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Heterogeneous products and tests for an appropriate aggregation level considering different qualities: evidence from fresh hake at Barcelona's wholesale market

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Abstract: This paper stresses the importance of considering an appropriate aggregation level for databases and demand analyses, as an inappropriate level may lead to biased estimates. This is illustrated by an analysis of different fresh hake products from Mercabarna, Barcelona's wholesale market. The literature on seafood demand regards hake as a single product species. Nevertheless, in the Spanish market, many types of fish, ranging from inferior to luxury goods, are marketed as hake. Our results were in accordance with empirical observations, and suggest the need for analysis at a greater depth than the species level. Thus, this questions the results of previous demand studies and most databases, which have not taken the appropriate product aggregation level into account.
JEL Classification: C43, Q22, Q11.
Keywords: aggregation, homogenous products, market, hake.

Resum: Aquest estudi destaca la importància de considerar un nivell d'agregació adequat en els anàlisis de demanda, ja que treballar utilitzant un nivell d'agregació inadequat pot donar lloc a estimacions esbiaixades. Aquest fet es mostra a través de l'anàlisi de diferents productes de lluç fresc comercialitzats a Mercabarna, el mercat majorista de Barcelona. La literatura sobre la demanda de peix tracta al lluç com un únic producte i espècie. No obstant això, en el mercat espanyol, es comercialitzen molts peixos com a lluç, els quals mostren comportaments molt diferents (des de béns inferiors fins a béns de luxe). Els resultats obtinguts, en concordança amb les observacions empíriques, demostren que l'anàlisi s'ha de realitzar amb un major grau de detall que a nivell d'espècie. Això qüestiona els resultats d'anteriors estudis de demanda i la majoria de les bases de dades, on l'observació del nivell d'agregació adequat dels productes no es té en compte.

Paraules clau: agregació, productes homogenis, mercat, lluç

1. Introduction

Given the vast numbers of consumer products available, databases and analyses devised for their study often involve some level of aggregation. Deaton & Muellbauer (1980, p.119) claim that aggregation (or separability) simplifies the difficulties in describing and estimating consumer behaviours. However, if the underlying assumptions are incorrect, the estimations will be biased.

The question of whether database and demand analyses use an appropriate aggregation level is rarely considered. However, it is essential to use the most suitable aggregation level, as only consistent aggregation ensures that the behavioural properties that apply to disaggregate relationships also apply to aggregate relationships (Shumway & Davis, 2001, p. 161). Inappropriate aggregation can lead to biased estimations, in this case to inaccurate estimates of demand elasticities (Deaton & Muellbauer, 1980; Lewbel, 1996; etc.).

The present study uses an analysis of different fresh hake products from *Mercabarna*, Barcelona's wholesale market, to stress the importance of considering an appropriate aggregation level. We used a highly detailed database provided by Mercabarna and Mr. Daniel Martinez (Head of the fish market), which enabled us to disaggregate fresh hake by size, fishing gear used, origin, and species.

Hake (*merluza*) is the main fish species consumed in Spain, in terms of both quantity and value. It accounts for almost 30% of Spanish fish consumption. Seafood consumption has traditionally been very important in Spain, reaching around 36.7 kg per capita in 2005 (MAPA, several years).

European Hake (*Merluccius merluccius*) has been the most frequently captured demersal fish in Spain for many years. However, catch levels can no longer meet Spanish demand for hake. Consequently, Spanish fleets have begun to exploit new fishing grounds and other species, marketing some of them as hake, but the catches still do not meet demand. This has pushed up the price of

hake in the Spanish market, which has fuelled an active global trade with Spain as the main destination, especially for fresh hake.

Thus, in the Spanish market, many fish from diverse species, origins, fleets, sizes, etc. are marketed as hake. These different hake products vary from inferior to luxury goods (Guillen 2007).

Consequently, it would be inappropriate to work with databases and analyses that have high levels of aggregation. The results presented here raise doubts about the findings of previous studies of demand and most databases (in particular for seafood), in which the appropriate product aggregation level was not considered.

2. Theory

It is generally accepted in economic theory that two or more products (or varieties of a product) can be classed in the same product group if they are close substitutes.

In fact, the first formal conditions for product aggregation in the literature can be found in Composite Commodity Theorem. This is based on the relationship between prices, taken from the works of Hicks (1936) and Leontief (1936) and the separability theorem (Leontief 1947, Sono 1961).

Normally, a weak separability assumption can be used to justify the creation of groups of products that are investigated in isolation from the rest of the consumer's consumption. However, data on all goods in the consumer bundle is required to formally test for weak separability. Consequently, tests are very difficult to conduct and have a low power (Lewbel, 1996). Therefore, the existence of weak separability is frequently assumed without testing (as can be seen in Revell & Fousekis, 2004).

The Composite Commodity Theorem states that if the individual prices of several goods move in parallel (proportionally) over time so that the relationship between their prices is constant, these goods can be treated as a single commodity group. Therefore, they can be characterized using a composite price index (Deaton & Muellbauer, 1980).

Accordingly, Stigler and Sherwin (1985) defined substitute products as those which are "in the same market" and whose relative prices "maintain a stable ratio".

Recently, Lewbel's work (1996) led to the rigid conditions of the Hicks' Composite Commodity Theorem being relaxed in the Generalized Composite Commodity Theorem (also known as GCCT).

The Composite Commodity Theorem is an exact relationship. However, Lewbel showed that regression errors (any deviation) may be unimportant for product aggregation. He stated that price ratios may vary across observations as long as the distribution of the ratio of the commodity price to the group price is independent of the level of the group price. Hence, the relative difference between the individual commodity price and the aggregate commodity price must be independent of the aggregate commodity price.

Thus, through the Generalised Composite Commodity Theorem, which is empirically testable, Lewbel showed that the relationships between prices can play a crucial role in aggregation theory.

3. Methodology

One way of testing the Generalised Composite Commodity Theorem when prices are non-stationary (and most economic time series are non-stationary), is to test whether the relative prices are cointegrated with the group indices. If they are not, the Generalised Composite Commodity Theorem holds.

Lewbel (1996) employed the Engle & Granger (1987) cointegration test. Davis (2002) also used the Engle & Granger cointegration test, and then used multiple applications of Lewbel's simple test in conjunction with modified Bonferroni procedures.

An alternative way of testing product aggregation can be deduced from the explanations given by Lewbel (1996) and Asche et al. (1999). When prices and the group's price index are non-stationary, price ratios may vary across observations as long as the distribution of the ratio of the commodity price to the group price is independent of the level of the group price and stationary. Then, it can be investigated whether the GCCT holds by assessing whether the ratio of non-stationary prices is stationary (as already performed in Asche et al., 2001).

This can be performed easily by running the Augmented Dickey-Fuller test (ADF, devised by Dickey and Fuller, 1979; 1981), which assesses whether the series are non-stationary against the alternative hypothesis of stationarity.

4. The Data

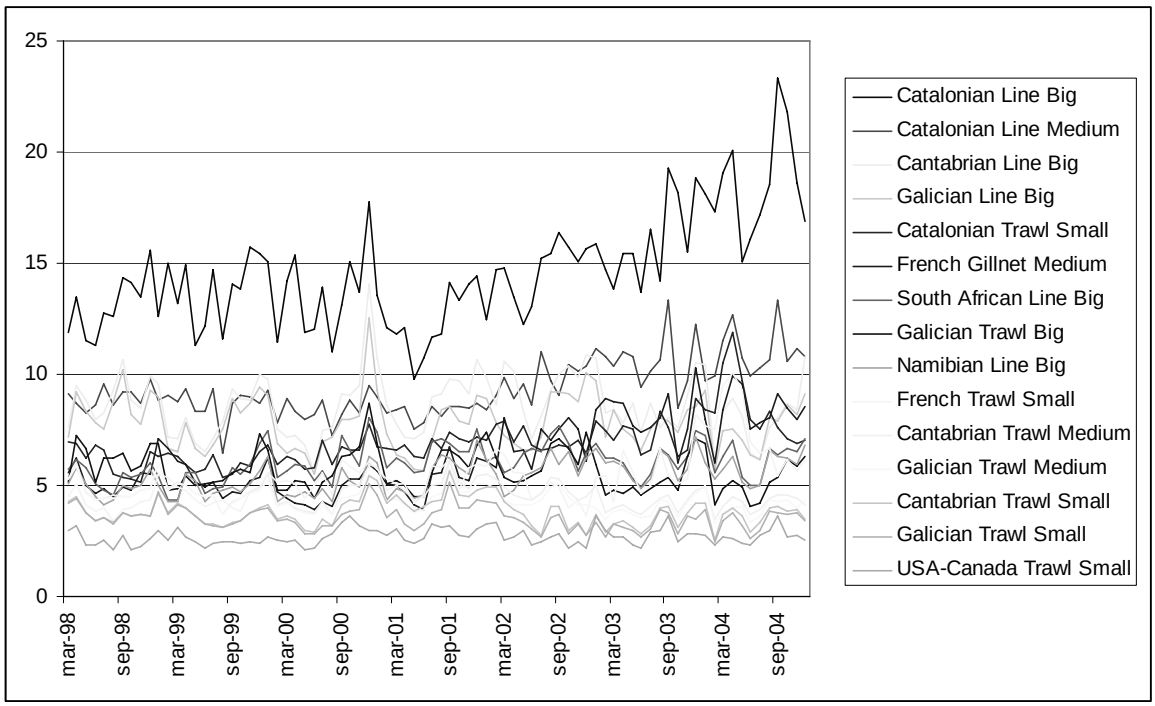
Barcelona's wholesale market is estimated to supply more than 8 million people on a regular basis (as its influence area is larger than the region of Catalonia itself). With around 100 thousand tonnes of seafood sold per year, it accounts for around 20% of the total seafood marketed in the Spanish network of wholesale markets. Hake is one of the main species sold in this market. It is supplied from a wide range of sources, mainly South Africa and Namibia, the Mediterranean and Atlantic waters (the Great Sole and the Cantabrian Sea).

For this analysis, we used 82 monthly price observations for 15 different fresh hake products sold during the period March 1998 to December 2004 in

Barcelona's wholesale market[1]. These 15 products were denoted first by their origin, then by the main fishing gear used (long-line, trawler or gillnet) and finally by size: small (less than 500 g), medium (between 500 g and 1 kg) or big (more than 1 kg). Thus, the 15 products analysed were: Galician Trawl Big, Namibian Line Big, South-African Line Big, Galician Line Big, Cantabrian Line Big, Catalonian Line Big, Cantabrian Trawl Medium, Galician Trawl Medium, Catalonian Line Medium, French Gillnet Medium, Cantabrian Trawl Small, Catalonian Trawl Small, French Trawl Small, Galician Trawl Small and USA-Canada Trawl Small hake.

This wide range of products enabled certain aggregation criteria like size, fishing gear and origin to be tested. Figure 1 shows the price evolution of the 15 hake products analysed.

Figure 1: Price evolution of the 15 fresh hake products analysed from Mercabarna



[1] Other fresh hake products were also sold in Barcelona's wholesale market during the period of analysis. However, these other products were not included in the analysis because they have some missing observations as

Figure 1 indicates that not all the different hake product prices followed the same evolution. Moreover, the mean prices were often quite different. Table 1 shows some descriptive statistics (mean, standard deviation and the coefficient of variation) for the 15 hake products prices and their logs.

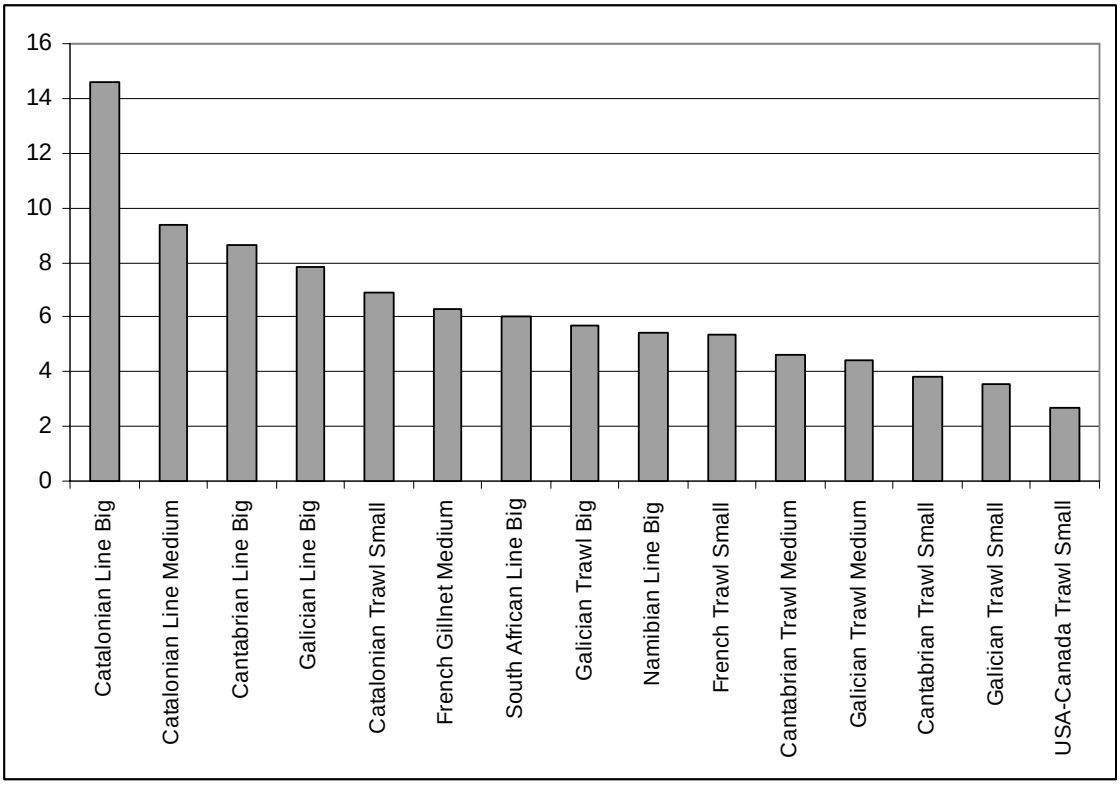
Table 1: Descriptive statistics for the 15 fresh hake products analysed from Mercabarna

	Mean	SD	CV	Ln Mean	Ln SD	Ln CV
Catalonian Line Big	14.61	2.56	17.50	2.67	0.17	6.32
Catalonian Line Medium	9.39	1.28	13.64	2.23	0.13	5.90
Cantabrian Line Big	8.63	1.41	16.28	2.14	0.16	7.53
Galician Line Big	7.82	1.22	15.57	2.05	0.15	7.51
Catalonian Trawl Small	6.91	1.10	15.85	1.92	0.15	7.60
French Gillnet Medium	6.32	1.62	25.59	1.81	0.25	13.92
South African Line Big	6.05	0.83	13.72	1.79	0.14	7.74
Galician Trawl Big	5.70	0.93	16.29	1.73	0.16	9.25
Namibian Line Big	5.41	0.77	14.33	1.68	0.14	8.53
French Trawl Small	5.38	1.27	23.57	1.66	0.22	13.00
Cantabrian Trawl Medium	4.62	0.58	12.55	1.52	0.12	8.17
Galician Trawl Medium	4.39	0.56	12.86	1.47	0.13	8.62
Cantabrian Trawl Small	3.80	0.62	16.38	1.32	0.16	12.30
Galician Trawl Small	3.55	0.53	14.99	1.26	0.15	11.83
USA-Canada Trawl Small	2.70	0.38	14.10	0.98	0.14	14.00

The price variability (coefficient of variation) seems to be quite similar for these products. It is slightly higher for the small trawl hake and the French medium long-line hake. In contrast, the price means show quite different and more interesting patterns, as shown in Figure 2.

Figure 2: Mean price of the 15 fresh hake products analysed from Mercabarna

they were not sold every month of the study period.



The mean prices of the different hake products shown in this figure may establish a consumer preference ranking of the different fresh hake products' attractiveness (taste, freshness, quality, size, etc.). Catalonian Line Big hake is the most highly appreciated product, followed by Catalonian Line Medium hake, Cantabrian Line Big hake and Galician Line Big hake. The next most popular is Catalonian Trawl Small hake, followed by French Gillnet Medium hake, South African Line Big hake, Galician Trawl Big hake, Namibian Long-line Big hake and French Trawl Small hake. At the end of the scale are Cantabrian Trawl Medium, Galician Trawl Medium, Cantabrian Trawl Small, Galician Trawl Small and USA-Canada Trawl Small hake.

In terms of species, this ranking coincides with those presented by Sylvia (1995), Anderson (2003) and Guillen & Franquesa (2005). All these studies indicate that the European hake (from different Spanish regions and France) is the most preferred, followed by the Cape hakes (from South Africa and Namibia) and finally the Silver hake (from USA-Canada).

Furthermore, this ranking clearly shows the preference in Mercabarna for Mediterranean hake, particularly the local one (which is fresher). It also shows a predilection for bigger hake, and for hake fished with long-lines rather than those that are fished with trawlers.

This price ranking also helps to explain the relations between the products. Products with similar prices tend to have high correlation coefficients, as can be seen in Table 2.

5. Analysis

Table 2 shows the degree of correlation between the log of the price series for the 15 products analysed from Mercarbana, Barcelona's wholesale market.

Table 2: Correlation matrix of the log prices of the 15 hake products analysed from Mercabarna

	Catalonian Line Big	Catalonian Line Medium	Cantabrian Line Big	Galician Line Big	Catalonian Trawl Small	French Gillnet Medium	South African Line Big	Galician Trawl Big	Namibian Line Big	French Trawl Small	Cantabrian Trawl Medium	Galician Trawl Medium	Cantabrian Trawl Small	Galician Trawl Small	USA-Canada Trawl Small
Catalonian Line Big	1	0.79	0.23	0.35	0.53	0.71	0.36	0.13	0.56	0.50	-0.06	-0.06	-0.02	0.02	0.19
Catalonian Line Medium	0.79	1	0.17	0.23	0.65	0.84	0.29	-0.02	0.56	0.44	-0.09	-0.13	-0.10	-0.09	0.19
Cantabrian Line Big	0.23	0.17	1	0.87	0.14	0.26	0.59	0.82	0.53	0.06	0.59	0.53	0.49	0.51	0.31
Galician Line Big	0.35	0.23	0.87	1	0.04	0.27	0.54	0.85	0.60	-0.04	0.53	0.56	0.38	0.51	0.28
Catalonian Trawl Small	0.53	0.65	0.14	0.04	1	0.70	0.41	-0.05	0.50	0.84	0.03	-0.10	0.20	0.07	0.33
French Gillnet Medium	0.71	0.84	0.26	0.27	0.70	1	0.35	0.04	0.65	0.57	0.02	-0.04	0.02	0.01	0.29
South African Line Big	0.36	0.29	0.59	0.54	0.41	0.35	1	0.57	0.84	0.39	0.45	0.33	0.46	0.38	0.45
Galician Trawl Big	0.13	-0.02	0.82	0.85	-0.05	0.04	0.57	1	0.49	-0.08	0.72	0.73	0.53	0.61	0.29
Namibian Line Big	0.56	0.56	0.53	0.60	0.50	0.65	0.84	0.49	1	0.41	0.32	0.25	0.28	0.27	0.44
French Trawl Small	0.50	0.44	0.06	-0.04	0.84	0.57	0.39	-0.08	0.41	1	0.04	-0.06	0.31	0.18	0.39
Cantabrian Trawl Medium	-0.06	-0.09	0.59	0.53	0.03	0.02	0.45	0.72	0.32	0.04	1	0.93	0.84	0.84	0.49
Galician Trawl Medium	-0.06	-0.13	0.53	0.56	-0.10	-0.04	0.33	0.73	0.25	-0.06	0.93	1	0.74	0.85	0.35
Cantabrian Trawl Small	-0.02	-0.10	0.49	0.38	0.20	0.02	0.46	0.53	0.28	0.31	0.84	0.74	1	0.93	0.65
Galician Trawl Small	0.02	-0.09	0.51	0.51	0.07	0.01	0.38	0.61	0.27	0.18	0.84	0.85	0.93	1	0.58
USA-Canada Trawl Small	0.19	0.19	0.31	0.28	0.33	0.29	0.45	0.29	0.44	0.39	0.49	0.35	0.65	0.58	1

As observed with the prices, the degree of correlation between products, according to the correlation matrix (Table 2) depends on:

- the proximity between origins, which can be related to both species and freshness. This is true of South Africa and Namibia, which both export Cape hakes to the Spanish market. It also holds for Galicia and the Cantabrian, as well as for Catalonia and France.
- the fishing gear used: long-line or trawl.
- the size: small, medium or big. As expected, the correlation decreases the farther apart the sizes are from each other.

It would be possible to consider hake as one category if all the products could be aggregated. In order to test whether the products could be aggregated, we investigated the stationary properties of the price series, using Augmented Dickey Fuller tests on the logs of the price series. All ADF tests were performed by minimising the AIC, with EViews 5.1. Results are shown in Table 3.

Table 3: ADF unit root tests for the log of the hake prices analysed

	In level	First differences
Catalonian Line Big	-1.17 (11)	-9.62 (1) *
Catalonian Line Medium	-0.92 (3)	-9.38 (2) *
Cantabrian Line Big	-1.45 (12)	-5.06 (13) *
Galician Line Big	-2.19 (13)	-3.91 (13) *
Catalonian Trawl Small	-2.05 (2)	-10.08 (1) *
French Gillnet Medium	0.04 (9)	-4.94 (8) *
South African Line Big	-1.75 (11)	-5.95 (10) *
Galician Trawl Big	-1.59 (10)	-3.98 (11) *
Namibian Line Big	-0.77 (11)	-6.79 (10) *
French Trawl Small	-2.20 (2)	-8.87 (1) *
Cantabrian Trawl Medium	-1.54 (12)	-6.63 (6) *
Galician Trawl Medium	-1.55 (12)	-2.83 (11) *

Cantabrian Trawl Small	-2.16 (12)	-9.21 (1) *
Galician Trawl Small	-1.83 (12)	-2.83 (11) *
USA-Canada Trawl Small	-1.72 (10)	-5.34 (9) *

The number of lags is shown inside the parentheses. * denotes when the null hypothesis of the existence of at least one unit root (non-stationarity) is rejected at a 5% significance level.

The null hypothesis of the existence of at least one unit root could not be rejected (at a 5% level) for any of the price series. All the first differences in the price variables reject the null hypothesis of the existence of a unit root. Therefore, it can be concluded that all the price series are non-stationary I (1) processes. This result was expected, as most economic variables (and therefore prices) are non-stationary.

Unit roots tests were undertaken on the ratios between the logs of price series with certain common features. These common features were size, fishing gear and origin. When a ratio between two non-stationary price series was stationary, the series could be aggregated. If all the products could be aggregated, then hake could be considered as one appropriate category.

5.1. Aggregation by size

One of the main distinctions between hake products is size. Guillen (2007) analyses the relation between size and product behaviour in hake. The bigger hakes behave like luxury goods, whilst than smaller ones tend to behave as normal or even inferior goods. Using these premises, we analysed whether hake products could be classified according to their size (big, medium and small categories).

Big hake category

First, it was tested whether all hake over 1 kilogram sold in Barcelona's wholesale market could be aggregated into a common category. As there were no price indexes available for any group (category), and such indexes could not be constructed due to the lack of information about quantities, the price series which had the highest correlation with the other price series in this potential group was selected.

Subsequently, the price series were divided by the Galician Line Big hake, which was the product that had the highest correlation with others in this potential category.

Table 4: ADF unit root tests for the log prices of hake over 1kg hake divided by the log of the prices of the Galician Line Big hake

	In level
Namibian Line Big	-2.92 (1) *
South African Line Big	-3.70 (0) *
Galician Trawl Big	-4.72 (0) *
Cantabrian Line Big	-4.38 (0) *
Catalonian Line Big	-0.16 (12)

As described in the previous ADF tests, the number of lags is shown in parentheses, and * denotes when the null hypothesis of the existence of at least one unit root (non-stationarity) is rejected at a 5 % level.

Table 4 shows that all the hake products except long-line hake from Catalonia can be aggregated together, as the ratio between prices is stationary (except for the Catalonian long-line hake).

Therefore, it is not possible to aggregate these species under the category "*Big hake*". However, the following products could be aggregated under the category "*non-Mediterranean big hake*": the Galician trawl big hake, the Namibian long-line hake, the South-African long-line hake, the Galician long-line hake and the Cantabrian long-line hake.

Medium hake category

Next, we tested whether medium (from 500 grams to 1 kg) hake sold in this market could be aggregated into a common category. In this case, the price series were divided by the Cantabrian Medium hake, which is the category that has the higher correlation degree with others in this potential group.

Table 5: ADF unit root tests for the log prices of medium hake divided by the log of the prices from the Cantabrian Trawl Medium hake

	In level
Galician Trawl Medium	-3.12 (1) *
Catalonian Line Medium	-2.34 (1)
French Gillnet Medium	-0.71 (2)

These results indicate that the Cantabrian and Galician medium hake can be put into the same hake group. This is not the case for Catalonian and French medium hake. Therefore, it is not possible to group these species under the category "*Medium hake*". However, the Cantabrian and Galician medium hake can be classified as "*non-Mediterranean Medium hake*".

In addition to degree of freshness, this delineation could be produced because hake between 500 grams and 1 kg is normally fished by trawl in the Atlantic, while in the Mediterranean it may be fished by long-line, gillnet or minor gears.

Small hake category

We then tested whether small (under 500 grams) hake sold in this market could be aggregated into a common category. In this case, the price series were divided by the Cantabrian Trawl Small hake, which is the category that had the highest correlation with the other members of this potential group.

Table 6: ADF unit root tests for the log prices of medium hake divided by the log of the prices from the Cantabrian Trawl Small hake

	In level
Catalonian Trawl Small	-2.88 (1) º
French Trawl Small	-0.29 (11)
Galician Trawl Small	-2.62 (1) º
USA-Canada Trawl Small	-5.74 (0) *

º denotes when the null hypothesis of the existence of at least one unit root (non-stationarity) is rejected at a 5 % significance level, but not at a 10% level.

These results show that the Cantabrian trawl small hake could be aggregated with the USA-Canada trawl small hake. However, surprisingly it seems that it cannot be aggregated with the Galician trawl small (although the null hypothesis was rejected at a 5% significance level, it was not at a 10% level). Moreover, as in previous cases, the aggregation of the Catalonian trawl small and the French trawl small hake in the group was rejected at a 5 % level (although the aggregation of the Catalonian trawl small hake was not rejected at a 10% significance level).

Therefore, it appears that these species could be grouped under the category "*Small trawl hake*". However, taking into account previous results, there may be one "*non-Mediterranean small trawl hake*" category, with the Cantabrian trawl small, the USA-Canada trawl small hake, and maybe the Galician trawl small.

5.2. Aggregation by origin

After assessing the possibility of aggregating hake products according to size, aggregation tests were required to discover whether the "*non-*

Mediterranean hake" and the "*Mediterranean hake*" were appropriate categories.

Non-Mediterranean hake category

We tested whether all non-Mediterranean hake products sold in Barcelona's wholesale market could be aggregated into a common category. In this case, the price series were divided by the Cantabrian Medium hake, which was the category that had the highest correlation with the others in this potential group.

Table 7: ADF unit root tests for the log prices of "non-Mediterranean hake" divided by the log of the prices of Cantabrian Trawl Medium hake

	In level
Galician Trawl Big	-2.26 (13)
Namibian Line Big	-0.95 (3)
South African Line Big	-1.85 (4)
Galician Line Big	-1.53 (12)
Cantabrian Line Big	-4.42 (0) *
Galician Trawl Medium	-3.12 (1) *
Cantabrian Trawl Small	-2.07 (3)
Galician Trawl Small	-6.26 (0) *
USA-Canada Trawl Small	-5.72 (0) *

From these results it can be seen that "*non-Mediterranean hake*" is not an appropriate category, as many products could not be aggregated into this group. A better option involves maintaining the "*non-Mediterranean big hake*" category, and adopting a "*non-Mediterranean medium and small hake*" category, which was only rejected for Cantabrian trawl small hake.

Mediterranean hake category

Subsequently, we tested the existence of a Mediterranean hake group, including all French and Catalonian hake products. In this case, the price series were divided by the Catalonian Line Medium hake.

Table 8: ADF unit root tests for the log prices of medium hake divided by the log of the prices of the Catalonian Line Medium hake

	In level
Catalonian Line Big	-6.62 (0) *
Catalonian Trawl Small	-2.63 (1) º
French Gillnet Medium	-1.76 (3)
French Trawl Small	-2.69 (1) º

It does not appear to be possible to aggregate all French and Catalonian hake products into the same category "*Mediterranean hake*", as the null hypothesis of non-stationarity for the Catalonian trawl small, the French gillnet medium and the French trawl small hake was rejected at a 5 % level; but was not rejected at the 10% level for the Catalonian trawl small and the French trawl small.

Nevertheless, the Catalonian long-line big hake and the Catalonian long-line medium hake could be aggregated into a common category, which could be called "*Mediterranean or Catalonian long-line hake*".

Small Mediterranean trawl hake and French hake categories

Finally, in order to better interpret previous results, we tested whether all small trawl hake from the Mediterranean (Catalonian and French) and all French hake (Medium and Small) could be aggregated.

Table 9: ADF unit root tests for the ratio of the log prices of small Mediterranean trawl hakes and French hakes

	In level
Catalonian Trawl Small / French Trawl Small	-2.75 (2) º
French Medium Gillnet / French Small Trawl	-2.11 (4)

Table 9 shows that the existence of a "*Mediterranean small trawl hake*" category was rejected at a 5 % level. However, it was not rejected at the 10% significance level. A "*French hakes*" category was fully rejected.

5.3. Aggregation by species

The results obtained in Tables 4 to 8, which show the possibility of aggregating hake products according to size or origin, indicate that species aggregation cannot be undertaken. Although such aggregation would work for the groups Cape hakes (Namibian Line Big and South African Line Big) and Silver hake (USA-Canada Trawl Small), it would not work for the European hake (which comprises all other products). Therefore, the two Cape hake products should be included in the "non-Mediterranean big hake" category, and the Silver hake product in the "non-Mediterranean medium and small hake" category.

5.4. Aggregation by fishing gears

The results obtained in Table 4, 7 and 7, which show the possibility of aggregating hake products according to size or origin, indicate that aggregation by fishing gears cannot be undertaken.

Furthermore, more categories have been analysed (e.g. non-Mediterranean trawl hake, long-line hake, etc.) with similar results to the ones already shown in the paper.

6. Concluding remarks

This study examines hake product preferences in *Mercabarna*, Barcelona's wholesale market, which supplies much of Catalonia. The analysis reveals a preference for fresher hake (from closest to the market), and especially for Mediterranean hake. It also shows a preference for bigger hake and for hake fished with long-lines. These preferences, which are reinforced by the significant, traditional consumption behaviour, suggest that hake should not be considered as one homogeneous category.

Likewise, the aggregation test results show that it is not possible to consider that all hake products can be aggregated into the same common category (hake). Instead, several categories should be used.

The aggregation results indicate that several products can be aggregated into different categories, depending on the size of imported hakes (non-Mediterranean). For the Mediterranean hake, a distinction is established between the origin and the fishing gear. Therefore, as detailed above, hake products can be aggregated into the following categories:

- "*Non-Mediterranean big (long-line and trawl) hake*"
- "*Non-Mediterranean medium and small (trawl) hake*" Although no clear evidence was found, it seems likely that medium and small groups can be put together in one category.
- "*Mediterranean (Catalonian) long-line (big and medium) hake*". However, the acceptance of more Mediterranean products in the same category was not clear.

The different categories are in accordance with the market perception, which considers some of these products as luxury goods (especially *Catalonian long-line hake*), while *Non-Mediterranean big hake* could be considered luxury or normal (high) products, and finally *Non-Mediterranean medium and small hake*, could be considered normal (low) or inferior products.

However, these results do not tally with most of the current results obtained on seafood product aggregation and seafood market integration literature. For example:

- Asche et al. (2001) analysed 6 different sizes (from 1 to 7 kg) of Norwegian salmon and found that all of them could be aggregated into a common category.
- Asche et al. (2004) used Eurostat's monthly import prices for the period 1983-1995 and found that the 4 frozen whitefish species analysed behaved as a single species with a single price.
- Asche et al. (2005) analysed the monthly Japanese price import data for 4 salmon products (wild coho salmon, farmed coho salmon, farmed salmon trout and wild sockeye salmon) for the period 1994-2000 and found them to cointegrate and behave as in a single market.

These divergences from previous seafood studies could be explained by the fact that the Spanish fresh hake market is very dynamic and contains a wide range of diverse products, due to traditionally high levels of consumption. While frozen products have a more stable trend and present less variation, as they do not lose their value over time as quickly and have a higher substitutability between products, markets can easily be arbitraged over space and time.

This study questions and rejects an existing and widely used category "hake", by looking at some of the products that make up this category. Hence, other studies' results, which consider hake as one category (product or species) and do not take into account the appropriate product aggregation level, should be questioned.

Only consistent aggregation ensures that the behavioural properties which apply to disaggregated relationships also apply to aggregated relationships. Therefore, it is important to analyse the validity of categories and work with more disaggregated data when necessary. This must be done, even though as

Davies et al. (2000) explain, it involves higher data collection costs, missing observations, multicollinearity, and limited degrees of freedom.

These results for fresh hake products were obtained from Barcelona's wholesale market data. This market regularly supplies over 8 million people. However, the results may diverge slightly if a similar analysis is performed in other markets, due to different consumer preferences, product transportation distances and supply availability.

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