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SEASONALITY AND COINTEGRATION IN THE FISHING INDUSTRY OF CORNWALL

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Abstract

This paper examines the evidence for seasonal effects and cointegration between fisheries prices of main species landed into Cornwall. This is the first comprehensive study of fisheries seasonality. The results show significant monthly effects in April and negative monthly effects in February. We also find cointegration between prices, and show that in the long run prices are converged. The results also reveal that Granger causality is unidirectional in fourteen cases and bi-directional in six cases. Examining the form and magnitude of seasonal fluctuations and fish price linkages can be beneficial to fisheries managers in their decisions regarding policy, development and management.

JEL Classification: C51, O52
Keywords: Fish prices, Cornwall, Seasonality, Cointegration.

1. Introduction

Behaviour of fish prices is an important factor in the formation of fisheries policy, development and management. The direction of prices between various fish species and markets is important to studies of fisheries economics and applied econometrics. It is obvious that changes in prices affect the incomes received by fishers. Jaffry *et al.* (1999, p. 473) report that '*an increase in landings could potentially result in a decrease in overall revenue if prices declined significantly as a result*'.

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Seasonal effects in prices have puzzled economists for many years. Researchers argue that these effects may arise because of factors that influence demand. Seasonal demand variations represent a central theme in policy-making and managerial economics. The most important calendar effect is the monthly effect, where several possibilities have been suggested. Although most of the calendar (seasonal) effects research has concentrated on capital markets (Mills *et al.*, 2000), it is therefore important to see what the results will be for another, and hence very interesting, market such as the fishery. Yet, to our knowledge, there has been a limited research in the past to analyse the seasonal movements in fisheries prices. Recently, Floros and Avdelas (2004) explain the seasonal behaviour of fish prices in Greece and argue that the main factors that influence the demand for species are (i) the weather conditions, (ii) the calendar effects and (iii) the increased/decreased demand during the year. Their results show evidence of weak positive monthly effects for the beginning of summer, and weak negative effects in autumn.

Furthermore, a number of studies investigate the price flexibilities/linkages in the fishing industries of Europe, Japan and U.S. Recent papers consider cointegration methods to study the long-run equilibrium between prices and market delineation. An early study on the price linkages in the fishing industry is introduced by Squires (1986). He examines the direction of ex-vessel price linkages between the three ports of Boston, New Bedford and Gloucester in New England. His results indicate that New Bedford's prices lead those of the other ports, and Boston's cod prices lead those of Gloucester.

Gordon *et al.* (1993) test for market linkages between high- and low-valued fish species on the Rungis fish market near Paris. They apply Engle-Granger and Johansen cointegration tests. Their results suggest that the market for salmon is not linked to the markets for turbot or cod. Further, Vassdal *et al.* (1994) report long run equilibrium between fresh and frozen salmon prices in Europe, while Guillotreau and Grel (2001) explain why prices for fresh fish are expectedly variable. Accordingly, this is due to the rigidity of supply with regard to prices. Bose and McIlgorm (1996) examine the long-run inter-species price relationships in the Japanese tuna market. First, they test for the existence of long-run relationships in both bivariate and multivariate contexts, and then they test whether the co-movement of prices is a result of the spillover effects of any macroeconomic shock to the economy.

Jaffry *et al.* (1998) investigate the market delineation of fish species in Spain. Using bivariate cointegration methods, they find little evidence of an integrated market. However, when multivariate cointegration methods are considered, the results suggest that markets are cointegrated. According to Jaffry *et al.* (1998), a demand analysis need to be undertaken, in order to determine how strong these relationships actually are. Furthermore, Jaffry *et al.* (1999) estimate the own and cross-price flexibilities for four high valued species (bass, lobster, sole and turbot) landed in the UK. Johansen's multivariate approach indicates more than one cointegration long run relationships between the variables. It is also reported that bass has the largest absolute long-run own price flexibility.

Fereira *et al.* (2003) use statistical cointegration tests for the monthly price series of codfish fish value chain for Norway-Portugal. They find that markets are integrated. Their results also suggest that the price of the wet salted cod is influenced both by retail price in Portugal and the exvessel price in Norway. Finally, Jimenez-Toribio *et al.* (2003) analyse the integration relationships (horizontal and vertical) in the Spanish distribution channel of the striped venus considering prices from exvessel and wholesale markets and foreign trade. Their methodology is based on cointegration and causality techniques, and results suggest no cointegrating relationship between prices. Also, they show that exvessel market prices are causing wholesale market prices.

In this paper, we focus on monthly seasonality and market analysis using data from fishing industry in Cornwall. The aim of this paper is to explain the movement of fisheries prices within the year and compare them across different models. We examine the evidence for seasonal effects and long-run relationships between the fisheries prices using AR(p), MA(q) and ARMA(p,q) models. We also apply Johansen method and Granger[1]-causality test for long- and short-run relationships among variables. The paper follows the previous works of Floros and Avdelas (2004) and Jaffry *et al.* (1999).

The paper is organised as follows: Section II describes the data, while Section III shows an overview of econometric models employed. Section IV presents empirical results from various econometric models. Finally, Section V concludes the paper and summarizes our findings.

2. Data

Cornwall is the most important county in the South West England. The SW fishing industry is estimated to be worth £244 million and accounts for approximately 3,350 jobs. A total of £72.4 million worth of fish was landed in SW ports in 2001. This is equivalent to 0.11% of the GDP of the region. The SW fishing fleet is made up of 1,149 vessels. The main species can be divided into the following groupings: pelagics 7%, prime fish 32%, non-quota shell 33% and medium value fish 28%. Newlyn (the main port in Cornwall), accounts for the great majority (64%) of landings.

The data employed in this study comprise 132 monthly observations on the main species landed into Cornwall covering the period from January 1992 to December 2002. Monthly average prices (£/tonne) for main species were obtained from Defra[2] (UK). We consider the following 12 species (based on three main fish types): Anglerfish, Cod, Dogfish, Haddock, Hake, Lemon sole, Plaice, Saithe, Sole and Whiting (Demersal fish), Mackerel (Pelagic fish) and Crabs (Crustacea fish). The data are plotted in levels in Appendix 1.

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[1] The Royal Swedish Academy of Sciences has announced an award of the 2003 Prize in Economic Sciences (Nobel Prize) to Clive Granger of University of California at San Diego (USA) for methods of analysing economic time series with common trends.

[2] DEFRA stands for Department for Environment Food and Rural Affairs.

Table 1a and Table 1b give the descriptive statistics for monthly growth rate of prices. The mean values range between –0.000654 and 0.006588. The negative (positive) values for skewness indicate that the series distributions are skewed to the left (right). The values for kurtosis are high for 11 out of 12 species. Hence, eleven species show excess kurtosis (i.e. leptokurtic pdf), implying fatter tails than a normal distribution. The Jarque-Bera test rejects normality at the 5% level for eight species. A necessary condition for stable relationship is that each of the variables should be integrated of the same order. The Augmented Dickey-Fuller[3] (ADF) test is performed on both the levels and first differences of the log-series. The results of ADF tests indicate that each series is nonstationary in levels and stationary in first differences. As a result, the series are individually integrated of order one, I(1). Therefore, all series are correlated, and regression techniques can be used to confirm whether there exists such a seasonal structure between fisheries prices in Cornwall.

Table 1a. Descriptive Statistics

	COD	CRABS	DOGFISH	ANGLERFISH	HADDOCK	HAKE
Mean	0.003267	0.002697	0.000856	0.002898	0.001389	0.003681
Median	0.007480	0.006990	0.021120	0.001277	0.003235	0.011375
Maximum	0.376217	1.098612	0.779751	0.284606	0.532279	0.606301
Minimum	-0.556357	-1.094588	-0.842547	-0.447955	-0.573979	-0.889677
Std. Dev.	0.161861	0.198567	0.327800	0.114082	0.200924	0.237256
Skewness	-0.266042	-0.045694	-0.241904	-0.536267	-0.006292	-0.372313
Kurtosis	3.780381	16.12241	3.257630	4.527561	3.205973	4.551623
Jarque-Bera	4.869421	939.9579	1.639919	19.01557	0.232434	16.16758
Probability	0.087623	0.000000	0.440449	0.000074	0.890282	0.000308
Observations	131	131	131	131	131	131
ADF- Level	-0.385023	-3.274321	-3.942354	-0.955897	-2.992184	-1.319906
ADF- 1st diff.	-6.067184	-9.180646	-5.37957	-4.651745	-5.916532	-6.823473

[3] The ADF is given by $\Delta Y_t = a_0 + aY_{t-1} + \sum_{i=1}^{n} d_i \Delta Y_{t-i} + e_t$ where Y is logarithmic price.

Table 1b. Descriptive Statistics

	LEMON SOLE	MACKEREL	PLAICE	SAITHE	SOLE	WHITING
Mean	0.006219	0.006588	0.003446	-0.002245	0.003465	-0.000654
Median	0.011880	0.006653	0.026628	0.005944	-0.012300	0.002571
Maximum	0.284176	0.922722	0.359477	0.788700	0.469376	0.427038
Minimum	-0.408993	-1.188859	-0.561632	-1.147402	-0.242224	-0.485001
Std. Dev.	0.129668	0.328206	0.169276	0.232366	0.108608	0.180860
Skewness	-0.544920	-0.068691	-0.768448	-0.527100	0.974066	-0.114496
Kurtosis	3.718049	4.880193	3.854433	7.544196	4.780474	2.993769
Jarque-Bera	9.297425	19.39891	16.87775	118.7791	38.01895	0.286432
Probability	0.009574	0.000061	0.000216	0.000000	0.000000	0.866567
Observations	131	131	131	131	131	131
ADF- Level	-3.455213	-2.574158	-2.193500	-0.174655	-1.455071	-0.107495
ADF- 1st diff.	-6.690700	-7.795142	-5.211974	-7.332792	-3.648442	-4.183389

Notes*:* Price series in first difference of logarithms. ADF regressions include intercept only. We employ ADF test on the logarithms of average prices.

3. Methodology

- *Seasonality (Monthly effect)*

The seasonal variations in a fisheries price series can be tested by regressing the growth rate of the variable DY_t against a set of seasonal dummy variables. The variable Y_t is the natural logarithm of the series, while D_{it} are seasonal dummies that take the value 1 if the variable at time t belongs to month i and 0 if it belongs to any other month ($i = 1,...,12$ corresponds to January through December). The following models are applied:

OLS model

The simple model is described by the following equation (see Kavussanos and Alizadeh-M, 2002):

$$\Delta Y_t = \sum_{i=1}^{i=12} d_i D_{it} + e_t \qquad (1)$$

AR(p) model

An AR(p) model is one where the current value of a variable depends upon the values that the variable took in previous periods plus an error term. An AR(p) can be expressed as

$$\Delta Y_t = c + a_1 \Delta Y_{t-1} + a_2 \Delta Y_{t-2} + ... + a_p \Delta Y_{t-p} + u_t + \sum_{i=1}^{i=12} d_i D_{it} \qquad (2)$$

where u_t is a white noise disturbance term.

MA(q) model

A moving average (MA) process is one in which the systematic component is a function of past innovations. An MA(q) model can be expressed as

$$\Delta Y_t = c + b_1 e_{t-1} + b_2 e_{t-2} + ... + b_p e_{t-p} + e_t + \sum_{i=1}^{i=12} d_i D_{it} \qquad (3)$$

ARMA(p,q) model

By combining the AR(p) and MA(q) models, an ARMA(p,q) model is a model that the current value of some series depends linearly on its own previous values plus a combination of current and previous values of a white noise error term. The ARMA(p,q) specification has the form:

$$\Delta Y_t = c + a_1 \Delta Y_{t-1} + a_2 \Delta Y_{t-2} + ... + a_p \Delta Y_{t-p} + e_t + b_1 e_{t-1}$$
$$+ b_2 e_{t-2} + ... + b_q e_{t-q} + \sum_{i=1}^{i=12} d_i D_{it}$$

Given the stated theories concerning the month of the year effect, the coefficient of the dummies d_i should be positive (negative) and significant in order to have positive (negative) monthly effect for each of the species landed into Cornwall.

- *Cointegration and Granger-causality*

Our aim is to examine how close fish products are linked. In a time series framework, market linkage implies a long run equilibrium relationship among the prices. This also indicates that prices must be cointegrated with each other. Granger and Newbold (1974) argue that a linear combination of two or more non-stationary series may be stationary, and hence, variables are cointegrated. Cointegration analysis has become a common econometric tool for empirical work. It is a powerful technique for investigating common trends in multivariate time series, and provides a sound methodology for modelling both long-run and short-run dynamics in a system of variables.

The basis of this approach is to estimate by maximum likelihood methods an equation of the form:

$$\Delta X_t = d + \Pi X_{t-1} + \sum \Gamma_i \Delta X_{t-i} + e_t \qquad (4)$$

where the i determines the number of lags specified in the dynamic VAR relationship. X_t is a column vector of the three indices. If Π has zero rank, no stationary linear combination can be identified, so the variables in X_t are non-cointegrated. However, if the rank is r, there will be r possible stationary linear combinations.

Furthermore, this paper explains whether current values can be explained by past values. Granger (1977) provides a definition of causality among a set of variables. A variable X causes another variable Y, if present Y can be better predicted by using past values of X. Feedback occurs if X causes Y and Y causes X. The Granger approach is given by bivariate regression of the form:

$$\begin{aligned} X_t &= a_0 + a_1 X_{t-1} + \ldots a_l X_{t-l} + b_1 Y_{t-1} + \ldots + b_l Y_{t-l} + u_t \\ Y_t &= a_0 + a_1 Y_{t-1} + \ldots a_l Y_{t-l} + b_1 X_{t-1} + \ldots + b_l X_{t-l} + e_t \end{aligned} \qquad (5)$$

The null hypothesis is that X does not Granger-cause Y in the first regression and Y does not Granger-cause X in the second regression, for all possible pairs (X,Y) series in the group.

4. Empirical results

We start the analysis of seasonality in the fishing industry of Cornwall by investigating whether monthly effects in the fish species can be adequately described by time series models. Table 2 gives seasonality results from selected time-series models[4]. The results suggest significant positive effect in April for 6 species (cod, crabs, haddock, mackerel, plaice and whiting). In addition, we find significant negative effect in February for 7 species (anglerfish, cod, hake, lemon sole, plaice, saithe and sole). Normally, the seasonality of fish species (and value of landings) is affected both by availability and market price. According to the Ekos Consulting (UK) Ltd. & Nautilus Consultants (2003) report, in the run up to Christmas important export markets in Spain may push the price of, for example, crabs higher than the rest of the year. The impact of seasonal fisheries and demand, particularly from export markets, on Newlyn port is highly significant. Newlyn landed the greatest monthly values in June 2001 with larger landings of prime fish and double the value of shellfish (e.g. crabs).

Table 2. Seasonality Results Panel A

Species-Models / Dummies	Anglerfish-ARMA (2,1)	Cod-MA(2)	Crabs-MA(3)	Dogfish-MA(2)	Haddock-MA(2)	Hake-ARMA (2,1)
January	0.024	0.018	-0.064	0.026	0.029	0.0655
February	-0.167*	-0.135*	0.018	-0.052	-0.089	-0.153*
March	0.058	0.044	-0.054	0.158*	0.109*	0.0549
April	-0.095*	0.135*	0.109	0.026	0.131*	-0.023
May	-0.043	-0.007	-0.076	-0.058	-0.039	-0.084
June	0.080*	-0.024	-0.014	-0.071	0.092	-0.097
July	-0.017	-0.036	-0.03	-0.072	-0.073	-0.008
August	-0.0007	0.036	0.067*	0.120	0.051	0.0118
September	0.067*	0.125*	0.046	-0.188*	-0.053	0.0402
October	0.071	-0.049	0.007	0.0008	-0.0042	0.0286
November	-0.014	-0.034	-0.061	0.202*	-0.130*	0.0928
December	0.103*	-0.038	0.089*	-0.084	-0.013	0.0697

[4] The results from selected (through the AIC) models are available upon request.

Panel B

Species-Models / Dummies	Lemon Sole-ARMA (1,1)	Mackerel -ARMA (2,2)	Plaice- ARMA (2,2)	Saithe-ARMA (1,1)	Sole-ARMA (2,2)	Whiting-MA(2)
January	-0.057	0.102	-0.090*	-0.047	-0.033	0.033
February	-0.166*	0.008	-0.286*	-0.105*	-0.072*	-0.097
March	-0.061	0.048	-0.022	0.050	-0.043*	0.061
April	0.062*	0.311*	0.163*	0.0062	-0.035*	0.125*
May	-0.046*	0.053	0.101*	-0.065	0.058*	0.095*
June	0.015	0.076	-0.024	-0.010	0.155*	0.011
July	-0.039	0.050	0.0254	0.004	0.057*	-0.12*
August	0.121*	0.003	0.0361	-0.045	-0.019	-0.088*
September	0.083*	-0.289*	0.0424	-0.070	-0.003	0.024
October	0.031	-0.288*	-0.025	0.051	-0.033*	0.052
November	0.069*	-0.082	0.051	0.094	-0.067*	-0.042
December	0.058*	0.032	0.029	0.144	0.053	-0.059

* Indicates significant monthly effect

This finding can be explained *"by the better weather allowing more fishing by the inshore fleet topping up the supplies of prime fish being landed by the larger vessels throughout the year"* (Ekos Consulting (UK) Ltd. & Nautilus Consultants, 2003; p. 40). Appendix 2 shows the percentage effects for top species in Cornwall during the months January – December.

The principle of price correlation analysis states that if products are in the same market, their prices should move together over time. Any event that affects one product and changes its price relative to others will trigger substitution either in demand or supply. Eventually, prices will come back into line. If substitution is easy and fast, we should see prices moving pretty much together over time. A better knowledge of demand conditions over time leads to the long run equilibrium; see Guillotreau and Grel (2001).

They argue that if demand is elastic and supply more elastic in the long run, prices would diverge from the long run equilibrium In this paper, the Johansen approach (1988, 1991) can be used to test for cointegration and long-run equilibrium among the twelve variables. The Akaike Information Criterion (AIC) for VAR system indicates that 1 lag is appropriate. Table 3 reports the results for the trace statistics of the Johansen test. We find evidence for cointegration and long-run relationship between the selected Cornish fish prices.

The null hypothesis that there is one cointegration equation (CE), r=1, gives a trace statistic of 448.4532, and it is rejected at 1% level. Similarly, the trace test rejects the null hypotheses r=2…9 at 1% level. The null hypotheses r=10 and r=11 give a trace statistic of 17.32739 and 4.043236, respectively. Both hypotheses are rejected at the 5% level. So, we conclude that monthly average fisheries prices are cointegrated, with eleven cointegration relationships. Therefore, there exists a linear combination of the monthly fisheries prices in the fishing industry of Cornwall. Statistical evidence, not reported in this study, based on the maximum eigenvalue test, arrives at the same conclusion.

Furthermore, Granger (1977) shows that if variables are cointegrated, the finding of Granger non-causality (null hypothesis) is ruled out. Table 4 shows the results from *Pairwise Granger Causality Tests* for the logarithms of prices. We reject the null hypothesis of no Granger causality in twenty-six cases. Also, we find six bi-directional relationships (feedback) between the variables. In particular, we reject the hypotheses that Hake does not Granger cause Whiting, Lemon Sole, Haddock, Cod and Anglerfish as well as Plaice does not Granger cause Mackerel. It appears that Granger causality runs two-way, and therefore we find significant short run relationships (bi-directional causality). The results suggest that hake helps in the prediction of other top species landed into Cornwall.

Table 3. Multivariate Cointegration Test

Trend assumption: Linear deterministic trend				
Series: LANG LCOD LCRABS LDOGFISH LHADDOCK LHAKE LLEMONSOLE LMACKEREL LPLAICE LSAITHE LSOLE LWHITING				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test				
Hypothesized No. of CE	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None (r=0)	0.491202	536.2948	NA	NA
At most 1 ** (r=1)	0.475362	448.4532	277.71	293.44
At most 2 ** (r=2)	0.420999	364.5970	233.13	247.18
At most 3 ** (r=3)	0.399114	293.5585	192.89	204.95
At most 4 ** (r=4)	0.319657	227.3429	156.00	168.36
At most 5 ** (r=5)	0.285852	177.2723	124.24	133.57
At most 6 ** (r=6)	0.274621	133.5059	94.15	103.18
At most 7 ** (r=7)	0.228308	91.76809	68.52	76.07
At most 8 ** (r=8)	0.157922	58.07603	47.21	54.46
At most 9 ** (r=9)	0.132004	35.73126	29.68	35.65
At most 10 * (r=10)	0.097138	17.32739	15.41	20.04
At most 11 * (r=11)	0.030623	4.043236	3.76	6.65
Notes: *(**) denotes rejection of the hypothesis at the 5%(1%) level.				
Trace test indicates 11 cointegrating equation(s) at both 5% and 1% levels. All series are in logarithmic form.				

Table 4. Granger Causality Tests

Pairwise Granger Causality Tests			
Sample: 1 132			
Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Probability
COD does not Granger Cause ANGLERFISH	131	14.6964	0.00020*
HAKE does not Granger Cause ANGLERFISH	131	9.30818	0.00277*
ANGLERFISH does not Granger Cause HAKE		7.23736	0.00809*
LEMONSOLE does not Granger Cause ANGLERFISH	131	8.20784	0.00488*
PLAICE does not Granger Cause	131	4.92081	0.02830*

ANGLERFISH			
ANGLERFISH does not Granger Cause SAITHE		4.99813	0.02711*
ANGLERFISH does not Granger Cause SOLE		5.30421	0.02289*
HAKE does not Granger Cause COD	131	7.53261	0.00693*
COD does not Granger Cause HAKE		13.6321	0.00033*
COD does not Granger Cause LEMONSOLE		4.32350	0.03959*
COD does not Granger Cause PLAICE		3.92038	0.04985*
SAITHE does not Granger Cause DOGFISH	131	4.34138	0.03919*
HAKE does not Granger Cause HADDOCK	131	5.88141	0.01670*
HADDOCK does not Granger Cause HAKE		14.1786	0.00025*
HADDOCK does not Granger Cause WHITING		4.18100	0.04293*
LEMONSOLE does not Granger Cause HAKE	131	5.71322	0.01830*
HAKE does not Granger Cause LEMONSOLE		10.1767	0.00179*
MACKEREL does not Granger Cause HAKE	131	9.88830	0.00207*
HAKE does not Granger Cause SOLE		8.31713	0.00461*
WHITING does not Granger Cause HAKE	131	3.98624	0.04799*
HAKE does not Granger Cause WHITING		6.33716	0.01306*
LEMONSOLE does not Granger Cause SAITHE		7.67047	0.00645*
SOLE does not Granger Cause LEMONSOLE	131	4.43884	0.03708*
PLAICE does not Granger Cause MACKEREL	131	6.93016	0.00952*
MACKEREL does not Granger Cause PLAICE		6.93769	0.00948*
MACKEREL does not Granger Cause SOLE		12.5159	0.00056*

Notes: * Reject Ho (null hypothesis).Series in logarithms.We highlight the bi-directional causalities (or feedback).

5.Conclusion

This paper examines seasonality (monthly effect) and cointegration (price linkages) in the fishing industry in Cornwall (SW England). The aim of this paper is to explain monthly effect on prices and test whether prices in the same market move together over time. Seasonal behaviour and market linkages of fish prices are important factors in the formation of fisheries policy, development and management. This paper shows that the impact of seasonal variation is significantly positive in April for six species (cod, crabs, haddock, mackerel, plaice and whiting), and significantly negative in February for seven species (anglerfish, cod, hake, lemon sole, plaice, saithe and sole). From 1992 to 2002, the overall trend in both volume and value of landings in SW England is upwards up to 1999 and downwards after that, although on the recent period, price increases have enabled total value to decrease significantly than landed volume (Ekos Consulting (UK) Ltd. & Nautilus Consultants, 2003). Despite this, the last 5 years has seen a 23% decrease in landed value. Two main factors explain this phenomenon: the first one is the growing proportion of small pelagic fishes (low commercial value) against the white fishes (high commercial value) in the total catches and the second one is the decrease of the allocated quotas for white fishes since the beginning of the 90s (Failler *et al.*, 1999).

Furthermore, this paper uses Johansen and Grange-causality tests to examine short- and long-run relationships between fish prices in Cornwall. We develop a VAR model and use a multivariate cointegration approach to test for price linkages. Based on the estimated results, we find evidence for cointegration and long-run relationships. Also, empirical results show that Granger causality is unidirectional in fourteen cases, while six bi-directional causalities are reported in which hake helps in the prediction of other top species.

These findings are strongly recommended to fisheries managers and analysts dealing with Cornish fish prices in the way that 90% of the Cornish landings are exported towards the London market or France (mainly shellfish) without any process and undergo the prices of a demand driven market as all landing ports of fresh fishes in Europe (Failler, 2004). The integration of price seasonality and cointegration phenomenon into the strategy of fishermen will allow them to benefit more from their landings. It will also force and add processing value into their catches in order to mitigate the low price months and take more advantage of the good price months. Such a strategy can be implemented at a broader level by involving the Producer organisations and the management bodies to generate more benefits for the Cornish Region. Since the fresh product cannot be store for a while, the only way to accommodate and take advantage of price seasonality is to process, store and sell at the right time. The signal that hake is given can be easily integrated into a fishery policy (and development) both at the port or regional level in the way that fishermen will know and be able to predict the market conditions for the other main species and adjust (according to that) their fishing strategies. In other words, the findings of this paper are a way for the Cornish fishery sector to be less vulnerable to price fluctuations and demand driven market itself.

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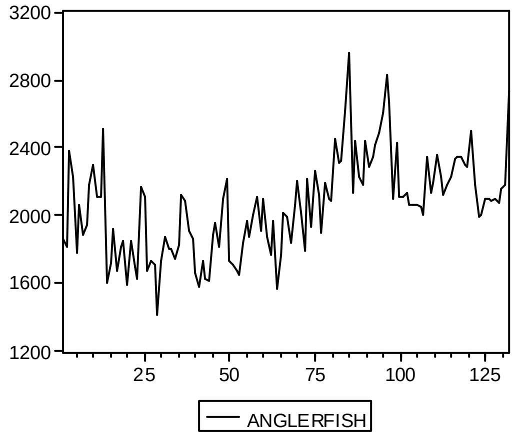
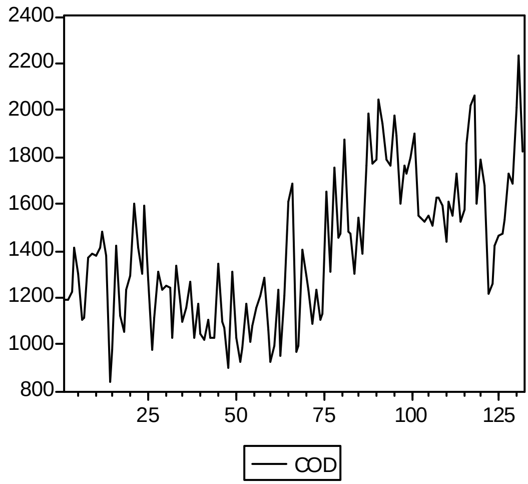
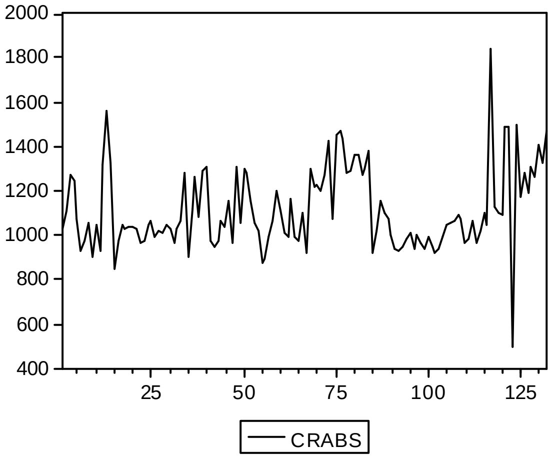
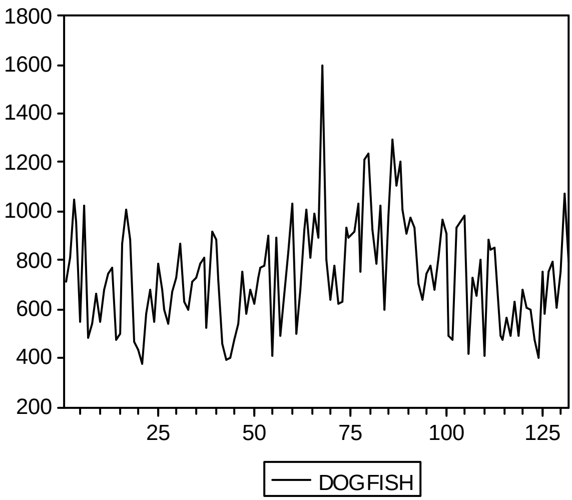
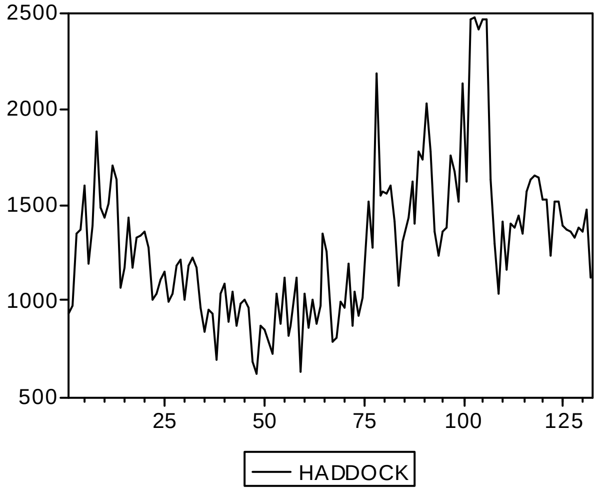
Appendix 1: Graphs for fish prices of main species landed into Cornwall (1992-2002)

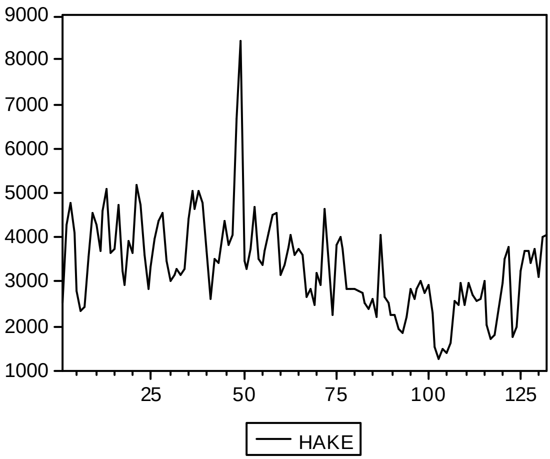


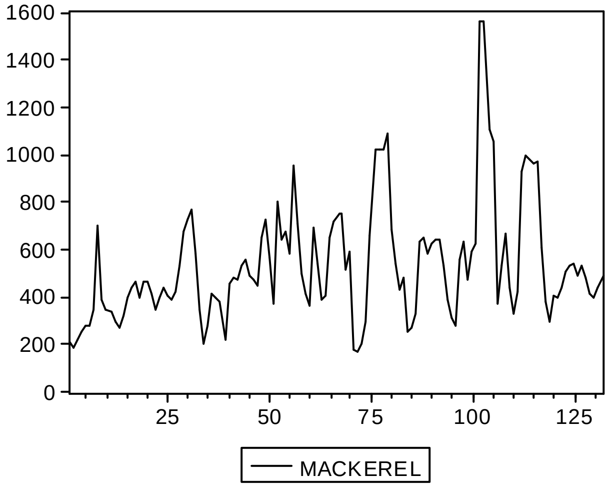


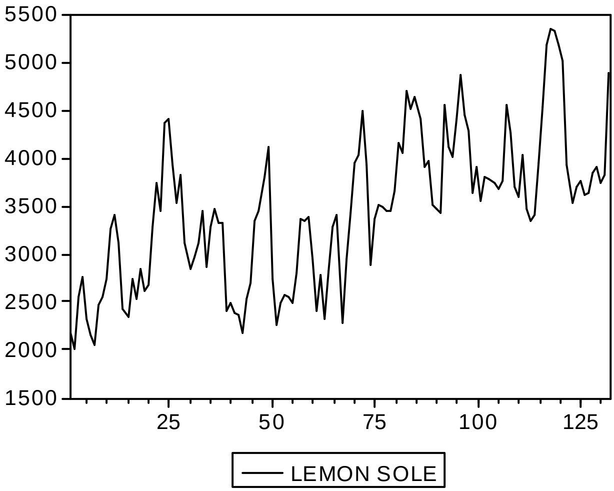

2000
1800
1600
1400
1200
1000
800
600
400
25
50
75
100
125
CRABS

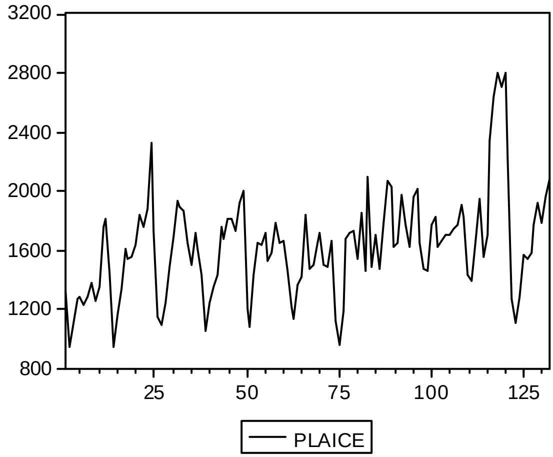

1800
1600
1400
1200
1000
800
600
400
200
25
50
75
100
125
DOGFISH

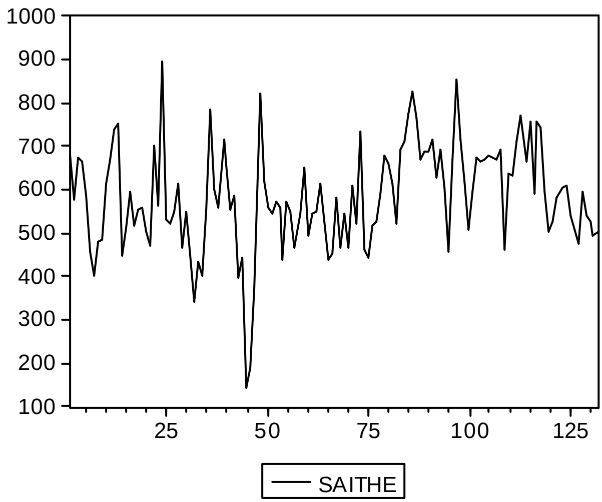

2500
2000
1500
1000
500
25
50
75
100
125
HADDOCK

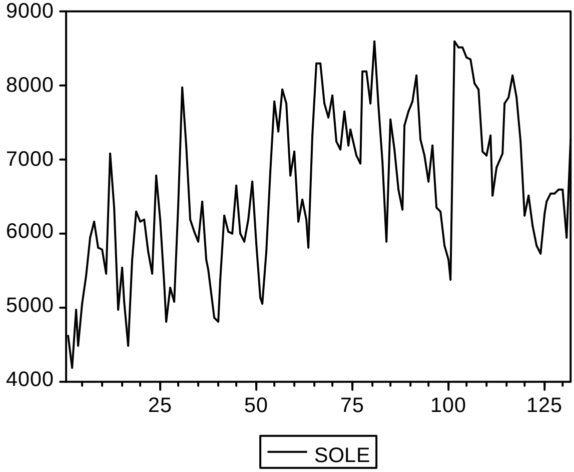

9000
8000
7000
6000
5000
4000
3000
2000
1000
25
50
75
100
125
HAKE

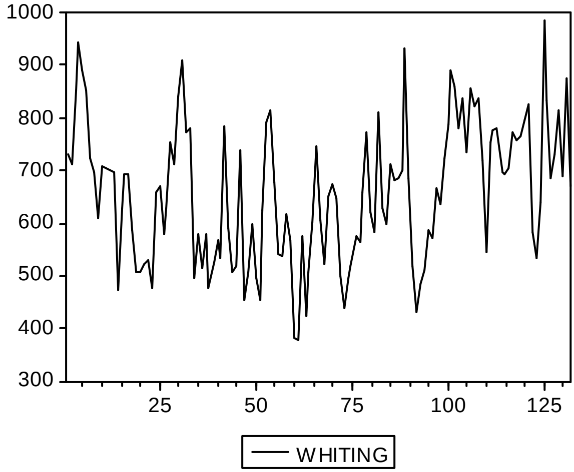

1600
1400
1200
1000
800
600
400
200
0
25
50
75
100
125
MACKEREL


5500
5000
4500
4000
3500
3000
2500
2000
1500
25
50
75
100
125
LEMON SOLE

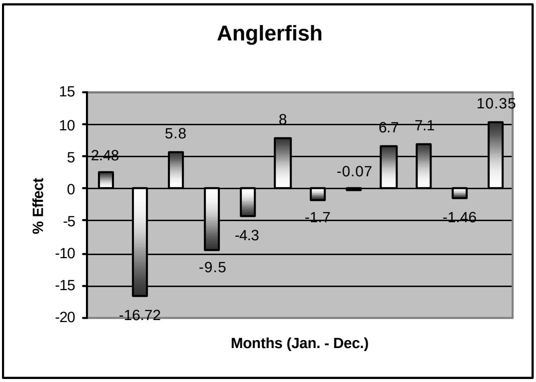

3200
2800
2400
2000
1600
1200
800
25
50
75
100
125
PLAICE

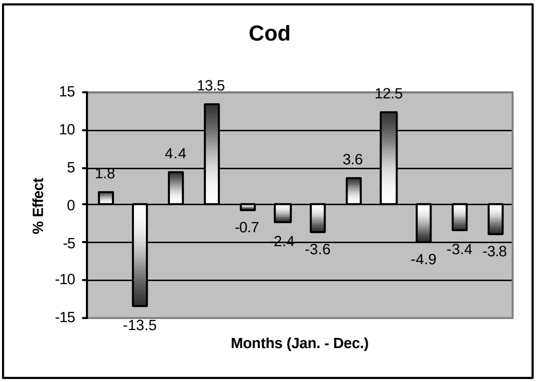

1000
900
800
700
600
500
400
300
200
100
25
50
75
100
125
SAITHE

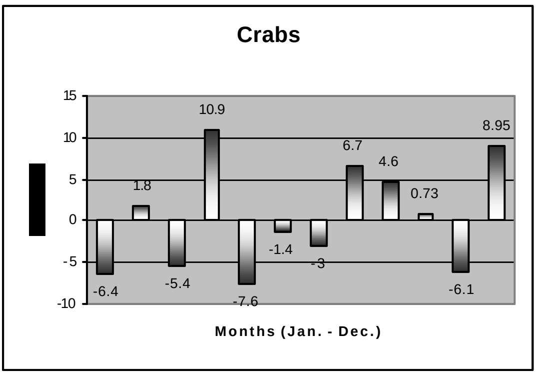

9000
8000
7000
6000
5000
4000
25
50
75
100
125
SOLE

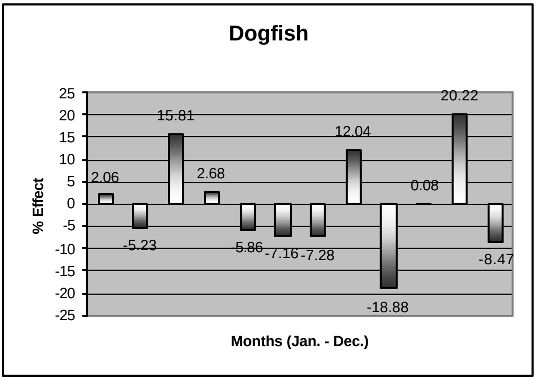

1000
900
800
700
600
500
400
300
25
50
75
100
125
WHITING

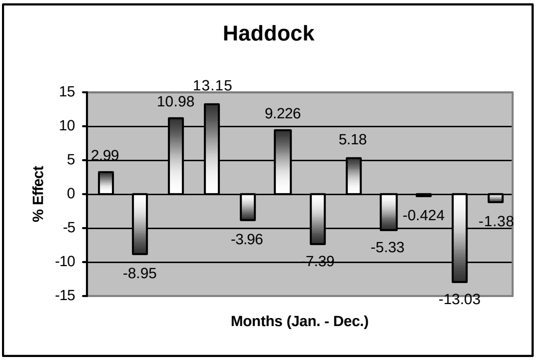
Appendix 2. Monthly Effect for Fish Species in Cornwall (%)

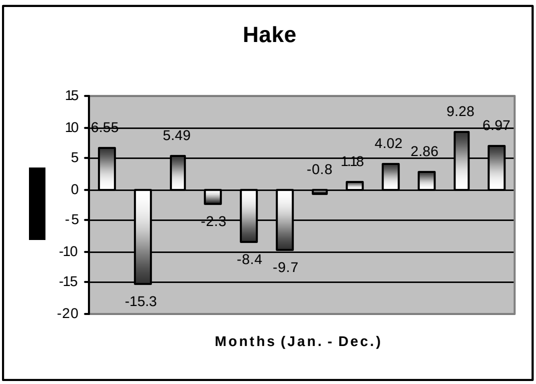


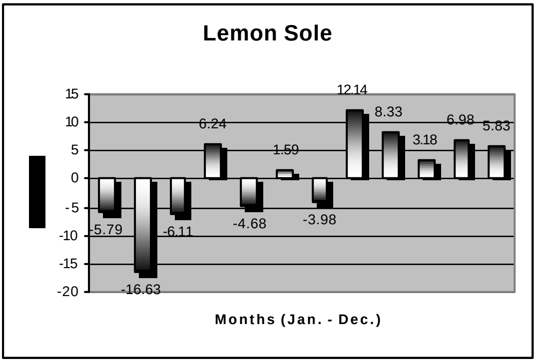


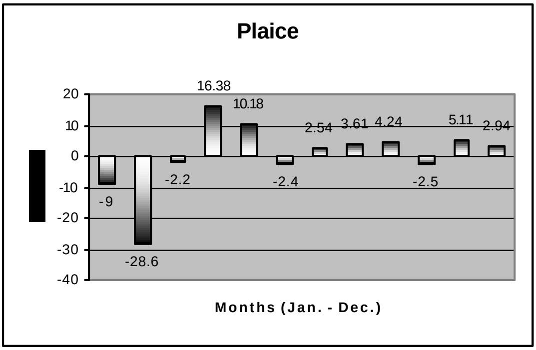


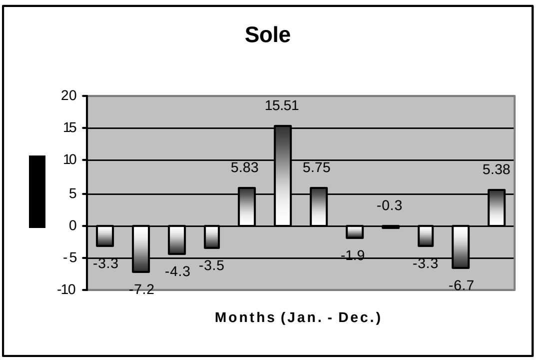

Dogfish
% Effect
25
20
15
10
5
0
-5
-10
-15
-20
-25
2.06
-5.23
15.81
2.68
5.86
-7.16
-7.28
12.04
-18.88
0.08
20.22
-8.47
Months (Jan. - Dec.)

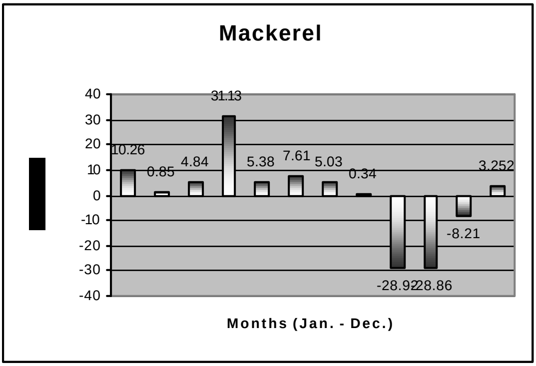

Haddock
% Effect
15
10
5
0
-5
-10
-15
2.99
-8.95
10.98
13.15
-3.96
9.226
7.39
5.18
-5.33
-0.424
-13.03
-1.38
Months (Jan. - Dec.)

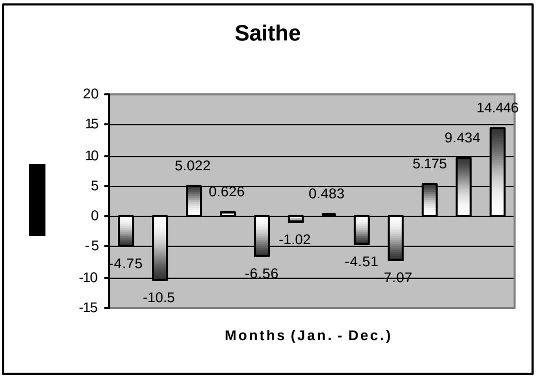

Hake
15
10
5
0
-5
-10
-15
-20
6.55
-15.3
5.49
-2.3
-8.4
-9.7
-0.8
1.18
4.02
2.86
9.28
6.97
Months (Jan. - Dec.)

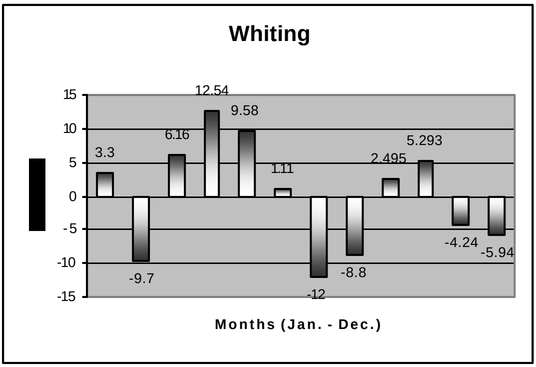

Lemon Sole
15
10
5
0
-5
-10
-15
-20
-5.79
-16.63
-6.11
6.24
-4.68
1.59
-3.98
12.14
8.33
3.18
6.98
5.83
Months (Jan. - Dec.)


Plaice
20
10
0
-10
-20
-30
-40
-9
-28.6
-2.2
16.38
10.18
-2.4
2.54
3.61
4.24
-2.5
5.11
2.94
Months (Jan. - Dec.)


Sole
20
15
10
5
0
-5
-10
-3.3
-7.2
-4.3
-3.5
5.83
15.51
5.75
-1.9
-0.3
-3.3
-6.7
5.38
Months (Jan. - Dec.)


Mackerel
40
30
20
10
0
-10
-20
-30
-40
10.26
0.85
4.84
31.13
5.38
7.61
5.03
0.34
-28.92
-28.86
-8.21
3.252
Months (Jan. - Dec.)


Saithe
20
15
10
5
0
-5
-10
-15
-4.75
-10.5
5.022
0.626
-6.56
-1.02
0.483
-4.51
-7.07
5.175
9.434
14.446
Months (Jan. - Dec.)


Whiting
15
10
5
0
-5
-10
-15
3.3
-9.7
6.16
12.54
9.58
1.11
-12
-8.8
2.495
5.293
-4.24
-5.94
Months (Jan. - Dec.)