Cointegration and Causality: An application to Fresh Hake in the Spanish Market*

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Abstract. The european markets for some products are strongly regulated by production and price instruments. In the fishing case, the mayority of instruments are adopted in cetralized way from experts who can only with difficulty consider the market pecularities for some species at a national, regional or local level in their analyses. Knowledge of these differentiating issues followed by consideration of the same, could improve the efficiency of the regulatory measures. This paper examines the long term relationship between the price of fresh hake and small hake in the port of Vigo (Spain). The empirical results show that the markets for both goods are interrelated.

Keywords: North Atlantic Hake, Cointegration.

1. INTRODUCTION

In the European Union (EU) the markets for some products are tightly controlled by measures which mainly affect production. In the case of fisheries, producers are subject to control measures that determine who can carry out the activity, where, with what techniques or how much of each species considered representative can be fished. To a great extent, these decisions are adopted in a centralized way on the basis of reports from experts who can only with difficulty consider the market peculiarities for some species at a national, regional or local level in their analyses. Knowledge of these differentiating characteristics followed by consideration of the same, could improve the efficiency of the regulatory measures or, at least, reduce some deficiencies and the likelihood for failure in the decisions adopted.

With the aim of illustrating this intuition, this paper develops an exercise which is confined to a particular case study: price evolution in the first sale market of fresh hake (a singularly important fishery species in Spain) in the Vigo port, which represents over 20% of the spanish Registered Gross Tonnage. This choice has been motivated by the fact that, while most regulatory measures refer to only one species, in the Spanish market the product is differentiated in terms of its freshness as well as its size, with the larger examples (hake) being appreciated more than the smaller ones (small hake). In principle, this circumstance could lead us to think that it would be necessary to adopt measures linked to the markets (minimum price fixing, for example), as though completely different fish species were being dealt with.

The objective of this work is to verify whether there is or not a long-term relationship between the market prices for both differentiated goods.

2. THE SPANISH HAKE MARKET

The European hake is a demersal species distributed over a wide area between the North coast of Morocco and the North Sea. This species is caught using different techniques, such as trawling (a less selective method, with a greater incidence of small-sized) the long lining and fixed gillnetting (Garza, 1995).
According to EUROSTAT in recent years the European hake catch is about 130,000 tons annually, and among the principal producers Spain features (with almost 50% of the catch), Italy (25%), France (10%) and the United Kingdom (5%).
Spanish consumers themselves show a high appreciation of the product, for which their own production is insufficient to satisfy the internal demand, and it is necessary to resort to importation from the other major European producers mentioned. So, Spain is the principal European market for these products and in respect to the fixing of the average prices reached. Also, this market shows a peculiarity: big fish are higher priced than small hake or "little fish". European fishery regulation is centred principally on catch control (annual TACs and limitation of minimum size caught) and the

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means of production used (minimum size of net mesh-size, number of ships, etc.) with the ultimate aim of protecting natural stocks from over-exploitation.
Other measures are directly related to the market, such as the establishing of guide prices per species, prices above which the Producers Organisations can establish prices of withdrawal.

In our case, the EU fixes a single guide price for the European hake (3,85 euros/kg in recent years). In Spain, given the lesser quotation for the small hake, only the producers of the same are the possible beneficiaries of the withdrawal mechanism with price guarantees. For their part, expert biologists estimate that the European hake stock situation is worrying and, for some years have recommended drastic reductions in TACs, increases in minimum specimen-size taken and other technical measures to slow the deterioration of the state of this natural resource.

3. EMPIRICAL METHODOLOGY

All process combinations I(0) are also I(0). In the same way, all process combinations I(1) are also I(1). However, a process combination I(1) that was I(0) could also occur. In this case we could say that the series were cointegrated (Engle and Granger, 1987).
For any set of cointegrated variables, the relationship between them may be expressed by an error correction representation. Here, variables are combined at levels, which collect the long-term relationships suggested by economic theory, as well as the differences from these. The general formula for the error correction model is:

$$\Delta Y_t = \theta_0 + \theta_1 \Delta X_t + \theta_2 ECT_{t-1} + lags(\Delta Y_t, \Delta X_t) + u_t \quad (1)$$

$$\Delta X_t = \alpha_0 + \alpha_1 \Delta Y_t + \alpha_2 ECT_{t-1} + lags(\Delta Y_t, \Delta X_t) + v_t \quad (2)$$

where u_t and v_t are white noise and ECT_{t-1} is known by the name of "error correction term" as it corrects the disequilibrium produced in the short term, allowing for stability or convergence in the long term.
The application of Granger's conventional causality test is common practice in empirical studies. One of the problems presented by this test is that it is possible not to find a causal relationship between variables that share a common trend. Hence the conventional Granger causality tests may lead to misleading results. An advantage of cointegration analysis with respect to this conventional test is that if two variables are cointegrated, there must be Granger - Causality in at least one direction. If the coefficient of the error correction term is significant, a causality relationship will exist between the two variables.
Given that only integrated variables of the same order can be cointegrated, the first thing that must be checked is the order of integrability of the variables. For this, we use the Dickey - Fuller test (1981).

4. EMPIRICAL RESULTS

The two variables used in the study are the average price for fresh hake (PMM) and the average price for small hake (PMP). These average prices can be defined as the quotient between the value obtained at the first sale, in pesetas, and the quantity, in kilograms, for fresh hake and for fresh small hake unloaded throughout the year in the port of Vigo.

The source for these data is the Vigo Port Authority, which publishes the information in its annual report. Altogether we have 35 observations corresponding to the years for the period 1962-1996.
First, we performed the unit root tests for PMM_t and PMP_t. The results in levels and first differences are reported in Table 1.

Table 1: Dickey and Fuller tests Results of unit root tests (levels and first differences)

	$Z(\phi_3)$	$Z(\phi_2)$	$Z(\tilde{t}_\alpha)$	$Z(\phi_1)$	$Z(t_{\alpha*})$	$Z(t\hat{\alpha})$
PMM	0.855	1.139	-1.225	1.211	-0.845	0.388
PMP	2.478	3.258	-2.216	2.2375	-0.40	1.30
ΔPMM	2.582	1.892	-1.808	2.373	-2.057	-2.18
ΔPMP	2.682	1.838	-2.022	2.84	-2.35	-1.846
critical values T=50 □=10%	5.61	4.31	-3.18	3.39	-2.60	-1.61

Note**:** Fuller (1976) and Dickey and Fuller (1981) critical values.

The results show that we could not reject the null hypothesis of unit roots for both variables in level forms. Based on the results in Table 1, we performed the cointegration tests.

Table 2: Test for cointegration

test	critical values at the 10%
CRDW =1.242	0.32
CRDF = -3.55	-3.04
Engle y Granger (1987)	
Z - Test = -23.46	-17.1
T - Test = -3.63	-3.04
Phillips y Ouliaris (1990)	

Note: Sargan and Bhargava, 1983; Davidson and Makinnon, 1993; critical values.

Table 3: Test for cointegration (Johansen, 1992)

test		critical values at the 10%
H0: r=0	26.7869	13.752
H0: r=1	2.6121	7.5250
Maximal Eigenvalue		
H0: r=0	29.3989	17.852
H0: r=1	2.6121	7.5250
Trace		

Note:Non – trended case (model 2). Ostewald – Lenum (1992) critical values.

What can be seen in Tables 2 and 3 the cointegration test (Engle y Granger, 1987; Phillips y Ouliaris, 1990; Johansen, 1992) indicates that the two variables are cointegrated.

Table 4 present the results of the Granger causality test based on the error-correction model (equations 1 and 2).

The results show a causality relationship between the average hake price and the average small hake price in both directions.

Table 4: Results of the causality between PMM and PMP using ECT

(based on cointegration regressions on PMM and PMP)

	Coefficient	t Statistics
PMM - PMP	-0.69 (*)	-3.25
PMP - PMM	-0.44 (*)	-2.82

Note: (*) indicates significant at the 10% level.

5. DISCUSSION

The empirical results suggest the existence of a bidirectional causality relationship between the two variables, which implies that the markets for both goods are interrelated. In principle, this circumstance could justify the Common Fisheries Policy establishing a single withdrawal and orientation price for hake independently of its size.

However, the peculiarity shown by the Spanish fresh hake market yields interesting information that we ought to take into account when adopting regulatory measures. On the one hand, the biologists insist on the harmful effects that the catching of immature specimens have on the evaluation of natural stocks. On the other hand, the EU establishes (withdrawal) price mechanisms thought, in principle, to protect the producers' profits. In our case, these instruments of intervention in the markets constitute protection for the fishermen most harmful to the natural stock (those who fish with less selective techniques and catch principally "little fish", small or immature hake which are of the lesser average price in the markets.)

The restrictive measures that the EU must adopt over the European hake fisheries must, in our opinion, principally affect the catching and commercialisation of the specimens of smaller size (immature hake). These initial restrictions favour in the long term greater possibilities of catching bigger specimens. Given that, in the long term, the large- and small-hake markets are integrated, both prices will evolve in the same sense, but will maintain the quotation differences. Therefore, the less selective fishermen will have greater incentive to re-orientate their activity towards less harmful fishing techniques and will increase the level of acceptance of possible restrictive measures over the fishing arts (for example, an increase in minimum net mesh-size), then there would be no sense in continuing to fish for small specimens when there exist greater possibilities of catching those which fetch a better price in the market.

References

Davison, R. and Mackinnon, J., *Estimation and inference in econometrics*, Oxford, University Press, 1993.

Dickey, D. and Fuller, W., The likelihood ratio statistic for autorregresive time series with a unit roots, *Econométrica* 49, 1057-1072, 1981.

Engle, R. and Granger, C., Cointegration and error correction: representatión, estimation and testing, *Econométrica* 55, 251-276, 1987.

Fuller, W., *Introduction to statical Time Series*, New York, John Wiley and Sons, 1976.

Johansen, S., Determination of cointegration rank in the presence of a linear trend, *Oxford Bulletin of Economic and Statistics* 54, 383 – 397, 1992.

Oxtewald – Lenum, M., A note with quantiles of the asymptotic distribution of the ML cointegration

rank test statistics, *Oxford Bulletin of Economics and Statistics* 54, 461 – 472, 1992.

Phillips, P. and Ouliaris, S., Asimptotic properties of residual based test for cointegration, *Ecométrica* 58, 165-193, 1990.

Phillips, P and Perron, P., Testing for a unit root in Time Series Regressión, *Biometrica* 75, 235-346, 1988.