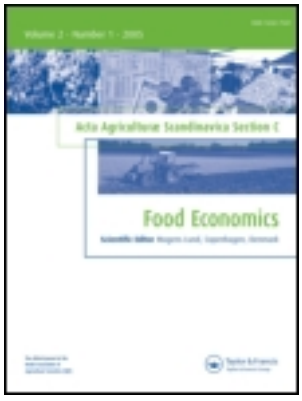

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ORIGINAL ARTICLE

Modeling market structure of the Spanish salted fish market

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Abstract
The Spanish market for salted fish products has been restructured over the last decade. A significant pattern is a steady increase in the consumption of frozen light salted fillets at the expense of traditional products. This study is to model the Spanish demand for salted fish using the Almost Ideal Demand System (AIDS). Our findings suggest that a significant trend exists that consumers in Spain prefer to purchase the new light salted cod fillets to traditional salted cod in general. The cross price elasticity of Norwegian salted whole cod with respect to frozen light salted fillets is significantly positive. This suggests that the light salted fillets are a strong substitute for Norwegian salted whole cod. Strong substitution effects also exist between the salted whole cod from Norway, Iceland, and the Faroe Islands. Since Norway has the dominant share of exports of traditional salted whole cod, the results overall indicate a strong challenge for the Norwegian salted fish industry to maintain its position in the Spanish market.

Keywords: *Cod demand, market structure, salted fish, Spain.*

Introduction

Salted fish, mainly cod, is one of the main traditional seafood products from the Nordic countries of Norway, Iceland, and the Faroe Islands. Exports of salted cod constitute some 50% of the total cod catches in these countries. The southern countries of the European Union (EU) are the main buyers of salted fish. Portugal is the largest importer in the EU, Spain the second. More than 90% of the salted fish in these markets are from the three Nordic countries.

As the second largest salted fish market in the EU, the Spanish market for salted fish products is undergoing a fundamental restructuring (Lindkvist et al., 2008). The total Spanish imports of salted fish doubled from 25,000 to 50,800 metric tons between 1991 and 2007.[1] The new light salted frozen fillets and the traditional products with new consumer packages have been successfully introduced to the market when more women are employed outside the home and have less time for cooking. The demand structure of the traditional salted fish market has therefore been significantly changed. A clear situation is that the Norwegian salted fish industry has failed to meet the increased international competition in Spain by introducing new products or new packages (Lindkvist & Sanchez, 2008).

Most previous studies of salted fish focus on the technological issues in the production such as salting and desalting (Barat et al., 2002; Andrés et al., 2005; Fernandez-Segovia et al., 2006) and raw fish materials (Lauritzsen et al., 2004; Barat et al., 2006). To our knowledge, there are only three studies related to social economic analysis. Trondsen (1995) addresses the relationship between product marketing strategies for salted cod and the product performance through differentiating in the EU market. Lindkvist et al. (2008) discuss how cultural, technological, and social factors contribute to the restructuring of the Spanish salted fish market and production systems. Lindkvist and Sanchez (2008) conclude that production systems dominated by domestic conventions seem to reduce the innovation capability of the Norwegian salted fish industry. No research, to our knowledge, has estimated the demand elasticities of salted fish.

The main purpose of this research is to model the demand structure for salted cod in Spain, which

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accounts for around 90% of Spanish salted fish imports. Special attention will be given to the interrelationship between salted cod products by countries (i.e. Norway, Iceland, and the Faroe Islands) and by-product forms (i.e. the traditional products and the new introduced light salted fillets). The total Spanish imports from the other countries (e.g. China, Canada, and Russia) are about 10%. To make the addressed problem manageable, the study therefore focuses on the salted cod from the three Nordic countries.

Empirical knowledge of the size of demand elasticities is crucial for both industry and policy makers to know the sensitivity of salted fish demand to the prices operating on it. In addition to being the first study to estimate the demand elasticities, the paper also takes into account demand interrelationships between products from different sources and in different product forms. This issue is particularly important for the Spanish salted fish market when the traditional market is relatively shared by the three Nordic countries and the traditional market as a whole is facing a big challenge from the new product introduced almost all by one country, Iceland.

Tomek (1993) argues that replication, i.e. estimating the same model with new or updated data, is essential for sound policy, learning, and research innovation (Kinnucan et al., 1997). As a by-product of our study, we examined the robustness of the estimated coefficients to sample updating. Moreover, Icelandic data have changed to record more abundant assortment of products since 2006. More consumer packages are included in the data set. Frozen light salted fillets have been specifically recorded since 2008. Before that, frozen light salted fillets are expected to be recorded as frozen fillets. It is thus important to know whether the market strategy change to convenient packaging and the measurement problem of the data have changed the estimated results.

The paper is organized as follows. We begin with a discussion of the model. Next, the data and estimation procedure are presented, followed by the empirical results. The paper ends with concluding comments.

Model

We will use the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) to model the demand for salted cod in Spain. Since export shares of salted fillets from the individual Nordic countries are small and salted fillets are considered relatively homogenous across supply sources, we combined them into a single category. For similar reasons, we combined the klippfish, whole, and fillets, into one category. This resulted in a six-equation system consisting of traditional salted whole cod from Norway, Iceland, and the Faroe Islands, respectively, undifferentiated salted fillets, undifferentiated klippfish, and frozen light salted fillets from Iceland. The Spanish demand for salted cod is assumed to be weakly separable from all the other goods and two-stage budgeting is invoked to justify the conditional demand specification. The AIDS model given by Deaton and Muellbauer (1980) is

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln(x/P) \tag{1}$$

where $w_I = p_i q_i / \Sigma_i \; p_i q_i$ is the budget share of ith good; p_i and q are the price and quantity of good i; $x = \Sigma_i \; p_i q_i$ is the total expenditure for n goods included in the demand system; and P is the price index defined by

$$\ln P = \alpha_0 + \sum \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_l \gamma_{kl} \ln p_k \ln p_l. \tag{2}$$

The model is linear except for the translog price index ln P. This problem has been circumvented in most applied work by instead using the linear Stone price index $\ln P = \Sigma_i w_i \ln p_i$. Deaton and Muellbauer argued that, if prices are highly collinear, the Stone price index should be a good approximation to the translog index. Moschini (1995) showed that the approximation properties may be seriously affected by the fact that the Stone index is not invariant to the (arbitrary) choice of units of measurement for prices and quantities. To circumvent this problem, we will follow one of Moschini's (1995) suggestions and simply use the following geometrically weighted average prices:

$$\ln P = \sum\nolimits_i w_i^0 \ln p_i \tag{3}$$

where $w_i^0$is the budget share of product i at the mean point.

As we are using monthly data, we expect there to be a problem of serial correlation. Therefore, a dynamic version of the AIDS model was estimated. The model is augmented with a lag-dependent variable $w_{i,t-1}$, trend variables (T and T^2), and seasonal dummy variables $D_{k,t}$. The final estimating equation takes the form:

$$\begin{aligned} w_{i,t} = \varphi_i + \sum_{k=2}^{4} \phi_{ik} D_{k,t} + \varsigma_i T + \iota_i T^2 + \sum_{j=1}^{6} \sigma_{ij} \ln p_{j,t} \\ + \theta_i \ln (x_t / P_t) + \lambda_i w_{i,t-1} \\ + u_{i,t} i = 1, \ldots, 6; t = 1, \ldots, T \end{aligned} \tag{4}$$

where subscript t is the index time and $u_{i,t}$ is a random disturbance term. Seasonality is specified on

a quarterly rather than a monthly basis to save degrees of freedom for model estimation, but also because Wessells and Wilen (1994) found little difference in the two approaches. To be in accordance with economic theory, theoretical restrictions on the price and expenditure parameters in Equation (4) are as follows:

$$\sum_{j=1}^{6} \sigma_{ij} = 0, i = 1, ..., 6. \text{ homogeneity} \quad (5a)$$

$$\sigma_{ij} = \sigma_{ji} \ \forall i \neq j \text{ symmetry} \quad (5b)$$

$$\sum_{i=1}^{6} \sigma_{ij} = 0, j = 1, ...6, \ \sum_{i=1}^{6} \theta_i = 0, \text{ adding up.} \quad (5c)$$

In addition, the following adding-up conditions apply to the intercepts and other variables in the model:

$$\sum_{i=1}^{6} \varphi_i = 0 \quad (6a)$$

$$\sum_{i=1}^{6} \phi_{ik} = 0, k = 2, 3, 4, \quad (6b)$$

$$\sum_{i=1}^{6} \varsigma_i = 0, \ \sum_{i=1}^{6} \iota_i = 0, \quad (6c)$$

$$\sum_{i=1}^{6} \lambda_i = 0. \quad (6d)$$

The short-run expenditure and price elasticities are calculated using the following formulas:

$$e_i = \frac{\theta_i}{w_i} + 1 \quad (7a)$$

$$e_{ij} = \frac{\sigma_{ij} - \theta_i w_j}{w_i} - \delta_{ij} \quad (7b)$$

$$e_{ij}^* = \frac{\sigma_{ij}}{w_i} + w_j - \delta_{ij} \quad (7c)$$

where δ_{ij} is the Kronecher delta defined as equal to 1 if $i = j$ and 0 if $i \neq j$. e_{ij} and e_{ij}^* are the Marshallian and Hicksian price elasticities, respectively. The long-run elasticities are the short-run elasticities divided by $(1-\lambda_i)$.

Data and estimation procedures

Monthly data on the quantity and FOB value of salted cod exports to Spain for the period January 1994 to February 2009 were provided by Kristin Lien, market manager at the Norwegian Seafood Export Council (NSEC). The NSEC data are collected on the basis of Eurostat and other national statistics. The original data were specified according to product description and the associated HS number for each product. We aggregated the data according to our model specification. The values are measured in Euros at the trade level. The quantity on a live-fish-equivalent basis for Norwegian export is available from the data set given by the NSEC. Those for Iceland and the Faroe Islands are converted from product weights according to the corresponding conversion factors given by the Norwegian Ministry of Fisheries. Unit prices were computed by dividing the value by quantity on a live-fish-equivalent basis. Table I presents the Spanish imports of salted cod products from the three Nordic countries, namely Norway, Iceland, and the Faroe Islands, between 1994 and 2008. Salted whole cod has declined from 20,541 to 10,684 tons. This mainly happened in the imports from Norway and Iceland, not the Faroe Islands. The imports of salted fillets declined, which is mainly contributed by the decrease of imports from Norway, not Iceland.

Table I. Trade volumes and market shares for Spanish imports of salted cod from Nordic countries, 1994 versus 2008.

	1994 Volume (tons)				2008 Volume (tons)			
Exporters	Norway	Iceland	the Faroe Islands	All	Norway	Iceland	the Faroe Islands	All
Salted whole cod	8656	9618	2267	20,541	4886	3539	2259	10,684
Salted cod fillets	2934	3727	–	6661	882	3422	–	4304
Klippfish	349	–	–	349	119	–	–	119
Klippfish fillets	–	–	273	273	–	–	2086	2086
Frozen light salted cod fillets	–	376	–	376	–	6905	–	6905
All	11,939	13,721	2540	28,200	5887	13,866	4345	24,098
	1994 Market share				2008 Market share			
Salted whole cod	0.42	0.47	0.11	1.00	0.46	0.33	0.21	1.00
Salted cod fillets	0.44	0.56	0.00	1.00	0.20	0.80	0.00	1.00
Klippfish	1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00
Klippfish fillets	0.00	0.00	1.00	1.00	0.00	0.00	1.00	1.00
Frozen light salted cod fillets	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
All	0.42	0.49	0.09	1.00	0.24	0.58	0.18	1.00

Source: NSEC (2009).

Klippfish fillets were all from the Faroe Islands in consumer packaging. It has increased from 273 to 2086 tons. Frozen light salted fillets from Iceland grew from 376 to 6905 tons. Overall, it appears that the significant pattern in Spanish imports of salted cod is a steady increase in the imports of frozen light salted fillets at the expense of traditional products. Klippfish fillets survived successfully by coming up with the consumer packaging.

Since the dominant share of Norwegian exports is salted whole cod, in addition, the exports of a small share of salted fillets have also declined tremendously. The result is that the market share of all salted cod from Norway decreased from 42% in 1994 to 24% in 2008. The loss of market share is taken up by Iceland and the Faroe Islands. The former seems mainly to benefit from the expanding exports of light salted fillets, and the latter from klippfish fillet exports. Figure 1 shows that there is the same trend for prices of different products and therefore they are expected to play in the same market. However, the price of frozen light salted fillets is much lower than any other salted cod products in Spain.

Data for the period January 1994 to February 2009 are used to estimate the model. However, two sample periods are chosen to test the robustness of the estimated coefficients to sample updating. The data set from January 1994 to December 2006 serves as the baseline estimates and we refer to it as the original sample hereafter. The updated sample covers January 1994 to March 2009. The reason for selecting the data periods in this way is as mentioned earlier. First, after 2006, Icelandic statistics began to include more product varieties, particularly products in consumer packages. Second, after 2008, frozen light salted fillets were specifically recorded. Before that, they were expected to be recorded as frozen fillets. Since more than 80% of frozen fillets exported from Iceland before 2008 were expected to be light salted, we use the data of frozen fillets as a proxy for the frozen light salted fillets before 2008.

We estimated Model 4 using seemingly unrelated regression (SUR). For the estimation, the econometric software LIMDEP was used. To estimate the demand system, one equation must be omitted to avoid singularity in the variance–covariance matrix of the residuals across equations. Therefore, we ran the model twice, first with the equation of frozen light salted fillets dropped and then with the equation of klippfish dropped. Theoretical restrictions of homogeneity and symmetry were first tested using the Wald test. Based on the test results, an appropriately restricted model was used to estimate elasticities. The elasticities are calculated at sample mean budget shares.

Results

The test results for theoretical restrictions are consistent in the two samples. That is, homogeneity is compatible with the data but symmetry is not (Table II). Therefore, we estimated the model with homogeneity imposed for both sample periods. The estimation results of the parameters for the two samples are reported in Tables III and IV. The results overall suggest that salted fish demands are subject to seasonal change and a trend effect.

Of the 12 parameters associated with the trend variables, eight are significant in both samples. This suggests that a structural change may be at work in the Spanish salted fish market. Specifically, the positive signs of trend variable T in the Icelandic light salted frozen fillets, klippfish and Faroe Island salted whole cod equations in both samples suggest

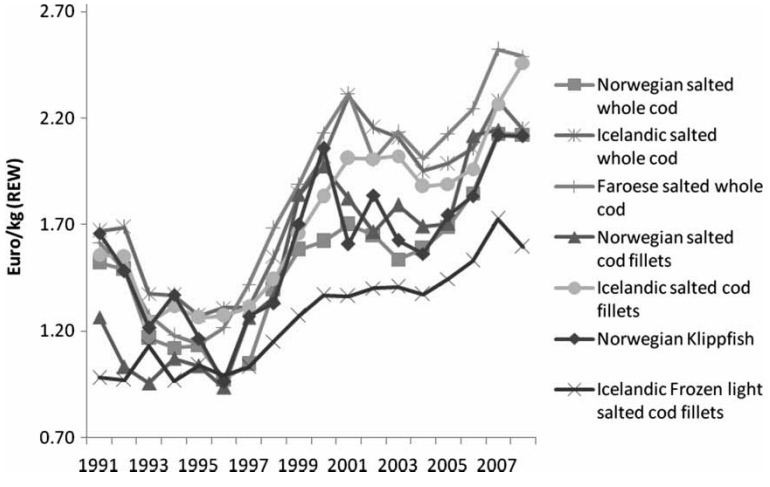

Figure 1. Export prices of salted cod products from Nordic countries to Spain.
Source: NSEC (2009).

Table II. Tests of theoretical restrictions in the AIDS model.

Model	Computed		5% critical value[a]	Test result
	Original sample (January 1994–December 2006)	Updated sample (January 1994–February 2009)		
Price homogeneity	7.75	4.58	11.07	Fail to reject
Price symmetry	23.15	26.79	18.31	Reject

[a]Degree of freedom for the tests are 5 and 10% for homogeneity and symmetry, respectively.

that consumer preferences for these products may be strengthening over time at the expense of salted whole cod from Norway and Iceland and aggregated salted fillets.

Estimated price effects and expenditure effects in general are consistent in the two samples. However, a sufficient difference exists in the two samples to suggest that the estimated results are sensitive to sample updating, particularly when the exact data for light salted fillets are not available before 2008 and the concept of the products may change when their packages are changed. Specifically, the majority of klippfish exported to Spain in recent years was in consumer packages from the Faroe Islands. More salted whole cod and frozen light salted cod from Iceland were in vacuum or consumer packages.

In the AIDS model, the statistical significance of estimated parameters per se has little economic significance; we focus on elasticities, which are computed by the Wald test using the Formulae 7 in "model" section. The conditional Marshallian price elasticities for the two samples are reported in Tables V and VI. The own price elasticities are all negative and significant in both the short- and the long-run and in the original and updated samples except for that of frozen light salted fillets. The own

Table III. SUR estimates of parameters for the AIDS model (sample January 1994–December 2006).

Independent variables	Norwegian salted whole cod	Icelandic salted whole cod	Faroese salted whole cod	Nordic salted cod fillets	Nordic klippfish	Icelandic light salted cod fillets
$\ln p_1$	−0.14	0.15	−0.003	0.04	−0.05	0.03
	(-2.00)*	(2.36)*	(−0.06)	(0.78)	(−1.85)**	(0.71)
$\ln p_2$	−0.07	0.01	0.13	−0.07	−0.01	−0.05
	(−0.78)	(0.09)	(2.04)*	(−1.02)	(−0.22)	(−0.93)
$\ln p_3$	0.10	−0.01	−0.08	0.04	−0.01	−0.02
	(1.70)**	(−0.22)	(−1.82)**	(0.86)	(−0.53)	(−0.42)
$\ln p_4$	−0.13	0.16	0.03	0.07	0.03	−0.19
	(−1.40)	(1.75)**	(0.52)	(0.95)	(0.73)	(−3.00)*
$\ln p_5$	−0.08	−0.03	0.02	0.00	0.04	0.04
	(−1.32)	(−0.48)	(0.53)	(0.08)	(1.56)	(0.94)
$\ln p_6$	0.31	−0.28	−0.10	−0.09	0.01	0.19
	(3.62)*	(−3.40)*	(−1.70)**	(−1.29)	(0.21)	(3.30)*
$\ln(y/P)$	0.10	0.01	0.002	−0.07	−0.04	0.001
	(3.93)*	(0.44)	(0.10)	(−3.58)*	(−3.78)*	(0.09)
D_2	0.04	0.02	−0.02	−0.02	−0.01	−0.002
	(1.99)*	(1.39)	(−1.74)**	(−1.58)	(−1.64)**	(−0.16)
D_3	−0.01	0.05	−0.01	0.01	−0.04	0.01
	(−0.50)	(2.54)*	(−0.73)	(0.64)	(−4.00)*	(0.40)
D_4	−0.02	0.02	0.01	−0.02	−0.01	0.02
	(−1.05)	(1.27)	(0.64)	(−1.14)	(−1.11)	(1.28)
T	−0.001	−0.002	0.001	−0.002	0.001	0.002
	(−1.30)	(−2.38)*	(2.68)*	(−4.06)*	(4.46)*	(3.46)*
T^2	−0.000002	0.000004	−0.00001	0.00001	−0.00001	−0.000002
	(−0.49)	(1.14)	(−1.87)**	(4.39)*	(−4.30)*	(−0.64)
$wi_{,t-1}$	0.18	0.23	0.30	0.05	0.22	0.24
	(3.63)*	(4.26)*	(4.82)*	(0.80)	(3.52)*	(5.09)*
Intercept	−0.59	0.101	−0.015	0.91	0.40	0.02
	(−2.55)*	(0.45)	(−0.091)	(5.00)*	(4.08)*	(0.13)
R^2	0.60	0.35	0.53	0.30	0.41	0.70
DW	1.93	2.06	1.82	2.13	1.91	2.24

Note: Numbers in parentheses are asymptotic t-ratio,*, **indicates significance at the 5 and 10% level, respectively.

Table IV. SUR estimates of parameters for the AIDS model (sample January 1994–February 2009).

Independent variables	Norwegian salted whole cod	Icelandic salted whole cod	Faroese salted whole cod	Nordic salted cod fillets	Nordic klippfisk	Icelandic light salted cod fillets
ln p_1	−0.06	0.09	−0.05	0.02	−0.04	0.04
	(−0.92)	(1.47)	(−1.03)	(0.42)	(−1.20)	(0.92)
ln p_2	−0.16	0.06	0.15	−0.02	−0.02	−0.01
	(−1.97)*	(0.85)	(2.41)*	(−0.31)	(−0.46)	(−0.23)
ln p_3	0.12	−0.02	−0.01	−0.03	0.01	−0.07
	(2.34)*	(−0.51)	(−0.36)	(−0.70)	(0.57)	(−2.01)*
ln p_4	0.004	0.08	0.05	−0.05	0.09	−0.17
	(0.05)	(1.07)	(0.83)	(−0.85)	(2.27)*	(−3.01)*
ln p_5	−0.08	−0.004	0.05	0.02	0.02	−0.004
	(−1.56)	(−0.09)	(1.25)	(0.42)	(1.01)	(−0.11)
ln p_6	0.18	−0.20	−0.19	0.06	−0.07	0.21
	(2.40)*	(−2.95)*	(−3.26)*	(1.09)	(−2.05)*	(4.20)*
$\ln(y/P)$	0.07	0.02	−0.01	−0.05	−0.04	0.01
	(2.96)*	(0.95)	(−0.63)	(−2.70)*	(−3.69)*	(0.61)
D_2	0.04	0.02	−0.03	−0.02	−0.01	0.01
	(2.12)*	(1.06)	(−2.12)*	(−1.66)**	(−1.35)	(0.59)
D_3	−0.03	0.06	−0.02	0.02	−0.04	0.01
	(−1.29)	(3.13)*	(−1.24)	(1.11)	(−4.25)*	(0.80)
D_4	−0.03	0.02	0.01	−0.01	−0.01	0.02
	(−1.88)**	(1.34)	(0.54)	(−0.56)	(−1.08)	(1.79)**
T	−0.003	−0.001	0.002	−0.001	0.001	0.002
	(−5.12)*	(−2.31)*	(4.09)*	(−1.36)	(3.21)*	(5.45)*
T^2	0.00001	0.00000	−0.00001	0.000003	0.00000	−0.000002
	(3.19)*	(−0.002)	(−3.21)*	(1.49)	(−2.83)*	(−0.90)
$wi_{,t-1}$	0.00004	−0.0001	0.00000	0.00002	0.0001	−0.0001
	(0.51)	(−0.96)	(0.08)	(0.33)	(1.88)**	(−1.24)
Intercept	−0.22	0.09	0.09	0.70	0.40	−0.06
	(−1.06)	(0.51)	(0.61)	(4.49)*	(4.18)**	(−0.46)
R^2	0.50	0.43	0.37	0.19	0.29	0.70
DW	1.45	1.57	1.23	1.83	1.35	1.81

Note: Numbers in parentheses are asymptotic t-ratio, *, ** indicates significance at the 5 and 10% level, respectively.

price elasticities of frozen fillets are positive in both sample periods, while they are not significant in the original sample and significant in the updated sample. The results indicate that demand for frozen light salted cod is not sensitive to price change or the quantity demanded increases with the rise of the unit price. This result is not what we might expect. However, as shown by Figure 1, the price of frozen light salted fillets is far lower than that of all the others. When the expenditure is fixed and allocated to the demand for all salted cod, it is reasonable to think that a portion of low-price-seeking consumers will keep purchasing the light salted fillets although their price is increasing, since the relative price of

Table V. Estimated Marshallian price and expenditure elasticities (short-run).

Quantity demanded from	e_{i1}	e_{i2}	e_{i3}	e_{i4}	e_{i5}	e_{i6}	e_i
Norwegian salted whole cod	−1.81*	−0.47	0.48	−0.81**	−0.45	1.55*	1.51*
	(−1.38)*	(−0.94)*	(0.60)*	(−0.07)	(−0.48)*	(0.92)*	(1.35)*
Icelandic salted whole cod	0.62*	−0.98*	−0.06	0.62**	−0.11	−1.13*	1.04*
	(0.36)	(−0.75)*	(−0.11)	(0.32)	(−0.03)	(−0.88)*	(1.08)*
Faroese salted whole cod	−0.03	1.11*	−1.69*	0.29	0.19	−0.89**	1.02*
	(−0.41)	(1.29)*	(−1.11)*	(0.46)	(0.44)	(−1.57)*	(0.91)*
Nordic salted cod fillets	0.22	−0.21	0.20	−0.65*	0.04	−0.32	0.72
	(0.12)	(−0.04)	(−0.09)	(−1.17)*	(0.08)	(0.27)	(0.82)*
Nordic klippfish	−0.51	0.02	−0.10	0.43	−0.52	0.13	0.55
	(−0.31)	(−0.09)	(0.19)	(1.03)*	(−0.69)**	(−0.72)**	(0.59)*
Icelandic Frozen light salted cod fillets	0.30	−0.50	−0.16	−1.73*	0.34	0.74	1.01
	(0.31)	(−0.12)	(−0.57)*	(−1.36)*	(−0.04)	(0.70)**	(1.07)*

Note: Number in parentheses are updated sample estimate, *, ** indicates significance at the 5 and 10% level, respectively.

Table VI. Estimated Marshallian price and expenditure elasticities (long-run).

Quantity demanded from	e_{i1}	e_{i2}	e_{i3}	e_{i4}	e_{i5}	e_{i6}	e_i
Norwegian salted whole cod	−2.20*	−0.58	0.58	−0.98**	−0.55	1.89*	1.84*
	(−1.38)*	(−0.94)*	(0.60)*	(−0.07)	(−0.48)**	(0.92)*	(1.35)*
Icelandic salted whole cod	0.80*	−1.27*	−0.07	0.81**	−0.15	−1.47*	1.35*
	(0.36)	(−0.75)*	(−0.11)	(0.32)	(−0.03)	(−0.88)*	(1.08)*
Faroese salted whole cod	−0.04	1.58*	−2.40*	0.41	0.27	−1.26**	1.44*
	(−0.41)	(1.29)*	(−1.11)*	(0.46)	(0.44)	(−1.57)*	(0.91)*
Nordic salted cod fillets	0.23	−0.22	0.21	−0.68*	0.04	−0.33	0.75*
	(0.12)	(−0.04)	(−0.09)	(−1.17)*	(0.08)	(0.27)	(0.82)*
Nordic klippfish	−0.66	0.02	−0.13	0.56	−0.67	0.17	0.70*
	(−0.31)	(−0.09)	(0.19)	(1.03)*	(−0.69)**	(−0.72)**	(0.59)*
Icelandic Frozen light salted cod fillets	0.39	−0.66	−0.21	−2.28*	0.45	0.97	1.33
	(0.31)	(−0.12)	(−0.57)*	(−1.36)*	(−0.04)	(0.70)**	(1.07)*

Note: Number in parentheses are updated sample estimate, *, ** indicates significance at the 5 and 10% level, respectively.

light salted fillets is much lower than that of the other product forms. In addition, there might be a group of consumers who strongly prefer to buy the light salted fillets, due to their unique taste and convenience for cooking compared with other salted cod products.

The estimated expenditure effects are consistent in the two samples. That is, the conditional income elasticities are all positive and significant in the short- and long-run estimates of the two samples. Thus, all the products benefit from the income-induced increase of market size. However, the benefit is distributed unevenly, with Norwegian salted whole cod gaining the most and klippfish the least. The same result applies to an income decline associated with the world economic crisis; Norwegian salted whole cod can be hurt the most and klippfish the least.

To gain insight into the relative strength of substitution relationships, we computed the Hicksian elasticities using the Slutsky equation. For applied analysis, we are always more interested in the long-run relationships. To save space and make the expression neater, we only report the long-run Hicksian elasticities in Table VII. The estimated results are robust across the samples for the relationship between salted whole cod from different sources. The estimated cross price elasticities of Norwegian salted whole cod with respect to the price of the Faroe Island whole cod e^*_{13} is positive, which indicates that the salted whole cod from the Faroe Islands substitutes the demand for salted whole cod from Norway. The same applies to e^*_{21} and e^*_{32}. That is, salted whole cod from Norway substitutes the demand for that from Iceland, and salted whole cod from Iceland substitutes that from the Faroe Islands. Given the large magnitude of these cross price elasticities, it indicates that salted whole cod from different sources are competing strongly against each other. This result is expected since the Spanish market for salted whole cod is a traditional saturated market relatively averagely shared by Norway, Iceland, and the Faroe Islands.

The cross price elasticity of Norwegian salted whole cod with respect to frozen light salted fillets is 2.09 and 1.09 in the original and updated samples, respectively. This suggests that a reduction in light salted fillets prices will greatly drag down the Norwegian salted whole cod demand since light salted fillets are a strong substitute for Norwegian salted whole cod. Bearing in mind that Norwegian salted whole cod is the second-cheapest product next to light salted fillets (Figure 1), this reflects that, in a cheaper market, the consumers prefer to buy tastier light salted fillets, which are also much easier to prepare for cooking.

The price of salted fillets has a positive effect on Icelandic salted whole cod demand and a negative effect on light salted fillets in both samples. This indicates that salted fillets are a substitute for the Icelandic salted whole cod and a complement to Icelandic light salted fillets. Since more than 80% of salted fillets come from Iceland, the result may in part suggest that both the product cuts and country of origin work in the same market. None of the cross price effects in column e^*_{i5} are significant, which means that the prices of klippfish will not affect the demand for the other salted products. This, combined with no estimated price elasticities that are significant in the klippfish equation in the original sample, may suggest that competition between klippfish and other salted products is limited. Klippfish is a wet salted fish dried to around 70–75% of the wet salted weight.

The robustness issue of the sample periods is most pronounced in the estimation of the light salted effects. For example, only two price elasticities are significant in column e^*_{i6} in the original sample. However, all the price elasticities are significant in the updated sample (Table VII). Specifically, in the

Table VII. Estimated Hicksian price elasticities (long-run)

Quantity demanded from	e^*_{i1}	e^*_{i2}	e^*_{i3}	e^*_{i4}	e^*_{i5}	e^*_{i6}
Norwegian salted whole cod	−1.85*	−0.13	0.80*	−0.52	−0.39	2.09*
	(−1.13)*	(−0.63)	(0.75)*	(0.27)	(−0.35)	(1.09)*
Icelandic salted whole cod	1.06*	−0.94*	0.08	1.14*	−0.03	−1.32*
	(0.56)*	(−0.50)	(0.02)	(0.59)**	(0.07)	(−0.75)*
Faroese salted whole cod	0.24	1.93*	−2.23*	0.77	0.40	−1.11
	(−0.24)	(1.49)*	(−1.00)*	(0.69)	(0.52)	(−1.46)*
Nordic salted cod fillets	0.38**	−0.04	0.30	−0.50	0.11	−0.25
	(0.27)	(0.15)	(0.01)	(−0.97)*	(0.16)	(0.37)**
Nordic klippfish	−0.52	0.20	−0.05	0.73	−0.60	0.24
	(−0.20)	(0.04)	(0.26)	(1.18)*	(−0.64)**	(−0.65)**
Icelandic frozen light salted cod fillets	0.65	−0.33	−0.05	−1.94*	0.57	1.12
	(0.51)	(0.13)	(−0.44)	(−1.10)*	(0.06)	(0.84)*

Note: Number in parentheses are updated sample estimate, *, ** indicates significance at the 5 and 10% level, respectively. Hicksian elasticities are calculated using the Slutsky equation: $e^*_{ij} = e_{ij} + w_j e_{i\cdot}$

original sample, the price of light salted fillets has no significant effect on the demand for Faroese salted whole cod, salted fillets, and klippfish, while in the updated sample, light salted fillets are complementary to Faroese salted whole cod and klippfish, and a substitute for salted fillets. The fragility of light salted fish parameters may be due to the measurement problem in our data set. As mentioned in "Data and Estimation Procedures," we use frozen fillets as a proxy before sample period 2008.

Concluding comments

The elasticities estimated in this study suggest that there are strong substitution effects between salted whole cod from Norway, Iceland, and the Faroe Islands. The basis for this claim is that the cross Hicksian price elasticities between salted whole cod from these countries are significantly positive and consistent with the large magnitude in both the original and updated samples. Since the Spanish demand for salted whole cod is shrinking overall, the strong substitution between the product forms will make the competition in this market even greater. The Icelandic light salted fillets are playing an important role in reshaping the Spanish salted fish market. According to consistent results in the two samples, a significant trend exists that consumers prefer to buy light salted fillets instead of traditional salted cod. Furthermore, the light salted fillets are a strong substitute for the Norwegian salted whole cod in the relatively cheaper market.

The study results suggest that the Norwegian salted fish industry is facing a big challenge in the Spanish salted fish market. This claim is based on the following findings. First, the estimated parameters of the trend variable (T) for the Norwegian salted whole cod equation in Tables III and IV are consistently negative, which means the consumer preference effect is negative in the demand for Norwegian salted whole cod. Second, the own price elasticity for Norwegian salted whole cod is bigger than that of other products in the market, which means that the demand for Norwegian salted whole cod is very sensitive to the change in its own price. Figure 1 shows that Norwegian salted whole cod is second cheapest next to light salted fillets, much lower than its main competitors, salted whole cod from Iceland and the Faroe Islands. How much room exists for the Norwegian salted fish industry to lower its price when the production of salted fish largely depends on the raw fish is questionable. Third, the estimated price effects of Faroese salted whole cod and Icelandic light salted fillets are positive and significant, which means that the substitute effects of these products on the demand for Norwegian salted whole cod are strong. Particularly the large magnitude of cross price elasticity with respect to the price of light salted fillets means that a reduction in the price of Icelandic light salted fillets can substantially drag down the demand for Norwegian salted whole cod. Fourth, although the price of Icelandic salted whole cod has no direct effect on the demand for Norwegian salted whole cod, it affects Norwegian salted whole cod indirectly via a substitution effect on the Faroese salted whole cod. For example, a reduction in the price of Icelandic whole cod would reduce the demand (and presumably price) for Faroe Island salted whole cod, which, in turn, would reduce the demand for Norwegian salted whole cod. Finally, the worst thing is that around 85% of Norwegian salted fish products are salted whole cod.

The findings that the effects of light salted fillets are sensitive to the sample period suggest that more estimation is needed to establish the robustness of the empirical findings in the Spanish salted fish market. We use the Icelandic frozen fillets as a proxy

for light salted fillets before 2008 due to the unavailability of the exact data for light salted fillets. Clearly, more research is needed when a longer period of data is available. It is also important to establish whether there are any other light salted fillets exported to Spain except for those from Iceland.

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Note

1. Our number is smaller compared to that given by Lindkvist et al. (2008), who also include the frozen cod and saithe fillets from the Faroe Islands as the light salted fillets. We did not, since the data regarding the Faroe Islands are uncertain.

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