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OLIGOPOLY AND PRICE TRANSMISSION IN TURKEY'S FLUID MILK MARKET

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Abstract: Farmers and consumers suspect that processing firms abuse their power in the milk marketing chain. We employ threshold autoregressive and moment threshold autoregressive tests and contrary to expectations find evidence of a downward trend in UHT milk real price without a corresponding decline in farm-gate prices. The downward trend coincides with increased competition in the dairy industry and with the growing market share of the formal sector at the expense of the informal sector. Major dairy processing firms expand their market share and still enjoy healthy profits thanks to increasing returns to scale in processing and distribution in a growing market.

Keywords: Dairy, Turkey, Oligopsony, TAR, M-TAR

1 INTRODUCTION

Two complaints are commonly heard in Turkey regarding milk markets, one among milk farmers and other among milk processors. On the one hand, milk farmers in Turkey point out that farm-gate milk price in Turkey is relatively low compared to the EU while the price of fluid milk remain among the highest (Section 2). The Cattle Breeders Central Association complains that milk processors collude in order not to bid each other in quarterly auctions where milk prices are set (Güngör, 2006). Consecutively, their biggest complaint is low and volatile milk prices. Producing milk suitable for delivery to milk processors with modern technology requires hefty investment in milking machines, cold storage and high yielding cow breeds. In order to recoup the costly investment one needs to foresee more than the immediate quarter. Yet, currently there is no national policy in Turkey that will protect milk farmers from price fluctuations, whether this is the result of ordinary market forces or is engineered by oligopolistic buyers. On the other hand, milk processors in Turkey complain about the low quality of milk produced in Turkey (i.e. very high bacteria count). They point out that, unlike many EU member countries, the milk farmers in Turkey are very small sized and (60 percent of households engaged in livestock farming owns 1-4 animals, (Uzmay, 2007)) and this small size increases the milk collection costs, and more importantly hampers the milk farmers' ability to modernize their operations. Several sources guesstimate that only 30 percent of total milk production is processed by modern enterprises (Voorbergen, 2004). The rest of the output is so low quality that they would not have qualified for support

under the current EU Common Agricultural Policy regulations[1]. The seasonality is pointed out as the evidence of traditional nature of milk production in Turkey which relies substantially on grazing. As a result, milk processing firms complain that they cannot find enough suitable quality milk to process and they are forced to operate below full capacity.

In this paper we try to sort out these competing claims and also propose an alternative scenario that weaves together all the seemingly competing facts. We observe that the cumulative effect of price transmission from farm-gate to retailers is indeed asymmetric. However, the asymmetry is the opposite of what we have come to expect from studying the empirical literature on price transmission in agricultural markets[2]. Over time, the vertical distance between farm-gate and wholesale milk prices are shrinking in Turkey. Following McCorriston et al., (2001), we propose that the most approximate explanation of the functioning of fluid milk production and processing chain is the one where milk processors enjoy oligopsony powers and hence can extract price concessions from the farmers. However, processing firms are passing the price concessions and the more to the retailers[3] because they also enjoy increasing returns to scale. Increasing returns to scale allows dairy firms to preserve their net profit rates even though the gross margin between farm-gate milk price (chief input) and Ultra High Temperature milk (major fluid milk output, UHT) is narrowing. We show that the capacity utilization ratio in modern dairy industry rose in Turkey in the study period (1994-2006) but it still remains low. We believe that the availability of excess capacity makes it evident that increasing returns scale is achievable in the short run. We show that UHT milk is gaining market share against the open milk – milk sold by the street traders without treatment –

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[1] The retail sector trade journal report on dairy industry (January 2007) can be reached at: http://www.perakende.org/haber.php?hid=1197885349

[2] Peltzman (2000) studies a wide variety of industries for the U.S. where a primary input costs at least 20 percent of output price and concludes that more often than not producers pass thru the reductions in input costs slower than increases and he suspects abuse of oligopoly market power. The abuse of oligopoly power is well documented for the U.S. dairy sector. For example please see Carman and Sexton (2005), Chidmi et al., (2005), Cotterill (2005), Lass (2005), Capps and Sherwell (2007) and Li (2008). Von Cramon-Taubadel (1998) is one of the first papers that deal with a European market while taking into account the unit root characteristics of time-series variables. Meyer and Von Cramon-Taubadel (2004) is an excellent review of the theoretical basis of asymmetric price transmission, time series econometrics and the empirical studies.

[3] We assume that reductions in wholesale milk prices are passed to final consumers. Celen et al., (2005) asserts that the supermarkets are generally competitive in Turkey.

suggesting that there is potentially increasing returns to scale in the medium and the long run due to the expansion of the market. We also find more direct evidence for increasing returns to scale: there is a structural break in unit root tests for the hourly labour productivity index in the dairy sector (hereafter labour productivity index) coinciding with the entry of two major competitors (Danone and Ülker) into the dairy market in 1997. We also detect a gradual but consistent decline in UHT milk price from 1998 onwards which coincides with the structural break in labour productivity index. The long term decline in UHT milk prices is accompanied by no major change in farm-gate milk prices.

Finally, we employ Threshold Autoregressive (TAR) and Moment Threshold Autoregressive tests (M-TAR) to look for evidence of abuse of market power by milk processing firms. We do not find much evidence for asymmetry, and the little evidence we get for asymmetry supports the contrary conclusion that milk processing firms in Turkey in the study period transmit input price decreases quicker to retailers than input price increases.

In the Section 2, we describe dairy sector in Turkey and justify the choice of fluid milk as the object of analysis. Section 3 presents a thorough analysis of unit root characteristics of variables. Section 4.1 presents the cointegration analysis. Because the Johansen's trace test is known to perform poorly in the presence of asymmetric price transmission, in Section 4.5.2 we employ TAR and M-TAR cointegration tests that are developed specifically for cases exhibiting potential asymmetric relationships. Section 5 recaps the empirical findings and concludes the paper.

2 DAIRY SECTOR IN TURKEY

In Turkey animal production systems differ depending on the animal product. At one end stands the broiler chicken industry where industrial farms dominate. At the other end stands sheep and goat husbandry which is dominated by scattered traditional producers. Dairy products lie in the intermediate terrain between these extremes, with a mix of large and small scale processors. Dairy products are the source of 50 percent of

the total animal protein in the Turkish diet and 60 percent of animal calories[4]. The dairy sector has a very diverse product spread. In Turkey the most consumed (in terms of fluid milk equivalent) dairy product is cheese, followed by yogurt, butter and fluid milk (MARA, 2004; Voorbergen, 2004).

Even though it is not the primarily consumed dairy product, in this paper we focus on fluid milk consumption and, specifically, on UHT milk consumption in Turkey owing to the distinctive features of the UHT market. UHT is the partial sterilization of milk by heating it for a short time, 1-2 seconds, at a high temperature (exceeding 135 °C, compared to heating at 72 °C for 15 seconds for pasteurization). In all primary dairy products except UHT milk, modern large scale enterprises (i.e., potential oligopolies) compete with 'mandra' (traditional, small-scale producers and semi-modern enterprises). As Voorbergen puts it, 'Processors operate in different worlds… At one pole, [stand] the big food conglomerates and foreign companies; at the other pole, [stand] the small-scale mandras' (Voorbergen, 2004: 12). Studying UHT milk will allow us to focus on the one product where mandras do not participate. UHT milk production requires costly initial investment in UHT machinery. FAO (2007) reports that ten largest dairies – five of them with nationwide presence – dominate UHT milk production (p. 69). Hence, by concentrating on the UHT milk market, we can most easily analyze whether big food conglomerates could manipulate prices for their benefit.

The retail price of fluid milk in Turkey is higher than that in most EU member countries. At the same time, the farm-gate price is among the lowest. In other words, the retail/ farm-gate price ratio is higher in Turkey compared to many EU members. Furthermore the farm-gate-milk-price to milk-feed-price[5] ratio is around 1.1-1.2 in Turkey in recent years. Koç et al., (2001) estimate that for a profitable farm, milk price/feed ratio should not be lower than 1.5 and preferably around 2[6].

Table 1 shows that the retail-to-farm-gate price ratio has been decreasing in Turkey but is still above the retail-to-farm-gate ratio for United Kingdom. On the one hand, farmer associations claim that the reason for the high retail/farm-gate ratio is the

[4] We calculate these estimates from the State Institute of Statistics (SIS) Household Budget Survey of 2003.
[5] On modern farms, which do primarily rely on milk feed (the special mixture of animal feed for milk production) can account for 63.7 percent of expenses in Turkey (Koç, et al., 2001: 26).
[6] Cow Breeders Association report p.2 ("Producers face the prices dictated by Industrialists") (Güngör, 2006); Agricultural Engineers Association of Turkey (TZOB, 2005) report p.11.

cartel power of milk processors (Güngör, 2006). On the other hand, dairy processors put the blame of the high retail-to-farm-gate ratio squarely on the dispersed and traditional nature of farmers (see footnote 1). In other words, since the farms are small-sized and dispersed, milk collection costs are higher than what would be if the farmers had modern and large milk farms. Also, most of the Turkish farmers do not have refrigerated storage tanks for milk and, hence, once the milk is collected it needs to be treated extensively in order to reduce the bacteria count to acceptable levels.

Table 1

A third group, the board for the 9th Development Plan for Food Processing Industry, takes a position somewhere in between these two (Ataman, 2006). It acknowledges the parcelling of milk supply among milk processors, and affirms that most farmers lack the means necessary to participate in modern markets. As a result, the authors of the report make a case for public institutions to regulate the market, implicitly acknowledging the institutional externalities arising from the quickly perishable nature of the product[7]. There is some evidence of concentration for the Turkish dairy processing industry indicating that it is indeed high (top four firms controlled between 50 to 60 percent during 1990s[8]). However, it is prudent to regard these statistics with scepticism. The coverage of the informal sector by State Institute of Statistics (SIS) is at best inadequate. For example, Voorbergen reports that only 19 percent of total raw milk in Turkey is processed by modern firms; 35 percent is processed by small and medium scale firms; roughly 10 percent is sold by street vendors as open milk and roughly one third is consumed/ processed on the farm itself (Voorbergen, 2004: 10).

The existence of oligopolies does not necessarily imply the exercise of oligopoly power to the expense of social welfare. Sometimes the benefits of oligopolies outweigh their potential costs. For example, oligopolies may enjoy “super profits” (in comparison to the perfect competition case) yet deliver lower prices to consumers because they can enjoy economies of scale, or they can overcome double marginalization that exists

[7] This report relies on expert opinion instead of empirical scrutiny.
[8] Personal communication with SIS staff.

between companies dealing with each other at arms length[9]. If barriers to entry are sufficiently low, the threat of entry can force existing monopolies or oligopolies to behave as if they are operating in competitive markets. Hence, in order to determine the welfare effects of oligopolistic market structure, it is not enough to show the market share of larger firms. Instead, McCorriston et al., (2001), provide a theoretical framework where increasing returns to scale in oligopolistic markets can lead to even greater price transmission than a perfect competition case:

> Specifically, whereas market power will reduce the level of price transmission (relative to perfectly competitive case), if the industry is characterised by increasing returns to scale, the level of price transmission will increase. Under reasonable conditions, the degree of price transmission may be greater than in the constant returns, perfectly competitive case. (p. 146)

An inspection of Figure 1 suggests that the farm-gate and UHT milk real prices are not moving together in the sense that there is no visible pattern in farm-gate milk real prices while UHT milk real prices are in a gradual long term decline. Formal cointegration analysis of farm-gate and UHT milk real prices rejects cointegration between these two variables and confirms the visual inspection. In Section 3 we show that the sustained increase in labour productivity in the post-1997 period in the dairy sector coincides with the entry of two major producers and with the start of long-term decline in UHT milk prices. In Section 4, we show that when we consider the farm-gate and UHT milk real prices, and labor productivity index together they are indeed cointegrated, which stands as further evidence that dairy sector labour productivity have a significant role in explaining the movements in prices. We regard the upward trend in dairy sector productivity as an indicator of increasing returns to scale and as a clear structural break from the past in the post-1997 period.

Tables 2 and 3 present additional evidence that point out to increasing returns to scale in dairy industry. Table 2 shows that only seven percent of fluid milk consumption in 1994 was from the formal sector (pasteurized and UHT milk). By 2003 the formal

[9] When final consumer products firms (like food processors or supermarkets) deal with their suppliers at arms length, the resultant production is less than their profit maximizing optimum production level. Given supermarkets' demand, the profit maximizing optimum for their suppliers is less than consumer products firms' optimum. Double marginalization can be avoided if upstream or downstream activities are vertically integrated.

sector raised its market share relative to open source milk (street milk) to 18 percent and at the same time per capita fluid milk consumption kept increasing. Almost all of the increase in total consumption can be attributed to the formal sector. Potentially, UHT and pasteurized milk products are becoming normal goods consumed by middle class rather than luxury products as they evidently were in the mid-1990s. Thus the decline in the wholesale-to-farm-gate price ratio may point towards the evolution of a novel/luxury product into a mass consumer good. At the same time the oligopolistic nature of the dairy industry may not mean a net social welfare loss but it can be justified by dairy firms' efforts to introduce the better quality (more hygienic, healthy and with longer shelf life) products to the consumer basket.

Table 2

Table 3 shows that total fluid milk output and capacity utilization in the formal sector have been increasing[10] in Turkey for the years where data is available. We take tables 2 and 3 as evidence for potential increasing returns to scale both in the short- and long-run. Gradual decline in excess capacity also suggest potential for existence of increasing returns to scale even in the short run. In the long-run the UHT and pasteurized milk are gaining market share allowing for continuous upgrade and expansion of existing factories. During this process, excess capacity can lead to price wars among dairy processors to gain market share.

Table 3

3 DATA

3.1 Exploring Data Set

The most publicized price gauging cases are the ones concerning the manipulation of retail prices due to the direct link to the pockets of consumers at large. Unfortunately, the retail milk price data released by SIS also includes the open sourced milk in addition

[10] There is no import of fluid milk to Turkey, so all of the increase in consumption is sourced domestically.

to packaged milk and hence does not correspond one-to-one to the wholesale product (Ultra High Temperature packed milk – UHT milk) of modern dairy industry. Hence we will concentrate on the relationship between farm-gate (input) and UHT wholesale prices (output). Price data for many commodities and products are available monthly starting with January 1994 at SIS's web-site. We use available data up until to the end of 2006[11].

We want to control for returns to scale while exploring the relationship between farm-gate and wholesale milk price after McCorriston et al., (2001). Low capacity utilization rates presented in Table 3 suggest the potential of increasing returns to scale in the short run. Unfortunately, capacity utilization rate data are only available annually. Hence we use the labour productivity index as a proxy for returns to scale. This index is available as quarterly data on the SIS's web-site for the period 1994-2006. We convert the quarterly index data into monthly data by interpolating.

The very high level of inflation prior to 2002 makes it very hard to evaluate nominal price movements visually. To ameliorate the inflation problem, we index nominal prices using monthly wholesale price index. The gross margin between indexed farm-gate milk price and indexed wholesale UHT prices are narrowing in Figure 1. In other words, Figure 1 of indexed prices suggests that the two series may not be cointegrated since the relationship between the two series is not constant.

Figure 1

Figure 2 presents the time graph of indices of three indexed variables which illustrates the fluctuating movement of farm-gate prices, the long-term decline in UHT prices and the gradual increase in productivity index.

Figure 2

[11]We end the analysis at the end of 2006 because the labour productivity index for dairy sector is available only until the end of 2006. Recently, SIS has released data for indices for labour hours and total dairy prodcution for post 2006 but the base year has been changed to 2005 from 1997 and the data frequency for total production is monthly.

3.2 Unit Root Tests

After visual analysis of time-series data we check for the existence of unit root. We use JMulti software[12] for unit root tests and for the Johansen co-integration tests. Our testing strategy is to start with an augmented Dickey-Fuller (ADF) model with one lag including the trend variable if trend is visible in the data. If the final prediction error (FPE)[13] score indicate a lag length different than the default one lag, we conduct the ADF test with the suggested lag length. In the second step, we use the test developed by Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992). We choose the KPSS test as an alternative to ADF because it tests opposite null hypothesis. In the ADF test the null hypothesis is the existence of a unit root. In KPSS the null hypothesis is stationarity. While testing for both level stationarity and trend stationarity, we conduct KPSS tests with the same lag length as ADF tests. In the last step, we test for the presence of a unit root with structural break. Finally, since the data is monthly we add monthly dummy variables to see if the results changed significantly. In the unit root test with structural break, Saikkonen and Lütkepohl (2002) suggest first estimating Equation 1 and subtracting it from the original series. Then the ADF test is performed on the adjusted series.

$$y_t = \alpha_0 + \alpha_1 t + \gamma D_s + e_t \tag{1}$$

where $D_s = 0$ if $t < T$

$D_s = 1$ if $t \geq T$ and T is the shift date.

y_t is the time series, t stands for time and D_s is the dummy variable defined as above.

For the sake of brevity, we present only unit root test results with lag lengths minimizing FPE score. For the UHT milk real price and labour productivity index, we present unit root tests taking into account the prior information since there is visible trend in the time series (Elder and Kennedy, 2001). Table 4 shows that both the ADF and KPSS tests gave the same results for the UHT milk real price: the monthly prices are non-

[12] www.jmulti.de. JMulti is very user friendly and its main advantage is that it allows unit root analysis while testing for structural breaks.

[13] JMulti automatically provides optimal lag length from four alternative information criteria: AIC, FPE, Hannan-Quinn, and Schwarz Criterion. We based our decisions on FPE.

stationary. However, the conclusion changes drastically when we conduct the unit root test with structural break test. Prior to formal tests, we thought that February 2001 will be the date for structural break date due to the severe foreign exchange crisis and sudden jump in inflation.

Table 4

However, the structural break test suggests the break date as of October 1997. Figure A1 in Appendix shows the deterministic time trend with a structural break imposed on the inflation adjusted UHT milk price. The most significant developments prior to or during 1997 are the privatization of SEK (the publicly owned milk company[14]) and entrance of new firms to dairy sector. The privatization of SEK was mostly completed during August-September 1995. French multinational Danone bought a local company, Tikvesli, and entered the Turkish market in 1997. Moreover, the biggest domestic food company, Ülker, entered the consumer dairy market in 1997 (Voorbergen, 2004)[15]. In other words, structural break identified in empirical analysis coincides with significant change in industry structure rather than major macroeconomic events.

Table 4 also shows that the ADF and KPSS for farm-gate milk real price and labour productivity index and support the unit root null hypothesis in every alternative test. The structural break date is December 2000 (See Figure A2) for farm-gate milk real price. The structural break date is just prior to the 2001 crisis. Unlike the milk processing firms, there is no sector level drastic change to account for such a break. The sharp drop in real prices during 2001 is the result of the fact that the increases in nominal milk price were not able to match the increase in inflation rate.

In the case of labour productivity index, the suggested break date is May 1997. However, we cannot perform with structural break unit root test occurring May 1997 with suggested 22 lags because there are not enough prior sample observations. The closest

[14] Modern enterprises, private or owned by the state, have never processed majority of raw milk in Turkey. However, SEK, due to its presence in every region, was widely believed to set the reference price both for farmers (when buying milk from) and for processors (when selling their products).

[15] "Ülker is a diversified Turkish food company with sales of around USD 2.5 billion [2004] that expanded into the dairy business relatively recently. The company already manufactured powdered milk for its own cookie business but moved into the end consumer business with the acquisition of Ak Foods in 1997." (Voorbergen, 2004: 9)

possible date is October 1997 for structural break with 22 lags. We felt comfortable using October 1997 instead of May 1997 since, as discussed above, major new firms entered the dairy sector during 1997. Figure A3 shows the positive deterministic time trend imposed on actual productivity index data.

4 COINTRGRATION ANALYSIS

4.1 Johansen Trace Test and Saikkonen-Lütkepohl Test

In order to perform the cointegration analysis, all variables should have unit root properties. As we show in the previous section we can confidently claim unit roots for all variables in every case except when we introduce a structural break into the unit root analysis of the inflation adjusted UHT milk price. Despite this caveat, we continue with the cointegration analysis assuming that all variables are unit-root processes. We do not have any a priori expectation of the specific form the cointegrating relationship should take; hence we test the cointegration for all the possible variations. We also test for cointegration with the Saikkonen-Lütkepohl Test (2000) which estimates the deterministic part first, subtracts it from original observations and then applies a Johansen type test to the remaining adjusted series. Unlike Johansen trace tests, it is not possible to incorporate a structural break into the Saikkonen-Lütkepohl test.

We start by considering the cointegrating relationship between only inflation adjusted farm-gate and UHT milk prices. After visual inspection of Figure 1 we do not expect to find a cointegrating relationship between inflation adjusted farm-gate and UHT milk prices. Unsurprisingly Johansen trace tests, summarized in Table 5, confirm our intuition that these two series are not cointegrated, i.e. the regression relationship between them is spurious. When we introduce two break dates (i.e. shift dummies) for October 1997 and December 2000 then there is some evidence for cointegration. Likewise, when we follow Saikkonen and Lütkepohl's methodology and subtract the deterministic part from the original observations and test for cointegration in the adjusted observations, there is some evidence for cointegration.

The evidence for cointegration between farm-gate and UHT milk real price from Table 5 is not strong and we have evidence for substantial change in industry structure, so we proceed by including the labour productivity index to the cointegrating relationship.

The results in Table 5 are more consistent, i.e., less susceptible to specification, to choice of lag length, or existence or absence of structural break dates. Except for the case of applying the Johansen trace test with no structural break, cointegration is found in every specification. The most consistent finding of cointegration is the specification 'constant and trend'.

Table 5

4.2 Threshold Autoregressive and Moment Threshold Autoregressive Tests

The Johansen trace test is known to function poorly when applied to problems with asymmetric transmission. In order to improve the cointegration test, two alternative tests have been developed: threshold autoregressive (TAR) and moment threshold autoregressive tests (M-TAR) (Enders, 2004). In order to perform these alternative frameworks, we first need to estimate the long-term relationship to obtain the residuals. We include the deterministic components following the results of unit root tests. Following the findings in previous section, we include the productivity index ($prod_t$), and the trend term (t) on the right-hand side in Equations 2a and 2b. Furthermore, we add a structural break dummy variable suggested by the findings of Section 3 correspondingly (a shift dummy variable from October 1997 onwards for UHT milk and a shift dummy variable for from December 2000 onwards for farm-gate milk real price).

$$uht_t = \alpha_1 + \beta_{u1}t + \beta_{u2}farm_t + \beta_{u3}prod_t + \beta_{u4}DV9710 + \mu_t \qquad (2a)$$

$$farm_t = \alpha_2 + \beta_{f1}t + \beta_{f2}uht_t + \beta_{f3}prod_t + \beta_{f4}DV0012 + \theta_t \qquad (2b)$$

where $\mu_t = \rho\mu_{t-1} + \varepsilon_t$ and $\theta_t = \eta\theta_{t-1} + \tau_t$ (3)

In the threshold autoregressive (TAR) test, the coefficients of lagged error correction term, μ_t, are allowed to take different values across a threshold (Enders and Siklos (2001)):

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\rho_2\mu_{t-1} + e_t$$
$$I_t = \begin{cases} 1 \; if \;\; \mu_{t-1} \geq c \\ 0 \; if \;\; \mu_{t-1} < c \end{cases} \tag{4}$$

If c is equal to zero, μ_{t-1} is a simply negative or a positive deviation from equilibrium. We expect ρ_1 and ρ_2 to be negative so that deviations adjust toward the long run equilibrium. If the deviation of UHT price from long-run equilibrium is positive (more generally greater than c) in the previous period, than $\rho_1\mu_{t-1}$ will be eliminated in the current period and vice versa. The values of ρ_1 and ρ_2 indicate the relative speed of adjustment. If $\rho_1 > \rho_2$, faster convergence is observed when the prices are above the equilibrium[16].

The second alternative framework accommodating asymmetry is the moment threshold autoregressive (M-TAR) test:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\rho_2\mu_{t-1} + e_t$$
$$I_t = \begin{cases} 1 \; if \;\; \Delta\mu_{t-1} \geq c \\ 0 \; if \;\; \Delta\mu_{t-1} < c \end{cases} \tag{5}$$

In the case of the M-TAR model, economic agents adjust their behaviours according to the trend, or "momentum", of deviations instead of adjusting their behaviour according to deviations themselves. In other words, ρ_1 and ρ_2 describe adjustments in response to momentums in different directions. If $\rho_1 \neq \rho_2$, the adjustments are not symmetric and shows more "momentum" in one direction than in the other.

Following Enders and Siklos (2001), we perform a grid search to determine the value of the threshold. After sorting all of the estimated μ_t ($\Delta\mu_t$) from Equation 2a in ascending order, we consider values between the 15th percentile and 85th percentile as possible threshold values. These values are used to estimate Equation 4 (5). The value

[16] If $y_t > \hat{y}_t$ than μ_t will be positive. In other words, since $\hat{y}_t$ is the long-run equilibrium, positive μ_t indicates that actual price is above the long-run price.

that yields the least residual sum of squares is deemed to be the appropriate threshold value.

In order to ensure cointegration, ρ_1 and ρ_2 should be negative so that the long-term relationship between the variables do not deviate or shrink. The negative coefficients ensure that the short-term deviations are corrected towards long-term equilibrium. Enders and Siklos (2001) obtained critical values by recording the *t* statistics for the two null hypotheses $\rho_1 = 0$ and $\rho_2 = 0$ and the *F* statistic for the joint hypothesis $\rho_1 = \rho_2 = 0$. In the *t* tests, the larger of the two *t* statistics is called *t-Max*, and the smaller is called *t-Min*. If series are cointegrated, ρ_1, ρ_2 and the corresponding *t* statistics should be negative (*t-Min* < *t-Max* < 0). The null hypothesis of no cointegration is rejected if *t-Max* is smaller than the critical values. *t-Min* has little power and thus is ignored. In the *F* test, the *F* statistic for the joint hypothesis of $\rho_1 = \rho_2 = 0$ is called Φ, to distinguish from the usual *F* distribution. When only one of ρ_1 and ρ_2 is negative, the Φ statistic can be used to reject the null hypothesis of no cointegration. According to Enders and Siklos (2001) the Φ statistic has substantially more power than *t-Max* statistic. Moreover, they report that compare to Engle-Granger methodology, the TAR test has less power[17] but M-TAR test has more power.

Table 6 shows the test results both for TAR and M-TAR models for Equation 2a. For the TAR model, all coefficient estimates have the expected negative signs for both zero and non-zero thresholds. In the case of the TAR model, the threshold is more than zero, indicating that milk processors make adjustments in prices when the actual wholesale prices are above the long-term equilibrium price. Moreover, the absolute value of the coefficient estimate of ρ_1 is larger than that of ρ_2, suggesting faster convergence in response to positive deviations from equilibrium. When the threshold is zero the *t-Max* value for the TAR model is -1.92 (sligthly more negative than the 10 percent critical value of -1.90) and -1.68 for non-zero threshold which is less than 10 percent critical value of -1.61. Hence we fail to reject the no-cointegration hypothesis for the zero

[17] In other words, TAR test rejects null hypothesis of no cointegration correctly less often than Engle-Granger methodology in Monte Carlo experiments. Enders and Siklos (2001) allude that in the case of TAR model, gain from estimating the correctly specified model (asymmetric) is outweighed by the estimation of an additional coefficient – threshold (p. 171).

threshold model and we find some evidence (only at 10 percent) for cointegration in the case of non-zero threshold. However, when we performed the joint hypothesis with the more powerful Φ test, we reject the null hypothesis of no cointegration at a 5 percent significance level. If we accept the cointegration result of the joint test, then the next step is to test asymmetry. The usual *F-test* is sufficient in this case (see the last two columns of Table 4.6). For the TAR model we fail to reject the symmetry hypothesis in both cases (zero and non-zero thresholds).

Table 6

For the M-TAR test, coefficient estimates for ρ_1 are negative, but coefficient estimates for ρ_2 are positive (and not statistically significant) both in the zero and non-zero threshold cases. We cannot use *t-Max* because not all coefficient estimates are negative. The sample Φ statistics are 19.49 for zero threshold and 21.89 for non-zero threshold. The Φ statistics are greater than the 1 percent significance value of 8.85, so the null hypothesis of no cointegration can be rejected. Given these strong results for cointegration we test for asymmetry. The *F-test* statistics lead to a strong rejection of the null hypothesis of symmetry. In the case of the M-TAR model the threshold is also more than zero, indicating that milk processors make adjustments in prices when the deviations from long-term equilibrium are above the long-term for 'momentum'. Moreover, the absolute value of the coefficient estimate of ρ_1 is larger than that of ρ_2, suggesting faster convergence in response to positive deviations from equilibrium. Therefore, the farm-to-wholesale price transmission in Turkey is asymmetric, and adjustments are stronger when the previous period deviation is positive. That is, when actual wholesale prices are higher than the equilibrium prices, a more rapid adjustment back toward the equilibrium price occurs. In other words, dairy firms tend to be quicker in lowering prices.

We repeat the TAR and M-TAR cointegration analysis with the inflation adjusted farm-gate milk prices as the dependent variable. The results, shown in Table 7, are significantly different. For *t-Max*, the absolute value of the coefficient estimate of ρ_2 is larger than that of ρ_1, suggesting faster convergence in response to negative deviations from equilibrium. When the threshold is zero the *t-Max* value for the TAR model is -1.87

(less negative than the 10 percent critical value of -1.90) and -2.29 for non-zero threshold which is less negative than 1 percent critical value of -2.35. However with the more powerful Φ statistics, we fail to reject the no co-integration null hypothesis both when the threshold is zero or non-zero in the case of TAR. In the case of M-TAR, again *t-Max* test rejects the no cointegration hypothesis with zero and non-zero thresholds. However, with the Φ statistics, we find some evidence for cointegration (but only at a 10 percent significance level) only in the case of non-zero threshold. Since both of the coefficient estimates are not negative, we cannot use *t-Max* statistic. The Φ test score is 5.7, slightly less than 10 percent critical value of 5.73. If we assume the existence of cointegration, than there is evidence for asymmetry at 5 percent confidence level (last two columns).

Table 7

In the case of the M-TAR model the threshold is also more than zero, indicating that farmers make adjustments in prices when the deviations from long-term equilibrium are above the long-term 'momentum'. Moreover, the absolute value of the coefficient estimate of ρ_2 is larger than that of ρ_1, suggesting faster convergence in response to negative deviations from equilibrium. Therefore, the wholesale-to-farm price transmission in Turkey is asymmetric, and adjustments are stronger when the previous period deviation is negative. That is, when actual farm-gate prices are lower than the long-term equilibrium prices, a more rapid adjustment back toward the equilibrium price occurs. Nevertheless, evidence is weaker when farm-gate price is the dependent variable.

To sum up, we fail to detect any statistically significant asymmetry in price transmission that will be detrimental to social welfare. TAR and M-TAR tests indicate that if anything, the dairy firms are quicker to pass on the price concessions they extracted from farmers to retailers.

5 CONCLUSION

Time series variables are beset by non-stationarity. In Section 3, we test for the presence of a unit root in inflation adjusted farm-gate milk prices, UHT milk prices and the labour productivity index. In Section 4 we test whether these three variables are cointegrated. We find evidence for a structural break during October 1997 for the UHT

milk price and labour productivity index and another one during December 2000 for farm-gate milk price. Even after accounting for these structural breaks, we find evidence for unit root in most specifications and concluded that these variables are non-stationary. Next, we test for cointegration employing the Johansen trace tests and initially conclude that inflation adjusted farm-gate and UHT milk prices are not cointegrated; i.e., the detected relationship between the two is spurious. In the next step we add the labour productivity index to inflation adjusted milk prices and, using Johansen trace test, conclude that these three variables are indeed cointegrated. However, we suspect an asymmetric price transmission and Johansen trace test is known to perform poorly in the presence of asymmetry. Hence, we apply TAR and M-TAR procedures to test for cointegration in the case of asymmetry. When the dependent variable is inflation adjusted UHT milk price, we find strong evidence for cointegration both with TAR and M-TAR tests.

Interestingly the asymmetry suggested by M-TAR is the opposite of what the literature would have predicted. The estimated threshold is greater than zero suggesting that UHT milk producers adjust their prices quicker when the difference is above the long-run equilibrium (i.e. when gross profit margin is stretched). In the M-TAR procedure we test for whether agents adjust their behaviours according to the trend of deviations instead of adjusting their behaviour according to deviations. We find that the absolute value of the ρ_1 (coefficient of deviations that are above the threshold) is larger than ρ_2 meaning that speed of adjustment is faster when the deviations are above the long-run relationship[18]. The combined evidence from the TAR and M-TAR tests for the UHT milk price and the auxiliary evidence of short- and long-run economies of scale support the framework proposed by McCorriston et al., (2001). For UHT milk in Turkey, there is both scope for increasing returns to scale and evidence for passing price reductions to retailers quicker than price increases.

[18] In an extended version of this paper, we also construct an error correction model (ECM) for asymmetric price transmission model where the dependent variable is UHT milk price. In the ECM, we find some evidence for asymmetry but this evidence is not statistically significant.
http://people.umass.edu/hastek/papers.htm

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Table1: Comparison of retail and farm-gate prices and ratios in England and Turkey

	2002	2003	2004

UK Retail Milk	0.74 €	0.78 €	0.79 €
Turkey Retail Milk	0.80 €	0.81 €	0.86 €
UK Farm-gate Milk	0.29 €	0.30 €	0.31 €
Turkey Farm-gate Milk	0.22 €	0.24 €	0.27 €
UK Milk Feed	0.25 €	0.26 €	0.28 €
Turkey Milk Feed	0.18 €	0.21 €	0.20 €
UK retail / farm-gate	2.55	2.60	2.55
Turkey retail / farm-gate	3.64	3.37	3.19
UK farm-gate / feed	1.16	1.15	1.11
Turkey farm-gate / feed	1.22	1.14	1.35

Note: The feed conversion ratio, on average, is higher in Turkey, which means that for every kg of feed less milk is obtained in Turkey. Source: Reproduced from (TZOB 2005) report, p.10.

Table 2: Source of fluid milk consumed 1994 and 2003

	Rural			Urban			Total		
Years	**Open**	**Packed**	**Pc daily, lt**	**Open**	**Packed**	**Pc daily, lt**	**Open**	**Packed**	**Pc daily, lt**
1994	99 %	1 %	0.085	90%	10 %	0.081	93%	7%	0.082
2003	96 %	4 %	0.113	74 %	26 %	0.086	82 %	18 %	0.094

Our calculations are based on the SIS 1994 and 2003 Household Budget Surveys.

Table 3: Formal sector capacity, production and utilization

			UHT	
Years	**# of units**	**Capacity**	**Production**	**Capacity utilization**
1994	8	242,794	85,789	35%
1996	13	280,383	15,917	6%
1998	15	299,783	221,635	74%
2000	10	415,372	181,821	44%
2002	35	231,728	91,126	39%
			Pasteurized	
Years	**# of units**	**Capacity**	**Production**	**Capacity utilization**
1994	42	612,545	106,430	17%
1996	46	542,907	130,837	24%
1998	52	414,722	126,186	30%
2000	37	1,792,497*	142,181	8%
2002	48	286,629	170,645	60%

*: The significant increase from 1998 to 2000 and the subsequent substantial decline are probably due to a classification mistake: the buttermilk capacity has a reverse swing during the same period.
Source: Industry surveys by SIS originally reported by Ministry of Agriculture and Rural Affairs (MARA).

Table 4: Unit root tests for UHT and farm-gate milk prices and labour productivity index

Variable	**Test**	**Structural break date**	**trend variable**	**Lags**	**Test score**	**Conclusion**
UHT milk	DF		yes	13 lags	-1.5562	FTR Ho of unit root

real price	KPSS		yes	13 lags	0.2455	Reject Ho of stationarity
	Structural break	1997 M10	yes	3 lags	-4.0588	Reject Ho of unit root
farm-gate milk real price	ADF		no	1 lag	-2.9748	Reject Ho alpha=.05
	ADF		yes	1 lag	-2.7427	FTR Ho of unit root
	KPSS		no	1 lag	0.781	Reject Ho of stationarity
	KPSS		yes	1 lag	0.271	Reject Ho of stationarity
	Structural break	2000 M12	yes	1 lag	-2.6061	FTR Ho of unit root
productivity index	ADF		yes	22 lags	-1.1158	FTR Ho of unit root
	KPSS		yes	22 lags	0.1407	Reject Ho of stationarity
	Structural break	1997 M10	yes	22 lags	-1.6154	FTR Ho of unit root

Table 5: Cointegration tests for farm-gate, UHT milk prices and labour productivity index

Johansen Trace test - Constant			
Variables	**Structural break**	**Lags**	**Conclusion**
Farm-gate and UHT	No	2	0 cointegrating vector
Farm-gate , UHT, productivity index	No	8	0 cointegrating vector
Farm-gate and UHT	1997 M10	2	0 cointegrating vector
Farm-gate , UHT, productivity index	1997 M10	8	1 cointegrating vector 10 %
Farm-gate and UHT	1997 M10; 2000 M12	2	1 cointegrating vector
Farm-gate , UHT, productivity index	1997 M10; 2000 M12	8	1 cointegrating vector
Johansen Trace test - Constant & trend			
Farm-gate and UHT	No	2	0 cointegrating vector
Farm-gate , UHT, productivity index	No	8	0 cointegrating vector
Farm-gate and UHT	1997 M10	2	0 cointegrating vector
Farm-gate , UHT, productivity index	1997 M10	8	1 cointegrating vector
Farm-gate and UHT	1997 M10; 2000 M12	2	1 cointegrating vector
Farm-gate , UHT, productivity index	1997 M10; 2000 M12	8	2 cointegrating vectors
Johansen Trace test - orthogonal trend			
Farm-gate and UHT	No	2	0 cointegrating vector
Farm-gate , UHT, productivity index	No	8	0 cointegrating vector
Farm-gate and UHT	1997 M10	2	0 cointegrating vector
Farm-gate , UHT, productivity index	1997 M10	8	0 cointegrating vector
Farm-gate and UHT	1997 M10; 2000 M12	2	0 cointegrating vector
Farm-gate , UHT, productivity index	1997 M10; 2000 M12	8	1 cointegrating vector
Saikkonen & Lütkepohl test	**Test type**	**Lags**	
Farm-gate and UHT	constant	2	1 cointegrating vector 10 %
Farm-gate , UHT, productivity index	constant	8	1 cointegrating vector
Farm-gate and UHT	constant & trend	2	1 cointegrating vector 10 %
Farm-gate , UHT, productivity index	constant & trend	8	1 cointegrating vector 10 %
Farm-gate and UHT	orthogonal trend	2	1 cointegrating vector 5 %
Farm-gate , UHT, productivity index	orthogonal trend	8	1 cointegrating vector 5 %

*: Breaks are ignored for 'trend orthogonal' case. For constant and constant-and-trend cases, only breaks in levels assumed.

Table 6: Results of TAR and M-TAR for inflation indexed UHT milk price

	Threshold	ρ_1^a	t-value	ρ_2^b	t-value	Φ^c	$\rho_1 = \rho_2^d$	p-value
TAR								
c=0		(0.217)	-3.55	(0.133)	-1.87	8.06	0.79	0.38
c ≠ 0	0.131	(0.253)	-3.88	(0.110)	-1.68	8.95	2.4	0.12
M-TAR								
c=0		(0.362)	-6.20	0.044	0.67	19.44	21.49	0.00
c ≠ 0	0.058	(0.445)	-6.62	0.000	0.00	21.89	25.93	0.00

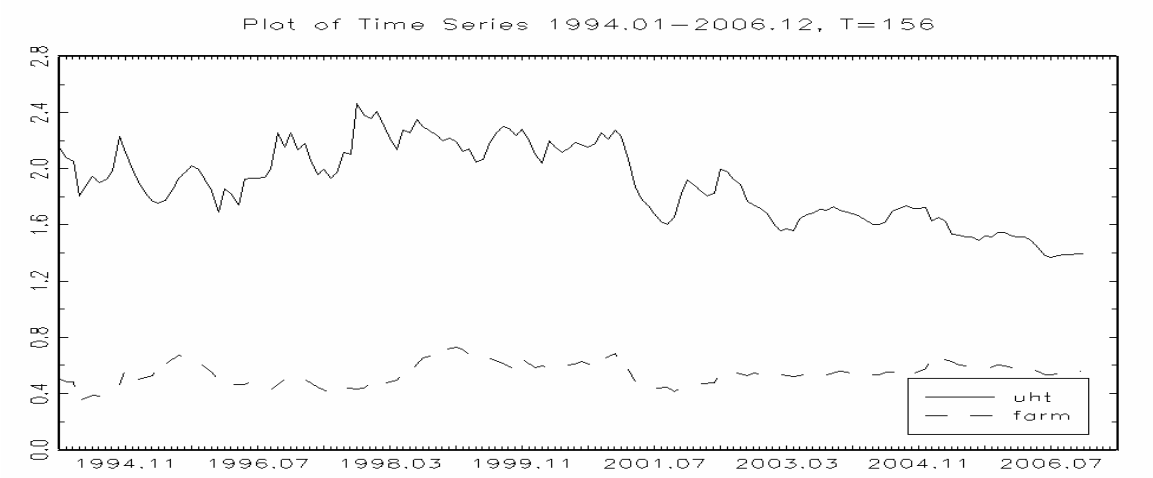
a: Coefficients and t-statistics for the null hypothesis $\rho_1 = 0$.
b: Coefficients and t-statistics for the null hypothesis $\rho_2 = 0$. t-Max critical values:
when c=0: TAR: 1%: -2.55, 5%: -2.11, 10%: -1.90. M-TAR: 1%: -2.47, 5%: -2.02, 10%: -1.77.
when $c \neq 0$: TAR: 1%: -2.35, 5%: -1.85, 10%: -1.61. M-TAR: 1%: -2.37, 5%: -1.90, 10%: -1.65.
c: F statistics for the joint hypothesis $\rho_1 = \rho_2 = 0$.
when c= 0: TAR: 1%: 8.24, 5%: 5.98; 10%: 5.01; M-TAR: 1%: 8.78, 5%: 6.51, 10%: 5.45.
when $c \neq 0$: TAR: 1%: 9.27, 5%: 6.95; 10%: 5.95; M-TAR: 1%: 9.14, 5%: 6.78, 10%: 5.73.
d: F statistics for the joint hypothesis $\rho_1 = \rho_2$ to test for asymmetric price transmission.
The test statistics are taken from Enders and Siklos (2001).

Table 7: Results of TAR and M-TAR for inflation indexed farm-gate milk price

	Threshold	ρ_1^a	t-value	ρ_2^b	t-value	Φ^c	$\rho_1 = \rho_2^d$	p-value
TAR								
c=0*		(0.076)	-1.74	(0.091)	-1.92	3.35		
c ≠ 0**	0.075	(0.063)	-1.34	(0.102)	-2.29	3.51		
M-TAR								
c=0		(0.025)	-0.49	(0.120)	-2.92	4.4		
c ≠ 0	0.015	0.023	0.39	(0.127)	-3.35	5.7	4.56	0.034

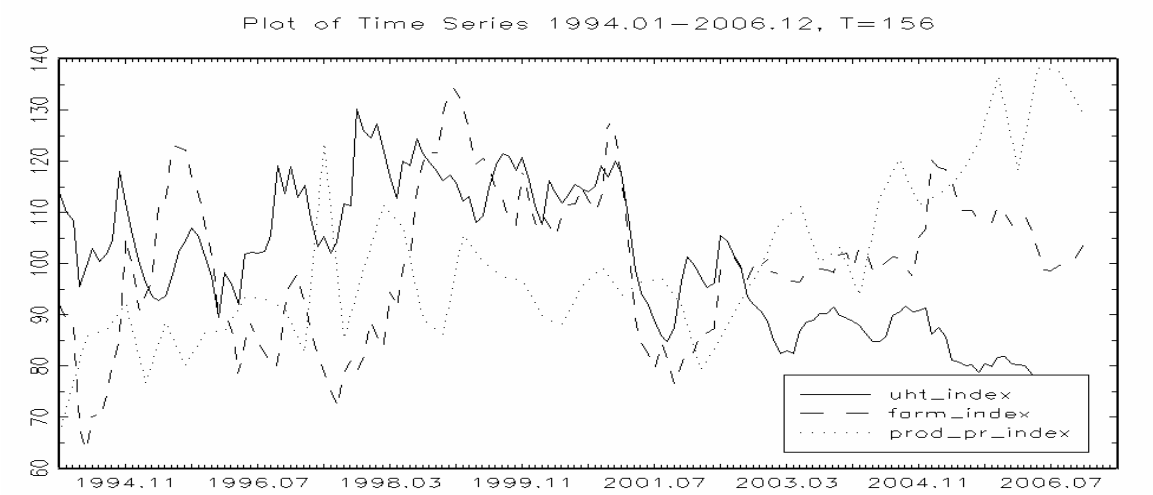
a, b, c, d: Same as Table 6.
*: Tests reveal that residuals for TAR model are not white noise. After augmenting to 6 lags we obtained white noise residuals at that point the estimated coefficients became negative, we conclude for cointegration at 5 percent and symmetry.
**: Tests reveal that residuals for TAR model are not white noise. After augmenting to 6 lags we obtained white noise residuals and at that point the estimated coefficients became negative, we conclude for cointegration at 5 percent and symmetry.

Figure 1: inflation adjusted Farm-gate and UHT (wholesale) milk prices, YTL*



*: YTL = 1,000,000 TL, SIS web-site.

Figure 2: Inflation adjusted Farm-gate, UHT prices and productivity indexed



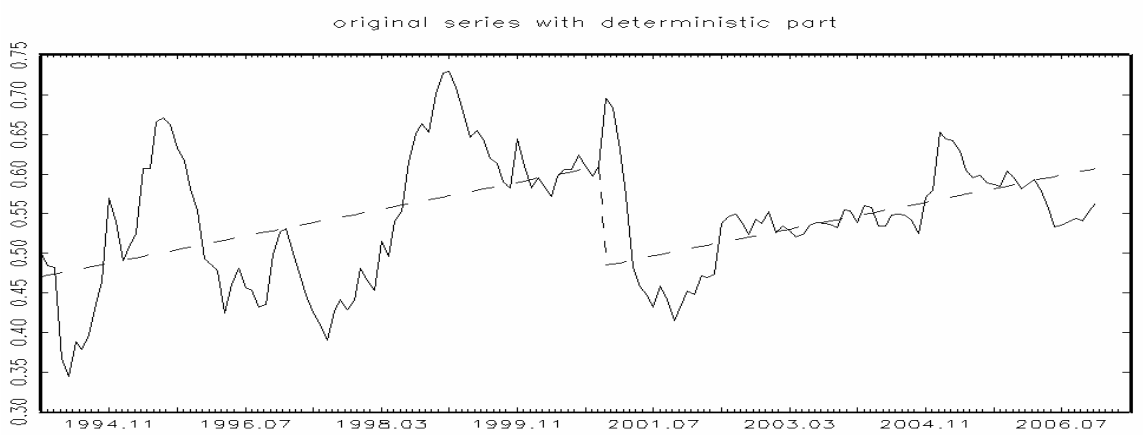
*: YTL = 1,000,000 TL, SIS web-site.

APPENDIX

Figure A1: Inflation adjusted UHT milk price with shift dummy, break (1997.M10), 3 lags

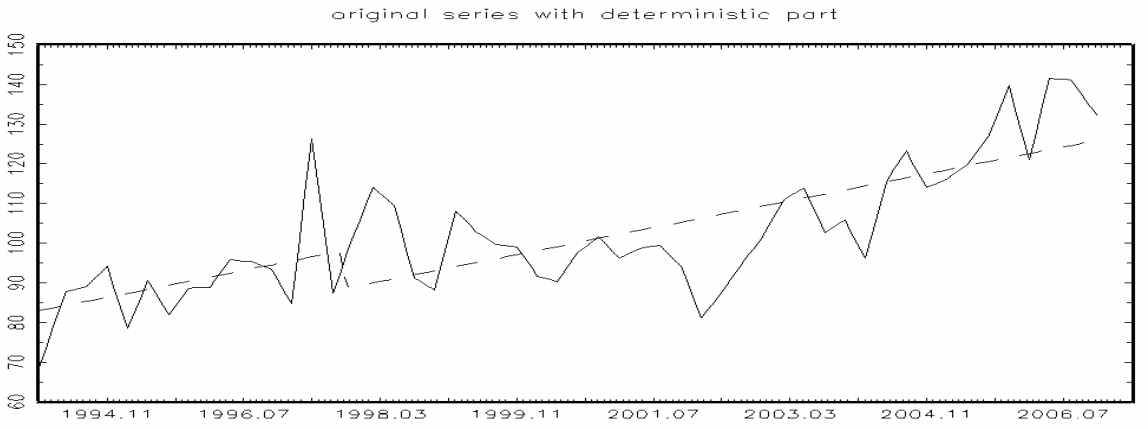
*: YTL = 1,000,000 TL, SIS web-site.

Figure A2: Farm-gate real price with shift dummy, break (2000.M12), 1 lag



*: YTL = 1,000,000 TL, SIS web-site.

Figure A3: Productivity Index with shift dummy, break (1997.M10), 22 lags



*: YTL = 1,000,000 TL, SIS web-site.