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Full Length Research Paper

The analysis of some factors on feed compound production: A case study focused on the Turkish feed industry

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Turkey witnesses development in the feed industry, one of the most important inputs of animal husbandry, which is largely dependent on private sector mixed feed manufactories. However, basic problems in animal husbandry, on the one hand, and the decrease of producers on the other hand, negatively affect mixed feed production. The number of animals suggests that Turkey needs more than the 7 million tons of mixed feed that is produced today. In this study, a long term equilibrium relationship is found between mixed feed production, feed price, number of manufactories and end (red meat, milk, broiler and egg) for each type of mixed feed production using four different models based on the Johansen method.

Key words: Turkey, feed compound, management, marketing, stationary test, Johansen model.

INTRODUCTION

Feed industry has become more effective in Turkey as a result of the development in animal husbandry. Today, with its number of establishments and usable capacity, it constitutes an important industry and offers jobs to approximately 500,000 people. The yearly revenue of this branch of industry reaches 3 billion USD (Anonim, 2008a). The development of animal husbandry and the increase in animal production is among other factors closely related to the mixed feed industry (Karabulut et al., 2000). In intensive animal husbandry feed costs constitute 60 - 70% of the operation cost, while in poultry production they constitute 70 - 80% of the operation cost (Akdeniz et al., 2006). Turkey produces 28 million tons of roughage and after the increase in recent years, more than 7 million tons of concentrated feed. In this study, the short-term and long-term balance relationship of mixed feed production in Turkey is examined by using a co-integration model, namely, the "Johansen Method". The number of studies based on co-integration models has increased in recent years. Yurdakul (1995), Guncavdi et al. (2000), Saatcioglu et al. (2004), and Gunaydın (2004) have estimated the effect of time series on inflation and monetary policy. In a study by Mushtaq and Dawson (2003), a co-integration analysis was performed with 1960-1996 production input data for cotton and wheat in Pakistan and it was found that the production input for cotton was elastic. In addition, in another study conducted for southern desert countries in Africa to adjust the price of agricultural products, co-integration vectors of the product prices affecting agricultural products were estimated (Rainer, 2003). Ozer and Kayalak (2006) using this method, found that a 1% increase in the option price for cotton resulted in a 3.3% increase in imports. In addition, Turkekul and Abay (2008) use the "Johansen Method" to determine the relationship between the foreign trade deficit problem in Turkey and foreign trade of agricultural products. It was found that a significant causal relationship runs from economic growth and foreign exchange rate to foreign trade of agricultural products.

The first mixed feed production in the short history of feed industry in Turkey started in 1955 by the private sector and witnessed an increase after the development of animal husbandry in 1975. In Turkey today, the majority of mixed feed manufactories exhibit a dynamic structure that allows them to closely follow technical and technological developments in the world and to rapidly

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integrate these. While Turkey produces 7.5 million tons of mixed feed, this number is estimated to exceed 10 million tons when the unregistered production is taken into account. While the amount of small ruminants and cattle feed, which holds an important share in this figure, was 2.5 million tons in 1990, it reached 4.5 million tons in 2006.

While the share of small ruminants and cattle feed in the total figure was 63.8% in 1990, it dropped to 60.5% in 2006. Whereas poultry feed production was 1.4 million tons in 1990, it reached 2.9 million tons in 2006. In the period 1960 - 2006, the share of poultry feed in the total feed production decreased from 60.0 - 38.5%, but the share of small ruminants and cattle feeds increased from 37.5 - 60.0% (Anonim, 2008a,b). In recent years, the practice of producing one's own feed within the enterprise has increased in integrated animal husbandry manufactories. Furthermore, an increase is observed in the production of fish feed and turkey feed in the last 4 - 5 years.

The mentioned feed production in Turkey is realized by 471 manufactories. Their average used capacity is 71%. The increase in the demand for mixed feed in 1975 and the subsidies provided in the 1985 - 1989 period increased the used capacity. Yet, in general, when the number of active manufactories and the used capacity ratio are considered, the marketable mixed feed production appears to be below capacity. This is mainly due to the low revenue obtained from animal husbandry, and the inability of manufactories to meet the high cost of feed.

The decrease in demand for feed due to the gradual increase in feed prices negatively affects manufactories' feed production. In the last decade, the price of broiler feed increased 22.7 times, that of egg 29 times, and that of milk and livestock 26 times (Anonim, 2008a). Moreover, in animal husbandry in Turkey, it is possible to use roughage in fields and meadows, and due to the decrease in purchasing power and state subsidies, the demand for mixed feed does not increase sufficiently. In Turkey, especially the scale problem of animal husbandry, the scarcity of integrated and great cattle and milk manufactories, the unawareness of the importance of using quality and safe feed, the low production relative to the number of animals, all result in low production. Furthermore, the decrease in the product/feed parity also affects the producers' demand for mixed feed. The increases in the price of animal husbandry products such as meat, milk, and eggs, increase the demand for mixed feed. Gunes (2008) states that in the period 1995-2006 1 kg meat bought 18.5–33.2 kg livestock feed, 1 L of milk bought 1.3-2.3 kg feed, 1 egg bought 0.2-0.4 kg feed and 1 kg broiler bought 3.4-5.,6 kg feed. While in this period a constant parity was observed for milk and eggs, for meat and broiler there was volatility. In order to make risk free operation of manufactories in mixed feed production possible, inconsistency in the mixed feed demands of animal husbandry manufactories should be prevented.

METHODOLOGY

In this study, the structure of mixed feed production is explained through 4 different Johansen models, each of which is simple supply models evaluated within themselves. Livestock feed production, milk feed production, broiler feed production, and egg feed production were included as mixed feeds in the models. The variables in the models are: LnBYF (small ruminants and cattle livestock feed price), LnKYF (broiler feed price), LnSYF (milk feed price), LnYYF (egg feed price), LnBYU (great and small cattle livestock feed production), LnKYU (broiler feed production), LnSYU (milk feed production), LnYYF (egg feed production), LnKEF (red meat price), LnBEF (white meat price), LnSF (milk price), LnYF (egg price), LnKYFAB (number of mixed feed manufactories in Turkey). In each model the dependent variable is feed production. The independent variables are feed price, final product price and number of manufactories, respectively. As in feed manufacturing there is more than one ration used for each type of mixed feed, and as there is no standard in these rations, sales price of product, instead of input price, is included in the model. Johansen's co-integration test will explain whether there is any effect between dependent variable and independent variables in short term or long-term period (Fadhil et al., 2007).

As time series models involve trends, when known linear econometric models are applied, the problem of spurious regression may result. Unit root tests are used to check whether a time series is stationary, and if a time series includes a unit root the series is said to be non-stationary. As non stationary series have longer lag lengths than stationary series, effects on stationary series disappear, whereas effects on non stationary series change the structure of the series (Ozer and Kayalak, 2006).

Moreover, regressing independent difference stationary processes on each other leads to the problem of spurious regressions, as Granger and Newbold (1974) have demonstrated in a simulation study. Later on Phillips (1986) gave the theoretical reasoning for this phenomenon: The usual t-statistics diverge to infinity in absolute value, while the R^2 does not converge to zero, hence indicating spurious correlation between independent difference stationary processes. Granger (1981) and Engle and Granger (1987) offered a solution to the spurious regression problem by introducing the concept of co-integration. The regression of these two variables will be a spurious regression (Halac, 2003).

In order to achieve stationary, series is differentiated. If the stationary is achieved after the series is differentiated d times, then the series is said to be integrated of order d, that is, I(d). A non-stationary series Y_t becomes a stationary process such as $^{d}y_t$ after differentiated d times. In the study, the stationary of the time series was tested with the "Augmented Dickey Fuller Test" (ADF), and equation (1) was applied for the test (Gujarati 2001);

$$\Delta Y_T = \alpha + \beta Y_{T-1} + \sum_{I=1}^{k} Y_{T-I} + \varepsilon \qquad (1)$$

In order to determine how many lags of the variable would take place on the right hand-side of the regression equation, the Schwartz and Akaike criterion was used. For the co-integration analysis, the methods suggested by Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990) and Osterwald (1992) were used. Johansen's methodology takes its starting point in the vector auto regression (VAR) of order *p* given by

$$Y_t = \mu_t A_1 Y_{t-1} + \ldots\ldots\ldots\ldots + A_p Y_{t-p} + \varepsilon_t \qquad (2)$$

Where *t* y is an *n*x1 vector of variables that are integrated of order one - commonly denoted I(1) – and *t* ε is an *n*x1 vector of innovations. This VAR can be re-written as:

$$\Delta Y_t = \mu + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

Where

$$\Pi = \sum_{i=1}^{p} A_i - I \quad and \quad \Gamma_i = - \sum_{j=i+1}^{p} A_j \quad (4)$$

If the coefficient matrixhas reduced rank *r*<*n*, then there exists *nxr* matrices α and β each with rank *r* such that Π = αβ′ and *t* β′y is stationary. *r* is the number of co-integrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a co-integrating vector. It can be shown that for a given *r*, the maximum likelihood estimator of β defines the combination of *t*−1 y that yields the *r* largest canonical correlations of *t* y with *t*−1 y after correcting for lagged differences and deterministic variables when present (2). Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and maximum Eigen value test are shown in equations (5) and (6), respectively.

$$-T \sum_{r+1}^{p} \mathrm{LN}(1 - \lambda_i) \quad (5)$$

$$(-T\,\mathrm{LN}(1 - \lambda_i \;=)) \quad (6)$$

Here, *T* is the sample size and *i* λˆ is the *i*:th largest canonical correlation. The trace test tests the null hypothesis of *r* co-integrating vectors against the alternative hypothesis of *n* co-integrating vectors. The maximum Eigen value test, on the other hand, tests the null hypothesis of *r* co-integrating vectors against the alternative hypothesis of *r* +1 co-integrating vectors. Neither of these test statistics follows a chi square distribution in general; asymptotic critical values can be found in Johansen and Juselius (1990) and are also given by most econometric software packages. Since the critical values used for the maximum Eigen value and trace test statistics are based on a pure unit-root assumption, they will no longer be correct when the variables in the system are near-unit-root processes. Thus, the real question is *how* sensitive Johansen's procedures are to deviations from the pure-unit root assumption.

Although Johansen's methodology is typically used in a setting where all variables in the system are I(1), having stationary variables in the system is theoretically not an issue and Johansen (1995) states that there is little need to pre-test the variables in the system to establish their order of integration. If a single variable is I(0) instead of I(1), this will reveal itself through a co-integrating vector whose space is spanned by the only stationary variable in the model.

Granger (1988) states that if there is a co-integration vector between variables, then at least a unidirectional causal relation should exist. Granger (1986) and Engle and Granger (1987) have pro-posed a causality model that takes into consideration information provided by co-integration features. This model can be called an error correction model. In the causality test among variables, the error correction model below was used (Gunaydın, 2004).

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \sum_{k=1}^{p} \psi_j \Delta Z_{t-j} + \delta \mu_{t-1} + u_t$$

In the error correction model, it is tested whether or not the constants of the Granger causality tests, the Yt-j or Zt-j terms as a group are statistically significantly different from zero according to the F statistic, and/or whether the constants (t) of the error cor-rection terms are meaningful or not. While the error correction term in the equation adjusts X*t* toward long term equilibrium, it shows the short term causality of the lag values of the independent variables.

RESULTS

As time series theories are based on the stationary assumption, it is important to assess whether economic series are stationary or not. The results of the unit root test obtained by applying Equation (1) at the level of the variables and the first differences are presented in Table 1. In the study, stationary condition is not met at the level of feed productions and price variables and is only achieved at the level of number of manufactories. When first differences are taken, only the variables livestock feed price, broiler feed and egg feed price meet the stationary condition within the 5% significance level. The other variables become stationary when second differences are taken. In order to realize the Johansen model, the analyses within the 10% significance level were considered so as to meet the stationary condition for all variables at the same level. For all variables, the first differences became stationary at this significance level.

The lag length for livestock feed, milk feed and broiler feed in each model was 2 for the Akaike Criterion and 3 for the Schwartz criterion. For egg feed, the lag length was 3 for both criteria (Table 2).

Table 3 presents the results of the trace and MED Statistic used in the reliability test of the Johansen model which is based on lag length. A trace statistic was run on the H_0 hypothesis that eliminates the existence of a co-integration vector (r = 0), and for each feed type a MED statistic was run. These values were found to be higher than the 5% significance level of the trace statistic and MED statistic. Consequently, the H_0 hypothesis that eliminates co-integration is rejected by both tests for each feed type. The 5% significance level value of the trace statistic indicates that at least one co-integration vector (r1) exists for each feed type. The 5% significance level value of the MED statistic indicates that for each feed type at least two co-integration vectors (r^2) exist. These findings suggest a long term balance relationship among feed production, feed price, number of manufactories, and final products (Red Meat, Milk, Broiler and Egg).

The co-integration equation obtained from the Johansen's test was normalized according to the pro-duction of different types of feed (Table 4). As indicated in the table, in the production of livestock, milk and egg feed an increase in the price of feed decreases manu-factories' feed production. However, in the production of broiler feed production, an increase in the price of broiler has a positive effect on feed production.

Table 1. Stationary test results.

Variables	Level	1st Difference	2nd Difference
(LnBYF)	$-1.040704_{k=0}$	$-2.6499_{k=1}$	$-8.790722_{k=0}$
(LnKYF)	$-1.375016_{k=0}$	$-2.65274_{k=0}$	$-5.920769_{k=1}$
(LnSYF)	$-1.088762_{k=1}$	$-2.765949_{k=1}$	
(LnYYF)	$-1.21682_{k=0}$	$-2.682955_{k=0}$	$-7.891219_{k=0}$
(LnBYU)	$-2.010467_{k=0}$	$-6.100752_{k=0}$	
(LnKYU)	$-2.037045_{k=0}$	$-4.696958_{k=1}$	
(LnSYU)	$-2.010467_{k=0}$	$-6.100753_{k=0}$	
(LnYYF)	$-2.037045_{k=0}$	$-4.696957_{k=0}$	
(LnKEF)	$-2.913671_{k=0}$	$-4.858339_{k=0}$	
(LnBEF)	$-1.471519_{k=0}$	$-5.313298_{k=0}$	
(LnSF)	$-2.081961_{k=0}$	$-5.138073_{k=0}$	
(LnYF)	$-2.183583_{k=0}$	$-4.618605_{k=0}$	
(LnKYFAB)	$-6.002742_{k=0}$	$-4.495073_{k=0}$	

*Critical values for 1, 5 and10% significance level are -3.724070, -2. 986225 and 2. 632604, respectively.

Table 2. Lag length determination, Akaike and Schwartz criteria values in the Johansen model.

Lag length	Akaike criterion	Schwartz criterion	Akaike criterion	Schwartz criterion
	Livestock feed		**Milk feed**	
k = 1	-9.724125	-8.756358	-8.103779	-7.13601
k = 2	-9.457502	-7.70232	-7.903472	-6.14829
k = 3	-9.675489	-7.123039	-8.306966	-5.75452
k = 4	-13.60805	-10.25093	-9.359765	-6.00265
	Broiler feed		**Egg feed**	
k = 1	-9.564981	-8.790767	-22.26463	-21.2969
k = 2	-9.20913	-7.648968	-22.16581	-20.4106
k = 3	-9.701209	-7.345102	-22.15343	-19.601
k = 4	-15.34723	-11.99012	-23.99761	-20.6405

Similarly, an increase in the price of final products decreases the production of feed, except for broiler feed. This is due to the expectation that an increase in a product price will decrease the demand. As the income of the domestic consumers is low nationwide, they will react to a price increase directly by reducing their consumption. This makes producers reduce their use of input in production when supply decreases in accordance with the decrease in demand.

Although the signs of the variables in the broiler feed production equation are not found to be meaningful economically, this result is due to the fact a large portion of the broiler feed production is realized by producers involved in integrated broiler production. On the other hand, in egg feed production the sign is negative, and this increases the expectation that egg producers will also move toward producing their own egg feed themselves.

When the lag lengths of the individual variables are examined, different results are observed for each feed type (Table 5). A Johansen model with maximum 3 lag lengths was used to examine each type of feed production. In the model where each lag represents one year, milk feed prices were found to affect milk production with two lags (t = -2.359**), while milk feed production and the increase in the number of milk producing manufactories are related proportionally with two lags (t = 2.118**). In livestock feed, none of the variables in short term equilibrium are related. In broiler feed production, broiler price affects production price positively with one lag only at 10% significance level (t=1.569*). In short, an increase in broiler price results in an increase in broiler feed production in the subsequent year. In egg feed production, egg feed production itself, egg feed price, and mixed feed producing manufactories, respectively, affect feed production with the first and second lags. Egg feed production is affected positively by egg production.

In the error model formed to test the long term equilibrium relationship in milk feed production, a change in milk price was found to negatively affect milk feed

Table 3. Johansen co-integration model trace statistic and MED statistic test result.

	Eigen value	Trace statistic	5% significance	Probability	MED Statistic	5% significance	Probability
				Livestock feed			
r 0	0.789	89.735	63.876	0.000	37.339	32.118	0.011
r 1	0.707	52.396	42.915	0.004	29.468	25.823	0.016
r 2	0.476	22.927	25.872	0.111	15.531	19.387	0.167
r 3	0.265	7.397	12.518	0.305	7.397	12.518	0.305
				Milk feed			
r 0	0.847	91.137	63.876	0.000	45.067	32.118	0.001
r 1	0.599	46.070	42.915	0.023	21.952	25.823	0.150
r 2	0.484	24.117	25.872	0.081	15.866	19.387	0.151
r 3	0.291	8.251	12.518	0.232	8.251	12.518	0.232
	Eigen value	**Trace statistic**	**5% significance**	**Probability**	**MED Statistic**	**5% significance**	**Probability**
				Broiler feed			
r 0	0.850	109.743	63.876	0.000	45.592	32.118	0.001
r 1	0.747	64.152	42.915	0.000	32.962	25.823	0.005
r 2	0.652	31.189	25.872	0.010	25.342	19.387	0.006
r 3	0.216	5.847	12.518	0.480	5.847	12.518	0.480
				Egg feed			
r 0	0.951	157.864	63.876	0.000	69.292	32.118	0.000
r 1	0.929	88.571	42.915	0.000	60.691	25.823	0.000
r 2	0.649	27.880	25.872	0.028	24.083	19.387	0.010
r 3	0.152	3.797	12.518	0.771	3.797	12.518	0.771

Table 4. Long term equilibrium relationship.

Variables	Relationship
Livestock feed	LnBYU= -0.174 LnBYF - 1.450 LnBEF+ 0.190 LnKYFAB + 0.078 Trend
Milk feed	LnSYU= -0.136 LnSYF -1.997 LnSF + 1.952 LnKYFAB + 2.403 Trend
Broiler feed	LnKYU= 0.234 LnKYF+ 0.300 LnKEF-4.914 LnKYFAB + 0.162 Trend
Egg feed	LnYYU= -0.011 LnYYF -14.227 LnYF + 0.125 LnKYFAB - 0.002 Trend

production with two lags, and an increase in the number of manufactories was found to affect feed production positively with two lags. In broiler feed production, broiler price has a short term one lag positive effect. In egg feed, the first and second lag values of all the variables, and the first and second lag values of feed production itself were found to directly affect production amount in the short term. No short term relationship was found in livestock feed. In milk, short term effects on price may result in a short term change in production amount. Several researchers have attempted to this model at their studies, especialy Cheung and Lai (1993), Sarantis and Steward (2001), Masood at al. (2009), Botha and Pretorius (2009) and Afzal and Abbas (2010) who used banking sector research. This studies included macroeconomic aspects and for instance, one of them, Ali et al. (2005) found no causal relationship between macro-economic indicators and stock exchange prices in Pakistan. Mookerjee (1988) and Ahmed (1999) found unidirectional causal relationship between stock prices and investment spending for the case of India and Bangladesh.

Conclusion

In the co-integration analysis of the structure of mixed feed production in Turkey, it was found that of all the variables only livestock feed price, broiler feed and egg feed price meet the stationary condition at 5% significance level. The other variables become stationary only after second differenced and below the 5% significance level. In order to realize the Johansen model and for all

Table 5. Error correction model.

Milk feed				Livestock feed			
Variables	**Constants**	**t- test**		**Variables**	**Constants**	**t- test**	
C	0.256	1.866**		C	0.167	0.815	
LnSYU(-1)	-0.879	-1.309		LnBYU(-1)	-0.086	-0.118	
LnSYU(-2)	0.524	0.844		LnBYU(-2)	0.044	0.08	
LnKYFAB(-1)	-1.424	-1.098		LBYF(-1)	0.121	0.386	
LnKYFAB(-2)	2.169	2.118**		LBYF(-2)	-0.231	-0.994	
LnSF(-1)	1.554	1.24		LnBET(-1)	-0.482	-0.369	
LnSF(-2)	-0.284	-0.287		LnBET(-2)	-0.15	-0.163	
LnSYF(-1)	-0.09	-0.445		LnKYFAB(-1)	-1.487	-1.227	
LnSYF(-2)	-0.692	-2.359**		LnKYFAB(-2)	1.009	1.035	
R^2	0.478	F test	1.422	R^2	0.409	F test	1.079
Akaike criterion	-9.601	Schwarz criterion	-7.392	Akaike criterion	-7.569	Schwarz criterion	-5.36
Broiler feed				**Egg feed**			
Variables	**Constants**	**t- test**		**Variables**	**Constants**	**t- test**	
C	0.039	0.368		C	0.307	2.138**	
LnKYU(-1)	0.024	0.082		LnYYU(-1)	46.269	2.088**	
LnKYU(-2)	-0.217	-0.773		LnYYU(-2)	24.84	1.335*	
LnKYFAB(-1)	-0.253	-0.246		LnYYU(-3)	9.815	0.987	
LnKYFAB(-2)	0.212	0.212		LnKYFAB(-1)	3.074	1.543*	
LnKEF(-1)	0.262	1.569*		LnKYFAB(-2)	4.401	2.413**	
LnKEF(-2)	-0.012	-0.072		LnKYFAB(-3)	0.049	0.063	
LnKYF(-1)	0.016	0.149		LnYF(-1)	-671.537	-2.110**	
LnKYF(-2)	0.032	0.232		LnYF(-2)	-363.458	-1.360*	
R^2	0.409	F test	1.079	LnYF(-3)	-145.762	-1.022	
Akaike criterion	-7.569	Schwarz criterion	-5.36	LnYYF(-1)	-0.873	-2.537*	
				LnYYF(-2)	-0.266	-1.255*	
				LnYYF(-3)	-0.149	-0.902	
				R^2	0.709	F test	1.689
				Akaike criterion	-22.904	Schwarz criterion	-19.893

F table value (at 5% significance level): 2.7278; t- table value at 10%* and 5%** significance level: 1.314 and 1.703, respectively.

the variables to meet the stationary condition at the same level, the analyses at 10% significance level show that the lag length in live-stock feed, milk feed and broiler feed is 2 with the Akaike criterion, and 3 with the Schwartz criterion.

In egg feed the lag lengths are 3 with both criteria. At 5% significance level, the trace statistic shows the presence of at least one co-integration vector (r1) for each feed type. At 5% significance level, the MED test indicates the presence of at least two co-integration vectors (r2) for each feed type. These findings show that there is a long term equilibrium relationship between feed production, feed price, number of manufactories, and consumer final products (Red meat, Milk, Broiler and Egg). Thus, while a long term positive relationship exists between milk and egg feed production and the number of manufactories, feed price and final product price negatively affect feed production. If today feed production input can be obtained cheaply, this will increase mixed feed production. However, broiler feed production is in an advantageous position since broiler producers produce their own feed themselves. While certain balancing elements in milk feed, broiler feed and egg feed were found in the short term equilibrium trace analysis, no short term equilibrium relationship was found for livestock feed.

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