.618 (0.429)
Domestic, fresh water	0.803*** (0.147)	0.887*** (0.131)	0.928*** (0.166)	0.785*** (0.238)	**-2.443***** (0.269)	-0.394* (0.229)
Other	0.032 (0.228)	1.572*** (0.212)	0.637** (0.268)	0.644 (0.447)	-0.545* (0.317)	**-1.775***** (0.515)

Table 45: Hicksian elasticities of demand for smoked fish in Finland (Stage 3.2)

	Salmon	Trout	Herring	Fat Fish	Lean/whiteFish	Other
Salmon	**-0.159***** (0.001)	0.299*** (0.005)	0.144*** (0.002)	-0.143*** (0.008)	0.116*** (0.008)	0.462*** (0.008)
Trout	0.952*** (0.015)	**-1.406***** (0.062)	0.346*** (0.022)	3.556*** (0.107)	0.641*** (0.104)	-3.368*** (0.104)
Herring	0.65*** (0.007)	0.489*** (0.031)	**-0.465***** (0.024)	0.317*** (0.067)	0.38*** (0.063)	-0.65*** (0.065)
Fat Fish	-0.904*** (0.052)	7.08*** (0.213)	0.447*** (0.095)	**-13.459***** (0.705)	2.721*** (0.497)	4.837*** (0.55)
Lean/white Fish	0.578*** (0.042)	1.005*** (0.164)	0.422*** (0.069)	2.144*** (0.392)	**-5.562***** (0.471)	2.132*** (0.368)
Other	2.955*** (0.051)	-6.767*** (0.208)	-0.924*** (0.092)	4.882*** (0.555)	2.73*** (0.471)	**-2.156***** (0.634)

Table 46: Hicksian elasticities of demand for smoked fish in France (Stage 3.2)

	Herring	Tuna	Anchovies	Sardines	Mackerel	Other
Herring	**-0.448***** (0.009)	0.582*** (0.007)	-0.114*** (0.026)	-0.013 (0.03)	0.385*** (0.032)	0.361*** (0.015)
Tuna	0.457*** (0.005)	**-0.443***** (0.007)	0.708*** (0.02)	0.101*** (0.02)	-0.174*** (0.022)	0.105*** (0.01)
Herring	-0.361*** (0.082)	2.855*** (0.079)	**-3.061***** (0.379)	1.68*** (0.373)	-0.015 (0.389)	-0.345** (0.153)
Cod	-0.063 (0.152)	0.647*** (0.131)	2.663*** (0.591)	**-7.639***** (1.14)	5.358*** (0.981)	-0.213 (0.34)
Mackerel	1.149*** (0.095)	-0.662*** (0.085)	-0.014 (0.366)	3.181*** (0.583)	**-3.335***** (0.642)	0.435** (0.187)
Other	0.776*** (0.032)	0.288*** (0.026)	-0.234** (0.104)	-0.091 (0.145)	0.313** (0.135)	**-0.299**** (0.124)

Table 47: Hicksian elasticities of demand for canned fish in Finland (Stage 3.3)

	Salmon	Cod	Crustacean	Lean/white Fish	Other
Salmon	**-0.593***** (0.042)	0.491*** (0.045)	0.255*** (0.02)	0.723*** (0.02)	-0.042** (0.021)
Cod	0.416*** (0.038)	**-1.162***** (0.051)	0.539*** (0.021)	0.464*** (0.018)	0.578*** (0.019)
Crustacean	0.207*** (0.016)	0.517*** (0.02)	**-0.66***** (0.016)	0.383*** (0.01)	0.388*** (0.011)
Lean/white Fish	0.497*** (0.013)	0.377*** (0.015)	0.324*** (0.008)	**-0.466***** (0.009)	0.104*** (0.009)
Other	-0.042** (0.021)	0.696*** (0.023)	0.487*** (0.014)	0.154*** (0.013)	***-0.46***** (0.018)

Table 48: Hicksian elasticities of demand for frozen fish in France (Stage 3.4)

	Salmon	Pollock	Other
Salmon	**-1.391***** (0.068)	0.708*** (0.027)	1.183*** (0.086)
Pollock	0.339*** (0.013)	**-0.284***** (0.009)	0.445*** (0.016)
Other	1.327*** (0.097)	1.043*** (0.037)	**-1.869***** (0.129)

Table 49: Hicksian elasticities of demand for frozen fish in Finland (Stage 3.4)

Appendix 3 – Market penetration rate

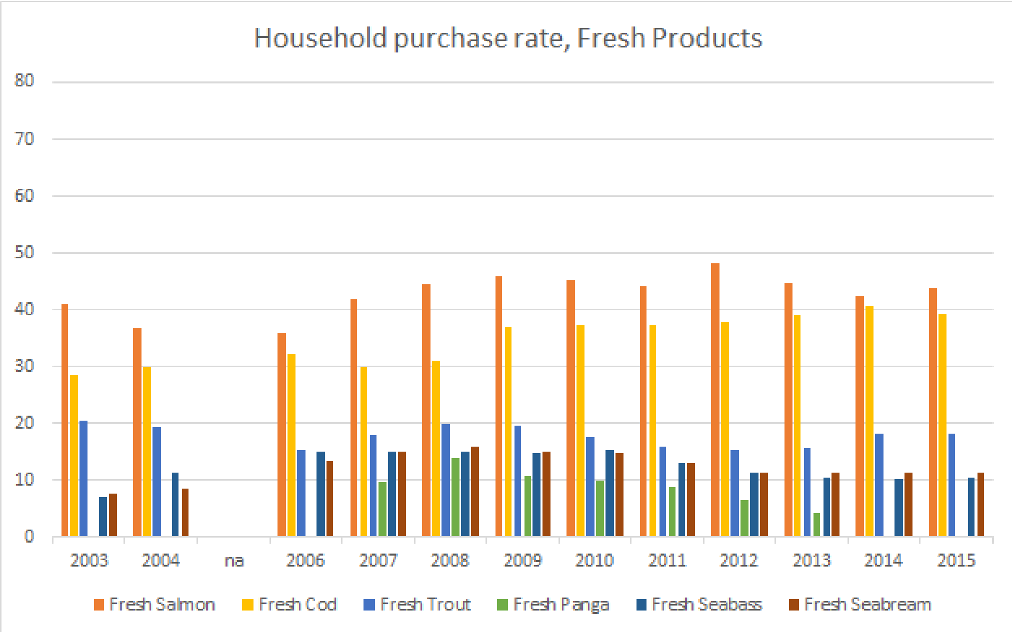

Figure 17: Market penetration rate of fresh products in France for project species (*Source: Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des produits de la mer et de l'aquaculture" from 2003 to 2015*)

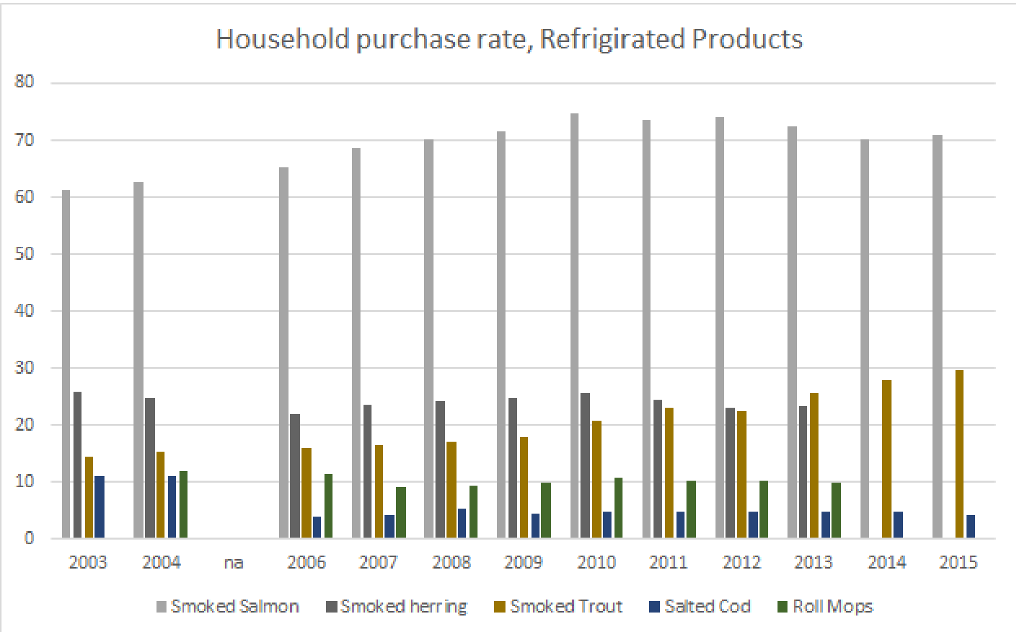

Figure 18: Market penetration rate of smoked products in France for project species (*Source: Authors construction based on: Annual report of FranceAgriMer – "Donnée et Bilan, Consommation des*

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produits de la mer et de l'aquaculture" from 2003 to 2015)