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DYNAMIC RELATIONSHIPS IN MEAT MARKET

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Abstract*: In this paper, the meat sector in Turkey was explored. Turkish meat sector has a striking production and foreign trade structure. Sector is highly protected by border measures. In such market conditions, interactions between monthly beef, sheep meat and poultry meat prices are investigated with conventional and periodogram based cointegration tests. Engle-Granger, Johansen's and Periodogram based cointegration tests do not reject the null hypothesis of no cointegration between red and poultry meat prices. We also found that OLS and Engle-Granger test, and Periodogram and Johansen cointegration tests produced similar results for beet and sheep meat prices.*

Keywords*: Meat prices, periodogram, cointegration.*

1. Introduction

There has been several serious changes in meat market during the last decade in Turkey. The Meat and Fish Agency (EBK), a state enterprise, was privatized in 1995. Part of the EBK has been run by the government since the early 2000 again. Subsidies to livestock sector were removed. However, a decree on livestock support was issued in 2000. A small number of medium to large fattening holdings were developed. Along with these developments, poultry sector showed a clear development trend. In addition, the sector has been protected by the border measures. Sector therefore can be considered a closed one, with a heavy government involvement. Meat prices are formed in such a market condition in Turkey.
In this article we try to investigate the possible relationships between different meat prices in Turkey by using conventional and periodogram based cointegration tests. Akdi, Berument and Cilasun [1], Akdi, Berument, Cilasun and Olgun [2], Sahin and Akdi [14] also employ cointegration analysis to assess possible relationships among price indices.

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Besides analyzing the dynamics of price indices using cointegration analysis; relationship between indices; some articles use external determinants or shocks to analyze the dynamics of meat prices. For instance; Hoffmann and Bernhard [11] examine the meat price differentials within markets. Reziti [13] analyses the relative price variability of 53 agricultural products and aggregate inflation rate and find that changes in inflation rate has a positive effect on relative price volatility also finds expected inflation as an important determinant of explaining price variability. Appleby [6] tells that free-market competition should not be seen as sole determinant of food prices and suggest a more traditional goal as increasing production efficiency. Gallimore [10] shows that the fluctuations in livestock product prices have an impact on market growth of vegetable proteins. Kinnucan and Myrland [12] analyze the relationship between responses of advertising on U.S. meat. Stefan and Liefert [16] examine the transmission between changes in both world trade prices and Russian exchange rates and changes in Russian consumer retail prices for meat by calculating elasticity. Sanjuan and Dawson [15] examine the transmission between producer and retail prices for beef, lamb and pork in the UK and the impact of public concern over bovine spongiform encephalopathy (BSE) in early 1996 using Johansen's cointegration procedure.

The rest of the paper is organized as follows. The second section describes the brief structure of Turkish meat market. The third section introduces the data and methodology employed in the paper. The fourth section presents the empirical evidence and the last section concludes the paper.

2. General Structure of the Meat Market in Turkey

The structure of the meat sector in Turkey gives some insight about the price determination mechanism. Therefore, the summary of Turkish meat sector is presented in this section. Livestock production is generally a small-scale activity carried out as a part of a mixed farming operation. In Turkey, only 2.4 % of about three million farm holdings are involved exclusively in animal husbandry. Sixty seven percent of the holdings carry out livestock activities along with crop production [18]. Therefore, livestock products are traditionally an important source of household income for many farmers. The value of the meat produced is around 40 % of the total value of the livestock production [17].

Turkey's livestock sector has displayed two clear trends during the last decades; one of which is the declining the number of livestock; and the other is the increasing meat production due to the rapidly growing poultry sector which is concentrated near urban centers. The output of poultry meat has grown at an annual rate of 2 % since 1990 [19]. Apart from backyard poultry, which has a 30 % market share, the poultry sector is dominated by vertically integrated producers that contract with larger firms or supermarkets. The growth in production of the poultry industry has been due to the major efficiency gain in production, based on foreign genetics and equipment. On the other hand, red meat production has not displayed a considerable increase.

The breakdown of the size of the specialized fattening holdings shows a very unequal distribution of animals; just 1.2% of the fattening holdings (150 or more animals) keep 43% of all fattening animals, whereas at the other end of the scale 68% of fattening holdings (less than 10 animals) keep only 19% of the total fattening animals. The 623 largest holdings (under 1% of the total) have an average of 722 animals each and account for about 30 % of the fattening

animals [5]. Thus, beef fattening industry is dominated by a very few medium and large-scale producers. Approximately 40% of small ruminants are fattened and slaughtered specially for the Festival of Sacrifice. It has to be noted that unregistered red meat production is considered to be significant but cannot accurately be estimated during these seasonal months.

The Turkish livestock sector has been supported with varying degree of government involvement in different periods. Since the mid-1990s, the Government's policies on livestock support have been changed. The State has withdrawn from feed milling; nearly withdrawn from meat and milk processing; somewhat withdrawn from input-related services (such as breeding and animal health). Direct state subsidies for livestock production have drastically declined as of 2000. However, a decree on the Livestock Support Scheme was issued in 2000 which covers the support measures among which are animal husbandry improvement, fodder crop support, animal health, protection of animal genetic resources, artificial insemination, expansion of disease free farms, milk premiums, meat premiums, support for the modernization of livestock farms, low rate interest credit, and encouraging environmental measures.

Small-scale livestock producers are inefficient and not responsive to the subsidies. The subsidy environment has been very encouraging for large-scale livestock sector businesses. Driven by the investments of major capital groups, efficient large-scale agricultural enterprises are flourishing, while supermarket chains and the food industry are starting to sponsor contract farming and to invest directly in modern livestock farms.

The consumption pattern of the households is another important factor affecting the general structure of the meat market. Rapid growth in population, urbanization and real per capita income has led to a faster expansion of food demand than agricultural production, resulting in a shift in consumption patterns towards other animal products (poultry and fish). Per capita consumption of red meat has not increased over the last decade. Imports have not been available to fill the gap in demand due to high import duties designed to protect the domestic production. Red meat imports have been negligible in recent years [8]. Meat consumption has shifted over time from red meat to greater consumption of poultry and fish. Therefore, per capita consumption of poultry meat has increased twice as much in the same period.

3. Data and Methodology

Monthly price data for beef (X) sheep meat (Y) and poultry meat (Z) were used in the analysis. Data on prices received by farmers were obtained from Turkish Statistical Institute (TUIK) for the period of 1994:01-2006:06. All variables are expressed in natural logarithms.

The linear relationship among X, Y and Z will be examined by Engle-Granger [9] and Johansen's cointegration tests. Ordinary Least Square (OLS) method will be applied to predict parameters to assess the short run relationships among series. Long- run relationship among the series will further be examined by periodogram proposed by Akdi and Dickey [3].

The method tests the unit root based on the periodogram ordinates. The method has certain advantages over conventional tests. First, conventional tests require the estimation of too many AR parameters to account for the dynamics/seasonality of the series. However, periodogram method requires no parameter estimation except for the variance. Second, test results change with the sample size in conventional tests, while in the periodogram based method the distribution does not change with the sample size. The analytic power of the test does not exist in

the conventional method while analytic power function is available in the periodogram method. Akdi and Dickey [3] also show that the same testing procedure developed to test for a single unit root for AR series can be used to test for seasonal unit roots.
Akdi [4] proposed a method to estimate the cointegrating vector by using the periodogram ordinates. Based on the simulation results he shows that periodogram method gives better estimates than those obtained by OLS proposed by Engle and Granger [9]. Berument, Akdi and Atakan [7] applied the periodogram to test whether a bivariate series is cointegrated or not. They simply regress the real part of the cross periodogram on the periodogram of any component of a bivariate series. The method is similar to one that Engle and Granger [9] propose but the repressors and the results are different.
A non-stationary bivariate series with components X_t and Y_t can be written as a linear combination of two stationary and non-stationary series as:

$$X_t = a_{11}U_t + a_{12}S_t$$
$$Y_t = a_{21}U_t + a_{22}S_t$$

where U_t represents a unit root time series and S_t represents a stationary time series. Note that both include a unit root series and thus both are integrated of order one. However the series $Y_t - (a_{21}/a_{11})X_t$ turns out to be a stationary time series. Therefore, in order to estimate the cointegration vector only the ratio a_{21}/a_{11} is estimated.

4. Empirical Evidence

Graphs of the series are presented in Figure 1. In the absence of a unit root in series, shock will disappear in the long run. Augmented Dickey-Fuller (ADF) test results are given in Table 1. All series are I(1).

Table 1. ADF Test Results

Series	ADF	ADF (First Difference)	1% level	5% level	10% level	Result
X	-2.3735	-7.3053	-3.4748	-2.8809	-2.5772	I(1)
Y	-2.5815	-7.2785	-3.4748	-2.8809	-2.5772	I(1)
Z	-1.0856	-10.047	-3.4748	-2.8809	-2.5772	I(1)

In order to search a linear relationship among X, Y and Z; each has to be integrated at the same order [9]. All series are I(1). Therefore, conventional and seasonal cointegration tests can be applied to assess long run relationships among series.

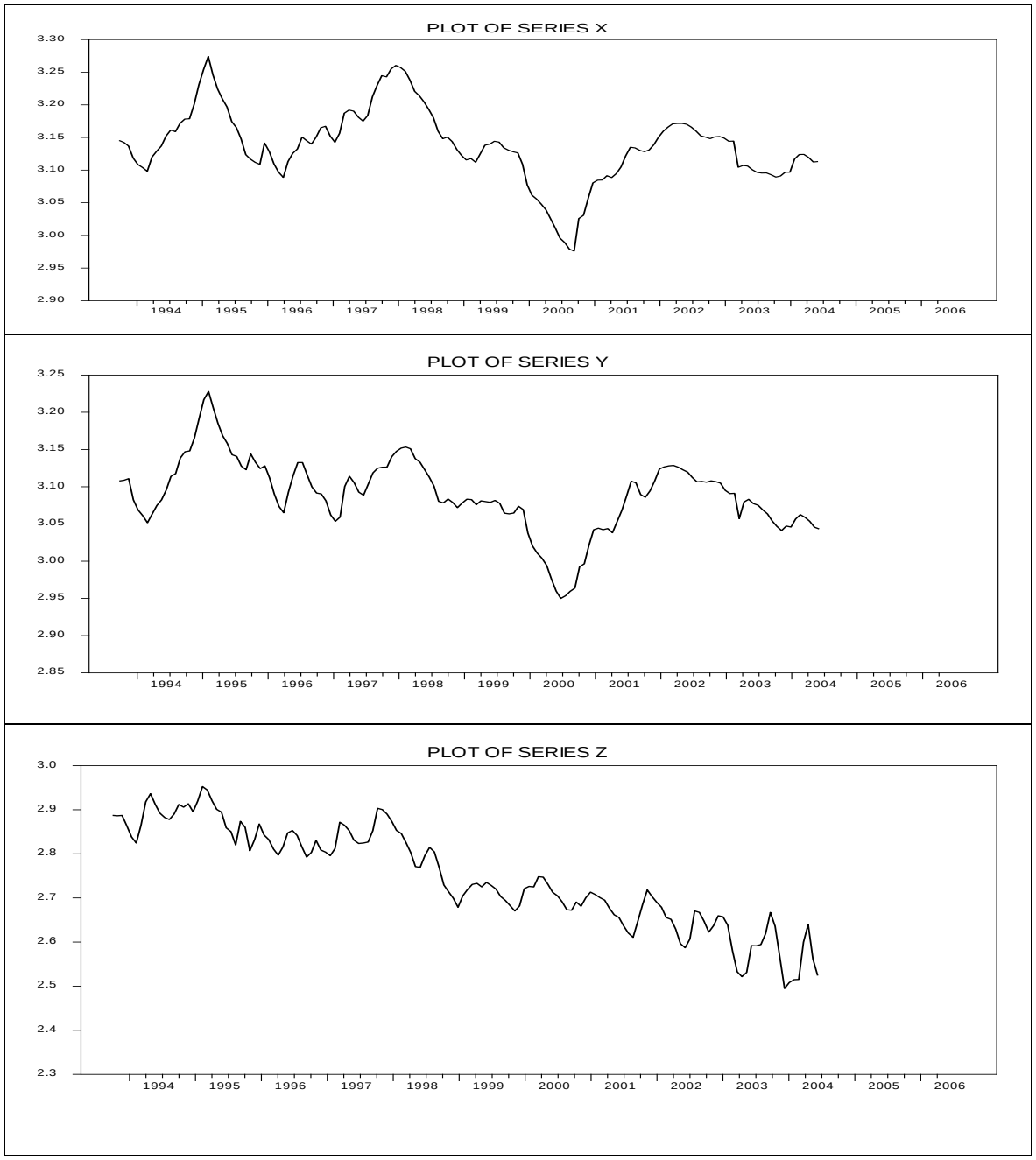

Figure 1. Logarithmic Graphs of X, Y, and Z

Initially, Engle and Granger [9] cointegration test was applied. Findings indicate that estimated residuals for Z-X and Z-Y are not stationary. The value of the statistic calculated from the residuals is greater than the critical value of -2.88 at 5%. Consequently, the null hypothesis that there is no cointegration relationship among the series Z-Y and Z-X are not rejected, but there is a cointegration among X and Y (Table 2).

Table 2. Engle-Granger Cointegration Test Results.

Series	β	ADF test statistics of residuals
Z-X	0.9676	-1.4164
Z-Y	1.1438	-1.6201
X-Y*	1.0204	-2.9172

* Indicates the level of significance at 5 %

Next, Johansen's cointegration test was applied to the series. Johansen's cointegration test also indicates no cointegration among X-Y, Z-X and Z-Y (Table 3).

Table 3. Johansen's Cointegration Test Results

Cointegration Relation	Hypothesized Number of Cointegration	Eigenvalue	Trace Statistic	Max Statistic	Trace test At 5%	Max test at 5%
Z-X	None *	0.0515	7.9847	7.6757	15.494	14.264
	At most 1 *	0.0021	0.3090	0.3090	3.8414	3.8414
Z-Y	None *	0.0570	8.9287	8.5125	15.494	14.264
	At most 1 *	0.0028	0.4162	0.4161	3.8414	3.8414
X-Y	None *	0.0480	11.790	7.1352	15.494	14.264
	At most 1 *	0.0315	4.6548	4.6548	3.8414	3.8414

When the real part of the cross periodogram ordinate of the X and Y series (say y_k) is regressed on the periodogram of the X (or Y) series (say x_k), the coefficient of x_k is also a consistent estimator for the ratio $\frac{a_{21}}{a_{11}}$ [4]. That is, when we consider the model,

$$y_k = \alpha + \beta\ x_k + \eta_k\ ,\ k = 1,2,3,...,[n/2]$$

the OLS estimator of β is a consistent estimator for the ratio $\frac{a_{21}}{a_{11}}$ and is calculated as $\hat{\beta}_P = 0.839012$. Here, $[n/2]$ denotes the integer part of $n/2$. If the series $Z_t = Y_{2,t} - 0.839012\ Y_{1,t}$ is stationary, then these two series are cointegrated. If Z_t is stationary, we will conclude that the Y and X series are cointegrated. In order to check it, we regress ΔZ_t on Z_{t-1} and calculate the value of the usual $t-$statistics. The value of the periodogram based test is –1.850. The critical values are –3.43564 at the 5% level and –3.12867 at the 10 % level. Therefore, the null hypothesis of no cointegration is not rejected. The same procedure was applied for X-Z and Y-Z and a cointegration among the series are not found (Table 4).

Table 4. Periodogram Based Cointegration Test Results

	β	$\hat{\tau}_a$	**Result**
X vs Y	0.8390	-1.8500	No cointegration
X vs Z	1.2568	-1.3450	No cointegration
Y vs Z	1.3440	-1.5520	No cointegration

[1] One may look at Berument et al. (2005) for the critical values.

Conventional and the periodogram based analysis suggest that the red and poultry meat prices are indeed not cointegrated. Conventional tests require estimation of too many parameters to address the dynamics of the series with AR parameters. Moreover, addressing seasonality requires estimating additional parameters. However, the periodogram based method is seasonally robust and requires no parameter estimation except for the variance, and any consistent estimator of the variance can be used in the test statistics. These may account for the differences in the test results [4].

Logarithmic first differences of the series are regressed on each other to assess the short run relationship between the series. OLS results are presented in Table 5. A short run relationship between X and Y can be observed, but there is not a strong evidence for Z-X and Z-Y relationship. In addition, R^2's are low indicating that changes in one price are not explained by the changes in the other price. In other word, price series move independently.

Table 5. Short Run Relationships Between Meat Prices.

	Coefficient	**Std. Error**	**t-statistics**	**Prob.**	**R^2**
Z-X	0.5048	0.1589	3.1763	0.0018	0.0556
Z-Y	0.4054	0.1687	2.4028	0.0175	0.0291
X-Y	0.8556	0.0495	17.2615	0.0000	0.6680

5. Conclusion

Red and poultry meats are considered as substitutes good. First, the meat market in Turkey was examined which has gone serious changes in the last decade. Meat and Fish Agency (EBK), a state enterprise was privatized in 1995. EBK returned partly to the market again. Removing subsidies were followed by a decree on livestock support issued in 2000. Some fattening holdings were developed. Poultry sector showed a clear development during this period. In addition, the sector has been protected by the border measures. Sector therefore can be considered a closed economy, with a heavy government involvement. Meat prices are formed in such a market condition. Therefore, it was of interest to examine the price relationship between red and poultry meat, two substitutes.

It was hypothesized that the red and poultry meat are two substitutes and changes in price of one type affect the price of the other considerably. The long-run relationships among beef, sheep meat and poultry meat were examined. Engel-Granger and Johensen's cointegration tests showed that the price series are not cointegrated. Therefore, it can be concluded that the price series do not move together in the long run. Prices move based on their own dynamics and supply of and demand for the related goods, contrary to the hypotheses. However, a weak short-run relationship among the prices of red and poultry meat are evident. We also found that OLS and

Engle-Granger test, and Periodogram and Johansen cointegration tests produced similar results for beef and sheep meat prices.

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