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Report on frequencies of consumer purchases

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Executive Summary

France is among the largest consumer markets for fish in Europe and its largest market for salmon, thus making it a key location for domestic and foreign sellers of fish. This article combines theory consistent demand analysis with the marketing convention of analysing purchase frequencies, to shed some light on the French fish market. We estimate a demand system of different fish types, in terms of purchase frequencies, using scanner data. The results show that consumers purchasing different types of fish are vastly heterogeneous. Furthermore, the results are used to provide an example of a marketing strategy which can increase store traffic and profits.

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Introduction

The European Union is the fifth largest producer of seafood in the world, after China, Indonesia, India, and Vietnam, producing a total of 6.1 million tonnes in 2015, or 3.2% of the global fish production (EUMOFA, 2016). The EU is, however, not self-sufficient in terms of seafood products. In 2015, net imports of seafood (wild captures and aquaculture) amounted to 6.8 million tonnes, or slightly above EU-production. This implies a self-suffiency rate of 47.5% (EUMOFA, 2016).

Per capita consumption of seafood averaged 25.5 kg. in 2015, with tuna, cod and salmon leading the way (EUMOFA, 2016). Per capita consumption of tuna averaged 2.6 kg., consumption of cod was on average 2.4 kg. and consumption of salmon 2.1 kg. All the tuna and 99% of the cod came from wild capture fisheries, while all the salmon and 1% of the cod was farmed. Only 12% of the cod is produced by EU-countries with most of the imports originating from Norway and Iceland. The self-sufficient rate of salmon is slightly higher, or 18%. Most of the salmon imported into EU comes from Norway.

Among the EU countries France is one of the largest consumer markets for seafood. In 2015, France ranked third in the EU in terms of salmon consumption, behind the UK and Spain, while only the British consumed more of cod. This makes France a good choice for our case study, serving as a representative of EUs member countries. Even though historically France is a great fishing nation, today it produces a relatively small fraction of its seafood consumption, meaning that the majority of French seafood consumption is imported (Girard and Paquotte; 2003, EUMOFA, 2016). The French fish market has undergone several structural changes in the last 40 years. An example would be the market for cod, where French cod catches in the Nothwest and Northeast Atlantic dropped from 207,000 tons in 1968 to a meager 5,000 tons in 2009, before rebounding again to 12,000 tons in 2015 (FAO, 2016).

A great range of seafood is available in the French fish market such as; salmon, cod, shrimp, saithe, trout, whiting, sea bream, sea bass, nile perch, sardine, pangasius, sole, mackrel, skate, etc. The most popular ones are salmon and cod, both in terms of value and frequency of purchases. According to ViaAqua (2010) salmon ranked first in 2008 with 45% rate of consumer purchases whereas cod ranked second with a 31% share. Furthermore, French fish consumption continuous to move from frozen, salted, or dried fish towards more valuable fresh seafood (INRA, 2007). For this reason, it was decided to base the analysis in this case study on five different groups of seafood products, two of which comprise salmon and two of which comprise cod. The categories are; fresh salmon, frozen salmonids (salmon and trout), fresh cod, frozen white fish (cod, haddock, saithe etc.) and all other seafood products. The last category therefore includes tuna.

The purpose of this case study is to analyse the fish consumption of French households. In

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particular, the aim is to determine what types of consumers purchase the five different seafood product categories mentioned above. We approach the problem from the angle of purchasing freequencies, that is, how often households purchase various types of fish. The object is to combine aspects from the marketing literature and the economic demand literature, which have analysed consumer behavior from different angles, to utilise the strengths of both approaches in order to produce valuable information for those who wish to sell fish in France.

Conventional demand analysis aims at understanding markets by predicting consumption and understanding how demand relates to prices, expenditure, and socioeconomic variables. Various studies of the demand for fish exist in the literature. Thus, Asche et al. (2011) analyse demand for Atlantic salmon in the EU, especially France. Gobillon and Wolff (2015) investigate spatial variations in product prices in French fish markets, while Onozaka et al. (2014) analyse the relationship between consumer perception and salmon consumption frequencies. Xie and Myrland (2011) apply an empirical test for the aggregation levels of French household demand for salmon. The marketing literature has focused more on count data models which have been widely applied for different purposes, such as evaluating brand success, brand loyalty, and store choice. Kau and Ehrenberg (1984) use the negative binomial (NB) Dirichlet[4] model to predict store choice. Uncles et al. (1995) is a review paper on buyer regularities based on predictions from the NB Dirchlet model. Bhattacharya (1997) estimates deviations from brand loyalty and compares it with predictions from the Dirchlet model, and Uncles and Lee (2006) estimate the purchase frequency of different age groups using predictions from the NB Dirichlet model.[5]

A specific branch of the demand literature has applied count data models in demand analysis, where the key references are Meghir and Robin (1992) and Robin (1993). However, these studies do not use count data estimation as their main focus, but rather employ the estimated probabilities to adjust conventional demand models to account for the actual purchase frequency of consumers, instead of utilising only the observed choice to purchase or not. In general, though, the economics literature has only applied count data models to a very restricted set of problems, e.g. the estimation of recreational demand and demand for health care. The standard count data models are the Poisson and the negative binomial, where the negative binomial is a natural extension to the Poisson which allows for a variance which differs from the mean. The Poisson and negative binomial have been applied, for example, by Creel and Loomis (1990), and Hellerstein (19991) to estimate recreational demand. Munkin and Trivedi (1999), Deb and Trivedi (2002), and Wang (2003) estimate the demand for health care.

4 The negative binomial Dirichlet model has two stages; the first is a form of the multivariate beta distribution known as the Dirichlet distribution, and the second is a Poisson gamma mixture which produces a variant of the negative binomial model. The Dirichlet is assumed to be the data generating process (DGP) of some choice and the negative binomial is assumed to be the DGP of the frequency of the corresponding choice.

5 The Dirichlet distribution is generally not used in economics, but one example is Shonkwiler and Englin (2005) who use it to estimate the willingness to pay for removing grazing land from hiking trails.

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Methods

In this deliverable, French scanner data is used to estimate a system of demand equations, in terms of purchase frequencies, using a negative binomial model, based on a modified version of the microeconomic model by Meghir and Robin (1992). In this section the model used is outlined in some detail.

Consider a consumer that faces the following optimisation problem

(1) $$\max_{l,c,n}\{U(l,c,n): wT + R = p'c + wl + wL(n), l > 0, c > 0, n > 0\}$$

where U denotes utility, l leisure, $c=(c1,c2,...,cM)'$ is a vector of consumption goods and $n=(n1,n2,...,nM)'$ represents the corresponding purchase frequency. We assume that the consumer's utility function, $u(l,c,n)$, is weakly separable and quasi-concave in l, c, and n. The consumer has income $y=wh$, where h is the hours spent working and w is the hourly wage rate, as well as other income through transfers and undeclared activities, R. Total available time is T, which is split into total hours worked h, time spent purchasing goods which is given by the function $L(n)$, which is increasing in n, and other non-market hours, l. From the aforementioned assumptions, the consumer's optimization problem can be expressed as follows:

(1) $$\max_{l,c,n}\{U(l,c,n): wT + R = p'c + wl + wL(n), l > 0, c > 0, n > 0\}$$

The solution to the optimization problem are three sets of Marshallian demand equations, $l(p,w,R)$, $ni(p,w,R)$, and $ci(p,w,R)$, where $i=1,2,...,M$. This deliverable, however, only focuses on the purchase frequency decision. Let the number of shopping trips be generated by a discrete distribution with a probability mass function $fN(n|Zi)$ for $n=0,1,2,...$ where Zi is a matrix of exogenous variables, then the probability of observing $n=0$ is given by $\Pr(N=0|Zi)$.

To be able to estimate the model it is necessary to specify the probability mass function of n. The usual starting point of count data estimation is to assume the Poisson distribution, which was used in Meghir and Robin (1992) to estimate their system of purchase frequency demand. This is a valid choice since quasi-maximum likelihood will lead to an unbiased estimation even though the distribution assumptions are incorrect as long as the mean is correctly specified. However, due to the Poisson limitations of equidispersion we assume intead the negative binomial distribution:

(2) $$f(n_i|Z_i) = \frac{\Gamma(\theta + n_i)r^{\theta}(1-r)^{n_i}}{\Gamma(1+n_i)\Gamma(\theta)}, r = \frac{\theta}{\theta+\lambda}, 0,1,2, \ldots$$

6 See Cameron and Trivedi (2013) for details.

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The conditional mean of ni is then $\mathrm{E}(ni|Zi)=\lambda i$ and the conditional variance is $\mathrm{V}(ni|Zi)=\lambda(1+1\theta\lambda)=\lambda(1+\kappa\lambda)=(\lambda+\kappa\lambda 2)$. This specification of the negative binomial model is known as the $\mathrm{NB2}$, due to the square of the lambda parameter in the variance specification.[6] As in Meghir and Robin (1992) no stochastic relationship is assumed between different $\mathrm{E}(ni|Zi)=\lambda i$. To be able to estimate a count data system with a dimension greater than two or three and an unrestricted covariance matrix one must use simulation based methods, see for example Chib and Winkelmann (2001).

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Data and empirical specification

The data used in this deliverable consists of a rotating consumer panel7 of fish purchases in France for the years 2010-2013. The data were collected by Kantar Worldpanel8 and consist of weekly observations on fish purchases of French households. The data set also included detailed sociodemographic information on consumers, which spans everything from the age of family members to the number of cats kept by the family. The panel includes each year around 20,000 households, but one third of the participants are rotated annually. On average, households remain in the panel for four years. In all, the survey includes 43,127 households, with a total number of 96,917 weekly observations.

The Kantar purchase data is collected with the use of bar codes. Kantar provides all surveyed households with a hand-held scanner and other relevant equipment to register purchases at home. Due to this form of data collection, this type of data has become known as scanner data. To register purchases without a bar code, households are assigned to two groups in order to reduce their workload. Each group is then required to register their purchases for specific types of food. This study only includes data on fish purchases and therefore assumes weak separability among different food categories in the consumer's utility function. This assumes that the utility maximiser, also known as the consumer, chooses her consumption of different food categories separately with respect to the share of income spent on each product group. For an example of the same data type used to analyse more food categories the reader is referred to Allais et al. (2010).

A common problem encountered in scanner data sets is the large share of zero observations. In order to address this, the data is aggregated over years to try to reduce the share of zero purchases. The time aggregation also significantly reduces the likelihood of autocorrelation and the need to include lagged variables of the dependent and independent variables in the model. Table 1 shows the empirical purchase frequency of the categories under investigation. The table demonstrates that even though the data has been aggregated over time they still containt a significant share of zero observations.

7 Here, a rotating consumer panel refers to a panel of served households where new households are added when others are inactive, to keep a stable number of households in the data collection process.
8 Kantar Worldpanel, former TNS Worldpanel, is an international company which focuses on data collection and consultancy in consumer markets.

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	Fresh salmon		Frozen salmonids		Fresh cod		Frozen white fish		Other fish	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
0	70646	72.910	77669	80.158	83548	86.225	84461	87.168	31631	32.644
1	11206	11.565	10138	10.463	5632	5.812	8078	8.337	10956	11.307
2	5300	5.470	3778	3.899	2550	2.632	2295	2.369	8587	8.862
3	2971	3.066	1865	1.925	1552	1.602	943	0.973	6725	6.941
4	1945	2.007	1123	1.159	972	1.003	429	0.443	5600	5.779
5	1242	1.282	698	0.720	667	0.688	227	0.234	4685	4.835
6	835	0.862	419	0.432	428	0.442	152	0.157	3898	4.023
7	612	0.632	315	0.325	340	0.351	94	0.097	3283	3.388
8	502	0.518	209	0.216	226	0.233	73	0.075	2828	2.919
9	340	0.351	153	0.158	198	0.204	31	0.032	2346	2.421
10	232	0.239	120	0.124	145	0.150	33	0.034	2083	2.150
11	193	0.199	69	0.071	141	0.146	19	0.020	1775	1.832
12	147	0.152	62	0.064	100	0.103	14	0.014	1548	1.598
13	135	0.139	67	0.069	68	0.070	12	0.012	1323	1.365
14	89	0.092	45	0.046	61	0.063	8	0.008	1166	1.203
15	66	0.068	31	0.032	41	0.042	5	0.005	976	1.007
16	85	0.088	23	0.024	30	0.031	5	0.005	814	0.840
17	50	0.052	17	0.018	31	0.032	3	0.003	706	0.729
18	40	0.041	22	0.023	26	0.027	2	0.002	626	0.646
19	37	0.038	8	0.008	25	0.026	2	0.002	552	0.570
20	31	0.032	15	0.015	16	0.017	1	0.001	466	0.481
> 20	191	0.197	49	0.051	98	0.101	8	0.008	4321	4.459

Table 1: Empirical purchase frequencies

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The data set does not contain any information regarding prices of the products. Prices are therefore estimated by dividing expenditures by quantities purchased of each good in each shopping trip to create unit values. When zero purchases are recorded, there is no price available so the average price is used. This approach is used in other demand studies such as Allais et al. (2010)9 and Bertail and Caillavet (2008). However, these constructed prices are not real market prices and will be influenced by the consumer's choices of quality, as has been pointed out by Deaton (1997). Thus, higher income households will tend to purchase higher quality fish and therefore the unit values will be positively related to income and expenditure, which will cause the price effects to be biased upwards.

The constructed price variables, or unit values, include a few outliers which we believe are due to errors in the data recording process. We therefore dropped all price observations which were more than 15 standard deviations from the mean. The dropping of these 22 observations, did not have any significant effect on estimation results.

Table 2 provides descriptive statistics of all variables used in the analysis, except for time dummies. The calculations are made after dropping the price outliers. The first five variables in the table are the dependent variables in the demand system, mentioned above, showing a fairly low average frequency during the four years. However, it should be noted that none of these five mean estimates are statistically different from zero, and should therefore not receive too much attention. The estimated prices and fish expenditures are normalized by dividing each price with the annual French consumer price index from 2010-2013. The normalization is not only for producing real values, but also to restrict the system to be homogenous of degree zero in prices and expenditures, in order to be consistent with economic theory.

9 They use scanner data collected by TNS Worldpanel. TNS is the former name of Kantar which collected the data used in our study.

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Variable	Mean	Std. Dev.	Min	Max
Fresh salmon (freq.)	0.836	2.371	0	87
Frozen salmonids (freq.)	0.479	1.532	0	44
Fresh cod (freq.)	0.440	1.765	0	49
Frozen white fish (freq.)	0.230	0.870	0	35
Other fish (freq.)	4.998	7.823	0	132
Real price of fresh salmon	0.161	0.039	0.017	0.716
Real Price of frozen salmonids	0.157	0.036	0.001	0.698
Real price of fresh cod	0.150	0.021	0.015	0.429
Real price of frozen white fish	0.099	0.018	0.006	0.405
Real price of other fish	0.108	0.053	0.008	0.918
Real expenditures on fish	0.641	0.861	0.003	16.576
Family size	2.617	1.381	1	9
Age (head of household)	46.490	15.364	17	95
BMI (head of household)	24.873	4.920	11.019	59.285
Upper class	0.138	0.345	0	1
Upper middle class	0.290	0.454	0	1
Lower middle class	0.411	0.492	0	1
Lower class	0.161	0.367	0	1
Number of cats	0.524	0.951	0	8
Number of vehicles	1.491	0.809	0	8
Secondary edu or kess	0.092	0.289	0	1
High school kevel education	0.515	0.500	0	1
University education	0.393	0.488	0	1
South	0.202	0.402	0	1
North	0.099	0.299	0	1
East	0.091	0.288	0	1
West	0.196	0.397	0	1
Central	0.219	0.414	0	1
Paris metropolitan area	0.193	0.394	0	1
Housing owner	0.590	0.492	0	1
Tenant	0.374	0.484	0	1
Free accommodation	0.036	0.186	0	1

Table 2: Descriptive statistics

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In order to increase the depth of the analysis, a large number of sociodemographic variables were included in the models, thus making it possible to determine better what type of consumers purchase the five different seafood categories. The choice of variables is determined mainly by convention established in the literature, see for example Allais et al. (2010). The families included in the data set included on average 2.6 family members, while the average age of the household head is about 46 years[10]. Age is a standard variable to include in a demand study, but is of even greater interest when analysing fish demand. Bourre and Paquotte (2008) show that older people in France are not consuming enough fish and according to the French recommended dietary allowance (RDA) of people 65 and older, seafood provides many of the necessary nutrients[11]. Low intake of these elements in older consumers' usual diets can thus be solved by increasing fish consumption thereby counteracting potential health problems due to low intake of these elements. It is thus a good marketing opportunity to promote the health benefits of fish in general and especially for the elderly. As a proxy for health, we included the body mass index (BMI) of the household head. A normal person, with no weight problems, would be expected to have a BMI in the range 18.5-25.0, while a lower score would indicate underweight and a higher score overweight. Individuals in this sample had an average BMI of 24.8 which shows that the average household head is at a healthy weight.

Four social class dummy variables are included; upper class, upper middle class, lower middle class and lower class, as well as two non-conventional variables; number of cats and number of motor vehicles. The cats and cars are taken to indicate social status and wealth. Moreover, it is interesting to see whether cats provide a significant contribution to fish consumption in French households. Three educational dummy variables are also included; secondary education or less, high school education or equivalent, and university education. The sample is well educated with over 50% with high school education or equivalent, and close to 50% with university education. There are also dummy variables for different regions in France; south, north, east, west, central, and Paris metropolitan area. Finally, the data set also includes a dummy variable indicating whether the household owned or rented their lodgings, and whether the enjoyed free accommodation.

10 The household head is the one who makes most of the purchasing decisions.

11 Fish, for example, provides 25% of overall vitamin RDA, 56% of the vitamin B12 RDA, 28% of iodine RDA, 23% of selenium RDA, and 203% of DHA RDA (Bourre and Paquotte, 2008).

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As is conventional when estimating count data models the conditional expectation is defined as a semi-logarithmic function. The set of demand functions is thus given by the following expression:

(3) $$\mathrm{E}(n_{ij}|Z_i) = \exp\left(\beta_{ij} + \sum_{s=1}^{M} \beta_{is}(p_{sj}/CPI) + \theta_i(y_j/CPI)\right)$$

for i=1,2,...,M fish categories and j=1,2,...,J households. The price of fish category i for household j is denoted by pij. The total fish expenditure of household j is given by yj, and CPI is the French consumer price index. For the demand system to be consistent with economic theory it is necessary to impose the following restrictions on the parameters (LaFrance and Hanemann, 1989; LaFrance, 1990): $\beta is=0\ \forall\ i\neq s$ and $\theta i=\theta\ \forall\ i$. Homogeneity of degree zero is imposed on the Marshallian demand system by dividing both prices and expenditure by the French CPI. Household heterogeneity is modelled by the following linear form:

(4) $$\beta_{ij} = \eta_{0i} + \sum_{k=i}^{K} z_{kj}\eta_{ki}$$

where zkj represents household characteristics and ηki are parameters to be estimated. Finally, it should be noted that even though cross price effects are zero, $\beta is=0$, compensated cross price effects are not. The Slutsky equation yieldse:

(5) $$e_{isj} = n_{ij}\frac{\partial n_{sj}}{\partial y_j} = \theta n_{ij}n_{sj}$$

where $eisj$ is the compensated substitution effect between products i and s for household j, and the n's are purchase frequencies of different product groups by household j.

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Results and discussion

The five demand equations in eq. (3) were estimated as a system and the results from that negative bionomial estimation are shown in Table 3.

The typical French fresh salmon consumer is a healthy upper-class individual with university education who comes from a small household. Furthermore, this individual owns his own house/apartment and has an above average number of motor vehicles, a further indicator of well-being. This consumer comes from the Paris metropolitan area or the north of France. The time dummies are all positive and significant, showing that the demand for fresh salmon has increased over the sample period. These time dummies capture effects on fresh salmon demand which are not otherwise accounted for in the model. One of the factors which could be affecting these variables, other than positive publicity, are cross price effects, which are not accounted for in the model. These effects should be positive indicating that fresh salmon and the other four categories are substitute goods.[12]

The frozen salmonids consumer is a healthy, younger, lower middle class individual with university education. Furthermore, this individual owns an above average number of cats. The consumer comes from the east, the south, or the Paris metropolitan area. Only the 2011 time dummy is statistically significant. The time dummy has a negative sign showing a reduction in demand between 2010 and 2011. This might be an indicator of a transition from frozen to fresh salmon.

The average fresh cod consumer comes from either of two groups of people: both are healthy, older, upper middle class individuals. The former one has only secondary education while the latter one has university education. Both groups come from a small household and do not own their own housing. These consumers are found in the east and west parts of France. The time dummies for 2011 and 2013 are significant, but have alternate signs. The demand for fresh cod in 2011 decreased relative to 2010, but then increased in 2013 relative to 2010. It is difficult to say exactly what causes these effects, but these variables might be picking up substitution effects and preference changes.

12 Even though some of the explainatory variables are correlated the results don't indicate any multicollinearity.

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	Fresh salmon		Frozen salmonids		Fresh cod		Frozen white fish		Other fish	
	Est.	t-val.	Est.	t-val.	Est.	t-val.	Est.	t-val.	Est.	t-val.
Const.	-0.58	-9.59	-0.35	-4.84	-2.28	-24.32	-1.98	-21.57	1.32	56.51
Price	-0.37	-2.67	-2.44	-14.66	-0.66	-2.26	-3.86	-11.18	-3.90	-62.28
Exp.	0.91	242.79	0.91	242.79	0.91	242.79	0.91	242.79	0.91	242.79
Family size * 10	-0.50	-7.14	0.03	0.30	-0.63	-6.28	0.83	8.24	0.29	10.79
Age * 1000	0.04	0.07	-6.04	-8.9	27.89	35.25	1.9	2.21	5.16	22.72
Upper class	0.05	2.31	-0.02	-0.83	-0.05	-1.63	-0.22	-5.98	-0.05	-4.93
Lower m. class	-0.12	-6.81	0.07	3.33	-0.18	-7.25	0.16	5.82	0.03	3.74
Lower class	-0.31	-12.23	-0.04	-1.22	-0.43	-11.46	0.21	5.57	0.02	1.68
Nr. of cats * 10	-0.27	-3.51	0.22	2.37	-0.66	-6.00	0.18	1.58	-0.02	-0.69
Nr. of cars.	0.03	2.82	-0.02	-1.82	0.07	4.79	-0.02	-0.99	-0.02	-5.01
D2011	0.06	2.83	-0.11	-4.45	-0.07	-2.51	0.05	1.7	-0.02	-2.08
D2012	0.23	11.78	-0.02	-0.98	-0.02	-0.71	0.11	3.78	-0.02	-1.92
D2013	0.13	6.47	0.01	0.21	0.10	3.49	-0.09	-2.89	-0.01	-1.03
Sec. edu.	0.03	1.22	-0.15	-4.74	0.09	2.67	0.05	1.26	0.02	2.00
High. edu.	0.14	9.10	0.06	3.27	0.06	2.72	-0.05	-2.15	-0.02	-3.43
Housing owner * 10	-0.78	-4.75	0.30	1.48	-1.07	-4.46	0.22	0.85	0.05	0.72
Accom. for free	0.06	1.47	-0.03	-0.52	0.05	0.82	-0.16	-2.6	-0.01	-0.46
BMI * 10	-0.03	-2.34	-0.07	-4.08	-0.18	-8.37	0.04	1.83	-0.02	-3.04
South	-0.19	-9.04	0.07	2.84	-0.39	-12.48	0.18	5.76	-0.02	-2.17
North	0.12	4.55	0.05	1.6	0.06	1.67	-0.23	-5.52	-0.13	-11.66
East	-0.13	-4.62	0.08	2.38	0.10	2.69	-0.07	-1.68	-0.08	-7.61
West	0.04	1.92	-0.13	-4.62	0.16	5.33	-0.10	-3.07	-0.04	-4.07
Paris	0.13	6.01	0.17	6.01	-0.21	-6.57	-0.07	-1.93	-0.08	-8.86
Dispersion Par.	0.69	63.22	1.15	93.96	1.25	83.42	1.33	81.40	-1.08	-134.06

Table 3: Estimation results from negative binomial model

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The average frozen white fish consumer is an older, lower middle to lower class individual from the south of France who comes from a large household. The BMI parameter is positive and significant, at the 10% level, which could indicate that consumers in this group are not as healthy as in the other categories. Several of the product forms in this category, e.g. fish fingers, are less healthy than those for fresh salmon and cod. The household head comes from a large family and is from a lower class than the fresh fish consumers and is thus more likely to buy cheaper less healthy food. The time dummies for 2012 and 2013 are significant and show that demand increased in 2012 but decreased in 2013, relative to 2010.

The consumer of other fish is a healthy, older, lower middle class individual with secondary education who comes from a large household in the center of France. This category includes a great variety of different fish products, but two of the largest ones are canned tuna and shrimp. The time dummy for 2011 was significant and shows that demand decreased that year relative to 2010. These results are summarised in Table 4.

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	Fresh Salmon	Frozen salmonids	Fresh cod	Frozen white fish	Other fish
Healthy	X	X	X		X
Young	NS	X			
Old			X	X	X
Small household	X	NS	X		
Large household				X	X
Upper class	X				
Upper middle class			X		
Lower middle class		X		X	X
Lower class				X	
University	X	X	X		
High school				X	
Secondary education			X		X
Own housing	X	NS			NS
Tenant		NS	X	X	NS
Large number of vehicles	X		X	NS	
Large number of cats		X		NS	NS
South		X		X	
North	X				
East		X	X		
West			X		
Central					X
Paris	X	X			

Note: NS denotes non significance.

Table 4: Consumer groups

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Results outlined in Table 5 indicate that the price elasticities of different product groups are significantly varied between frozen and fresh fish. The price elasticities of fresh salmon and fresh cod are quite low demonstrating that price changes have little effect on these products purchase frequency. Frozen fish on the other hand has a significantly higher price elasticity, which is further evidence that price is a deciding factor for the consumer purchasing decision, Results outlined in Table 5 indicate that the price elasticities of different product groups are significantly varied between frozen and fresh fish. The price elasticities of fresh salmon and fresh cod are quite low demonstrating that price changes have little effect on these products purchase frequency. Frozen fish on the other hand has a significantly higher price elasticity, which is further evidence that price is a deciding factor for the consumer purchasing decision, which is consistent with the fact that this consumer is less well-off and therefore needs to think more of the product price before she feeds her large family. Store traffic could therefore be increased by raising the price of fresh salmon and cod, while at the same time lowering the price of frozen fish is lowered and promoting this lower price.

The age elasticities indicate that sellers should target their sales of fresh cod and frozen white fish towards older individuals, but sales of frozen salmonids towards younger consumers. And as was mentioned previously, a promotion strategy, focused at older individuals, could be through health effects, namely the large concentration of vitamin D, B12, iodine and selenium, which are important to prevent potential health problems at older age. The BMI elasticities show that in general consumers of fish are healthy individuals, so promoting fish as a healthy food full of vitamins and omega-3 fatty acids should attract the largest share of fish consumers. Finally, consumers of fresh salmon and cod come from smaller households than those who purchase frozen white fish. This is consistent with our previous reasoning that larger households, those that have many children, are more likely to purchase products from the frozen white fish category which includes less healthy food such as fish fingers which children might like.

	Fresh salmon		Frozen salmonids		Fresh cod		Frozen white fish		Other fish	
	Est.	t-val.	Est.	t-val.	Est.	t-val.	Est.	t-val.	Est.	t-val.
Price	-0.06	-2.67	-0.38	-14.66	-0.10	-2.26	-0.38	-11.18	-0.42	-62.28
Exp.	0.58	242.79	0.58	242.79	0.58	242.79	0.58	242.79	0.58	242.79
Family size	-0.12	-7.14	0.01	0.3	-0.16	-6.28	0.22	8.24	0.08	10.79
Age * 10	0.01	0.07	-2.81	-8.9	12.96	35.25	0.85	2.21	2.40	22.72
BMI	-0.08	-2.34	-0.18	-4.08	-0.44	-8.37	0.10	1.83	-0.04	-3.04

Table 5: Elasticities

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The compensated substation effects are shown in Table 6. These were calculated using eq. (5), where the substitution effects are assumed to be symmetric. The results show that if the price of fresh salmon increases by one euro per kilo then the purchase frequency of frozen salmonids increases by 0.36, fresh cod increases by 0.33, frozen white fish increases by 0.18, and other fish increases by 3.8. Thus, reducing the price of frozen white fish by one euro per kg reduces the purchase frequency of salmon the least, and increases purchase frequency of frozen white fish by 0.38%. Moreover, the compensated substitution effect between frozen white and all the other categories are lower than for any of the other groups. The results therefore show that frozen white fish is the best product group to put on sale to increase store traffic. Then to counter the price reduction of white fish the price of fresh salmon can be increased at the same time, where the own price elasticity of fresh salmon in terms of frequencies is the lowest of all groups at only -0.06%.

Table 6: Compensated substitution effects

	Estimate
Fresh salmon vs frozen salmonids	0.36
Fresh salmon vs fresh code	0.33
Fresh salmon vs frozen white fish	0.18
Fresh salmon vs other fish	3.80
Frozen salmonids vs fresh cod	0.19
Frozen salmonids vs frozen white fish	0.10
Frozen salmonids vs other fish	2.18
Fresh cod vs frozen white fish	0.09
Fresh cod vs other fish	2.00
Frozen white fish vs other fish	1.05

Note: All t-values are 242.79, due to equation (5).

Finally, an example of a good marketing strategy given our results would be to reduce the price of frozen white fish and promoting it as healthy for all age groups and even more so for the elderly, since it has a high concentration of vitamin D, B12, iodine and selenium. Then the seller should discretely increase the price of fresh salmon. This sort of strategy works particularly well on households which purchase infrequently (Chen and Rey, 2012), since they will not be up to date with prices at many different stores. This is perfect for a product like fish which is so infrequently purchased, see tables 1 and 2.

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Conclusion

This deliverable analysed how frequently consumers buy fish using a microeconomic model presented by Meghir and Robin (1992). A budget constraint was introduced where consumers receive revenue from income and other transfers and a semi-logarithmic functional form used for these demand functions. Relevant restrictions were imposed on the system to be theory consistent. The frequency of purchases for different seafood products was then estimated using a demand system of five fish categories. The empirical analysis was based on French scanner data of fish purchases for the years 2010-2013, assuming a negative binomial data generating process for the purchase frequencies.

The results clearly reveal that there are different groups of fish consumers for the five categories, fresh salmon, frozen salmonids, fresh cod, frozen white fish and all other fish. The average consumer of fresh salmon differs substantially from the consumer of frozen white fish. The typical consumer of fresh salmon is a healthy upper-class individual with university education who comes from a small household in Paris and the of north France, but the average frozen white fish consumer is an older, lower, middle to lower class individual who comes from a large household in south France. Secondly, it was shown that by combining the demand literature and the marketing approach of estimating purchase frequencies it is possible to create sound marketing strategies for fish retailers which increase store traffic and profits.

Improvements to the method could be made in at least three areas. Firstly, the demand for quantity could also be estimated, which would provide a more complete framework to form sophisticated marketing strategies. Secondly, the statistical model could be estimated with simulation based methods which would make it possible to incorporate an unrestricted covariance matrix between demand equations. Thirdly, the statistical model could be extended to a hurdle or zero inflated framework to account for all the zeros in the data set specifically.

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References

Allais, O., Bertail, P., and, Nichele, V. (2010). The Effect of a Fat Tax on French Households' Purchases: A Nutrition Approach. American Journal of Agricultural Economics 92, 228-245.

Asche, F., Dahl, R.E., Gordon, D.V., Trollvik, T., and. Aandahl, P. (2011). Demand Growth for Atlantic Salmon: The EU and French Markets. Marine Resource Economics, 26, 255-265.

Bhattacharya, C.B. (1997). Is Your Brand' s Loyalty too Much, too Little, or Just Right? Explaining Deviations in Loyalty from the Dirichlet Norm. International Journal of Research in Marketing, 14, 421-435.

Bourre, J.M., and, Paquotte, P. (2008). Seafood (Wild and Farmed) For the Elderly: Contribution to the Dietary Intakes of Iodine, Selenium, DHA, and Vitamins B12 and D. The Journal of Nutrition, Health and Aging, 12, 186 – 192.

Bertail, P., and, Caillavet, F. (2008). Fruit and Vegetable Consumption Patterns: A Segmentation Approach. American Journal of Agricultural Economics, 90, 827-842.

Chen, Z., and Rey, P. (2012). Loss Leading as an Exploitative Practice. The American Economic Review, 102, 3462-3482.

Chib, S. and Winkelmann, R. (2001). Markov Chain Monte Carlo Analysis of Correlated Count Data. Journal of Business and Economic Statistics, 19, 428-435.

Creel, M.D., and Loomis, J.B. (1990). Theoretical and Empirical Advantages of Truncated Count Data Estimators for Analysis of Deer Hunting in California. American Journal of Agricultural Economics 72, 434–441.

Deaton, A. (1997). The Analysis of Household Surveys. Baltimore: Johns Hopkins University.

Deb, P., and Trivedi, P.K. (2002). The Structure of Demand for Health Care: Latent Class versus Two-Part Models. Journal of Health Economics, 21, 601-625.

EUMOFA. (2016). The EU fish market – 2016 edition. The European Comission. Available at http://eumofa.eu.

FAO. (2016). Fisheries and aquaculture software. FishStatJ - software for fishery statistical time series. Available at http://www.fao.org/fishery/statistics/software/fishstatj/en.

Girard, S., and, Paquotte, P., (2003). The French Market for Fresh Fish: An Opportunity for Farmed Cod? In 15th EAFE Conference, Ifremer, Brest, France, 15-16.

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

Gobillon, L., and, Wolff, F.C. (2015). Evaluating the Law of One Price Using Micro Panel Data: The Case of The French Fish Market. American Journal of Agricultural Economics, 98, 134-153.

Hellerstein, D.M. (1991). Using Count Data Models in Travel Cost Analysis with Aggregate Data. American Journal of Agricultural Economics, 73, 860–866.

INRA, (2007). 5 scenarios for French fish farming to 2021. Technical report, INRA Fish Comission.

Kau, A.K., and Ehrenberg, A.S.C. (1984. Patterns of Store Choice. Journal of Marketing Research, 21, 399-409.

LaFrance, J.T. (1990. Incomplete Demand Systems and Semilogarithmic Demand Models. Australian Journal of Agricultural Economics, 34, 118-131.

Meghir, C., and Robin, J.M. (1992). Frequency of Purchase and the Estimation of Demand Systems. Journal of Econometrics, 53, 53–85.

Munkin, M.K., and Trivedi, P.K. (1999). Simulated Maximum Likelihood Estimation of Multivariate Mixed-Poisson Regression Models, with Application. Econometrics Journal, 2, 29-48.

Onozaka, Y., Hansen, H., and, Sørvig, A. (2014). Consumer Product Perceptions and Salmon Consumption Frequency: The Role of Heterogeneity Based on Food Lifestyle Segments. Marine Resource Economics, 29, 351-374.

Robin, J.M. (1993). Analysis of the Short-Run Fluctuations of Households' Purchases. The Review of Economic Studies, 60, 923-934.

Shonkwiler, J.S., and Englin, J. (2005). Welfare Losses Due to Livestock Grazing on Public Lands: A Count Data Systemwide Treatment. American Journal of Agricultural Economics, 87, 302-313.

Uncles, M., Ehrenberg, A.S.C., and Hammond, K. (1995). Patterns of Buyer Behavior: Regularities, Models, and Extensions. Marketing Science, 14, 71-78.

Uncles, M., and Lee, D. (2006). Brand Purchasing by Older Consumers: An Investigation Using the Juster Scale and the Dirichlet Model. Marketing Letters, 17, 17-29.

ViaAqua, 2010). Elements about French cod market. Technical report, Via Aqua Seafood and Prospects.

Wang, P. (2003). A Bivariate Zero-Inflated Negative Binomial Regression Model for Count Data with Excess Zeros. Economics Letters, 78, 373-378.

Xie, J., and Myrland, Ø. (2011). Consistent Aggregation in Fish Demand: A Study of French Salmon Demand. Marine Resource Economics, 26, 267-280.

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