

Market power and price asymmetry in farm-retail transmission in the Turkish meat market

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1. Introduction

Increasing food prices and volatility for major agricultural products have recently raised concerns and posed risks for consumers and policy makers. Formation of the market price is the central mechanism by which different segments of the market are interlinked. A well-functioning supply chain is vital for a market to operate efficiently. Examining the nature of price transmission along the supply chain from producer to consumer and measuring the spread in vertical price relationship, provides insight to the functioning of markets and degree of competition in markets (Weldesentbet, 2013). However, empirical studies have shown that the transmission of these price changes are not being completely and immediately reflected along with the marketing chain. The absence of complete pass-through of price and cost changes from one market to another has important results for welfare loss in economics. Price transmission studies ensure important implications for the efficient functioning

Abstract

Recent price increases in red meat have been higher than the inflation rate, so they have raised the concerns on monopoly power abuse in the meat sector in Turkey. This study aims to examine the asymmetric price transmission process in the meat supply chain in the Turkish market. For this purpose, market power was investigated by the Asymmetric Error Correction Model (AECM) developed by von Cramon Taubadel in order to analyze the transmission between farm meat prices and retail meat prices. The long-run relationship between these two prices was examined by using two step Engle-Granger and Gregory-Hansen co-integration test and monthly data set covering the period from January 2003 to February 2015. According to the results of co-integration test, the price series move together in the long run, which means they are co-integrated. We found evidence of a structural break in 2009. Results also indicate that, contrary to common belief, price transmission between producer and retail levels is symmetric. Although no evidence has been found supporting the monopoly power, it should be highlighted that there is further need to improve the competitiveness of producers against the big retailers/wholesalers in the sector.

Keywords: red meat price, positive price asymmetry, negative price asymmetry, market power.

Résumé

En Turquie, la récente hausse des prix de la viande rouge a été supérieure au taux d'inflation, suscitant ainsi des préoccupations autour d'un abus de monopole dans ce secteur. Cette étude vise à examiner le processus de transmission asymétrique des prix dans la filière de la viande sur le marché turc. Le pouvoir de marché est examiné par le modèle à correction d'erreur asymétrique (AECM), mis au point par von Cramon Taubadel, pour analyser la transmission entre le prix de la viande à la production et le prix au détail. La relation de long terme entre ces deux prix et évaluée à l'aide du test de cointégration en deux étapes d'Engle-Granger et Gregory-Hansen, utilisant les séries de données mensuelles de la période Janvier 2003 à Février 2015. Les résultats du test de cointégration indiquent que les séries de prix évoluent parallèlement dans le temps et qu'elles sont donc cointégrées. Nous constatons une rupture structurelle en 2009. Les résultats indiquent, en outre, que, contrairement à ce qu'on pourrait croire, la transmission des prix entre la production et la distribution est symétrique. Bien qu'on n'ait pas démontré l'exercice d'un pouvoir de monopole, il y a tout lieu de souligner que la compétitivité des producteurs vis-à-vis des grands distributeurs/grossistes du secteur devrait être renforcée.

Mots-clés: prix de la viande rouge, asymétrie positive des prix, asymétrie négative des prix, pouvoir de marché.

of markets. It is important to study the pass-through mechanism because imperfect price transmission can be an indicator of the existence of market power (Guillen and Franquesa, 2015). As underlined by von Cramon-Taubadel (1998), the general belief is that middlemen in the food marketing chain use market power to pass on input price raises to consumers more rapidly and completely, rather than input price reductions.

Asymmetric Price Transmission (hereafter APT) arises if downstream retailers respond differently to cost increase versus an equivalent cost decrease and consists of two cases: Positive APT and negative APT. Positive APT occurs when price increases that squeeze the margin are transmitted more rapidly to output prices, but not the price decreases. Conversely, negative APT occurs when price decreases that stretch the margin are transmitted more rapidly

than increases that squeeze the margin (Misra *et al.*, 2010). As stated by Meyer and von Cramon Taubadel (2002), since the flexible prices are required for efficient resource allocation in neo-classical economies, APT is of significant importance. First, as Peltzman (2000) has pointed out, APT may point a gap in economic theory since it is not its general implication. Peltzman has found APT "to be more the rule than the exception" and implies that standard economic theory of markets is wrong (Peltzman, 2000, p. 493). Second, since it

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is assumed that APT is a market failure and mostly caused by market power, presence of asymmetry may require intervention to the sector and have implications for policy (Meyer and von Cramon-Taubadel, 2002).

Asymmetric price transmission has been examined by numerous authors using different econometric methods such as co-integration and threshold autoregressive model (TAR) following the pioneering studies of Wolfram (1971) and Houck (1977). The adjustment of the price through the supply chain has attracted the attention of agricultural economists as well as policy makers. As pointed out in many empirical studies³, while a price decrease at the farm level is slowly, and possibly partially, transmitted through the supply chain, conversely, price increases at the farm level are passed more quickly on to the final consumer. In the price theory, flexible prices are responsible for efficient resource allocation. Hence, imperfect price transmission means that consumers are not benefitting from a price reduction at the producers' level, or producers are not benefitting from a price increase at the retail level. APT results from the concentrated agents' exploitation of their perceived market power (Vavra and Goodwin, 2005). It should be noted that, however, although market power may be an important explanation for asymmetric price transmission, it may not be the only reason. Incomplete price transmission may be designated as characteristic of competitive, as well as oligopolistic market structure. That is, it cannot simply be concluded that presence of APT automatically has been caused by market power (Meyer and Von Cramon-Taubadel, 2004, Vavra and Goodwin, 2005, pp. 4-5).

It should be stated that monopoly power might be an important reason for existence of asymmetry in price transmission mechanism, but it is not the only causal factor (Vavra and Goodwin, 2005). Price rigidity due to transaction costs, government policy and product storage characteristics were also discussed as potential reasons for price asymmetry in empirical studies (Awokuse and Wang, 2009). Although there is no strong theoretical framework to analyze price asymmetry in economics, several reasons have been put forward that could potentially account for asymmetric price transmission in the literature (Aguiar and Santana, 2002). As mentioned above, adjustment problem at the retail level (sticky prices) can create imperfect pass-through of prices in the transmission process. Retail prices cannot adjust due to menu costs which are related to making changes in retail prices, such as advertising and labeling (Vavra and Goodwin, 2005). Moreover, accountancy methods and inventory valuation can lead sluggish adjustment of retail prices with respect to increase or decrease in the input prices. For example, if FIFO (first in first out) inventory valuation method is adopted, the firm does not adjust its output immediately when cost changes, but waits until the stocks of inputs bought at the old price are depleted. On the contrary, if LIFO

(Last in first out) is adopted, the firm adjusts its price quickly in response to input price changes (Frey and Manera, 2007). As Balke *et al.* (1998) and Wohlgenant (1985) found that imperfect transmission between retail and wholesale/farm prices could be explained by the inventory choice of retailers. Serra and Goodwin (2003) investigated the price transmission process in the Spanish dairy sector and found that the quota imposed by the government created price asymmetry in the supply chain. Ward (1982) proposed an explanation for price asymmetry based on the product characteristics. Since perishable products cannot be stored for a long time, economic agents possessing the perishable products may not increase prices to avoid the risk of spoiled product.

Meyer and Von Cramon-Taubadel (2004), Vavra and Goodwin (2005) and Frey and Manera (2007) surveyed empirical literature of price asymmetry. Majority of the studies on asymmetric price transmission refer to anti-competitive market structures as an important reason (Kinnucan and Forker, 1987; Miller and Hayenga, 2001). It is suspected that imperfect competition in processing and retailing allows middlemen to use market power. It is generally expected that monopoly power results in positive price asymmetry (Meyer and von Cramon-Taubadel, 2004). Balke *et al.* (1998) and Brown and Yuçel (2000) argued that if oligopolistic firms engage in unspoken collusion to maintain high profits, asymmetric price transmission can arise. As pointed out by Peltzman (2000), price asymmetry may be characteristic of competitive as well as oligopolistic markets, and it should not simply be concluded that existence of asymmetric price transmission automatically leads to market power.

Although many studies investigated the asymmetric price transmission in agricultural markets, it is not possible to draw effective conclusions upon which policy decisions could be based (Vavra and Goodwin, 2005). As pointed out by Meyer and von Cramon-Taubadel (2004), there is still need for further researches to distinguish whether evidence of imperfect price transmission is theoretically relevant in economics.

The Turkish food industry as well as the livestock sector have experienced many structural changes in recent years. For example, the food manufacturing sector has experienced numerous consolidations leading to significant increases in the industry concentration. According to the Turkish Competition Authority (hereafter TCA), most mergers and takeover operations have been realized in the food and agricultural sector in the last 15 years (TCA, 2015). The four-firm concentration ratio (CR_4) in processing and preservation of meat increased from 41% in 2007 to around 50% in 2012 (TurkStat, 2013; TurkStat, 2014). This restructuring process has triggered the interest in farm retail linkages. The increase in food prices and volatility raised the common concern that wholesalers/retailers respond to increases in the producer prices faster than to decreases in Turkish food sector. For instance, the red meat prices increased by 160% between 2007 and 2015 (TurkStat, 2016a). Significant increase in meat prices caused some complaints about abuse of monopoly power practices - harmful to meat producers' interest

³ See Ward (1982), Balke *et al.* (1998), Brown and Yuçel (2000), Bunte and Peerlings (2003), Ben-Kaabia and Gill (2007).

- by the companies to TCA in 2010 (TCA, 2010). TCA decided that there had been no monopoly power abuse in the red meat sector. TCA, however, underlined that bargaining power of food manufacturer and downstream retailers increased against the unorganized and small-scale producers in the agri-food supply chain by a specific sector report in 2012 (TCA, 2012).

The aim of this study is to investigate and compare the dynamics of price transmission and marketing margins in Turkish red meat markets and contribute to the limited literature on asymmetric price transmission in the meat sector. We are particularly interested in understanding how changes in farm affect retail prices in vertically-linked meat market. To our best knowledge, there has been only one unpublished study⁴ which examines the asymmetric price transmission in meat supply chain using Engel-Granger (1987) co-integration approach in Turkey. In this study, however the relatively new Gregory-Hansen (1996) co-integration technique, allowing for the presence of potential structural breaks in data, was employed to empirically examine the long-run relationship as well as the short-run error correction mechanisms (ECM) between farm and retail prices of red meat.

The remainder of the paper is organized as follows: Section two presents an overview of the meat sector in Turkey, Section three describes the empirical procedures and data for analysis, Section four reports and discusses the results. Concluding remarks and policy implications are presented in the final section.

2. An Overview of the Meat Sector in Turkey

The livestock sector mainly consists of cattle, buffalo, sheep and goats and includes traditional and commercial activities. Livestock farming contributes about one third of Turkey's agricultural output, involving around 2.9 million enterprises (Bor *et. al.*, 2014, p. 3; MFAL, 2015). The Turkish Statistical Institute (hereafter TurkStat) reported the total number of cattle (14.1 million), sheep (31.5 million) and

goats (10.4 million) in 2015. The total number of bovine animals, sheep and goats increased by 36.7 % in 2010-2015. In the same period, the highest increase rate (64%) was found in the number of goats. Around 9.9 million bovine, 14.6 million sheep and 3.8 million goats were cut to meet the red meat demand in 2012-2014 (TurkStat, 2015). The annual size of the red meat market is estimated to be around 8-9 billion USD (Ozertan *et.al.*, 2012).

The livestock sector has several problems despite the higher potential. Outdated technology is being used in the majority of farms in Turkey. Although the use of technologies and know-how has increased in agricultural firms, transition to intensive agriculture has been slow probably due to small-scale firms. (Yesilada *et. al.*, 2010). Moreover, the Turkish livestock sector suffers from low yields, extreme price fluctuations, and unpredictable government support policies (Tutkun *et. al.*, 2014). The Turkish meat sector has been shaped according to the domestic demand and has low presence in the world market. Family owned farms are the basic units of agricultural production and family members provide most of the farm labor. However, since Turkey is a candidate for EU membership, it has been modifying livestock and animal health-related policies and regulations in order to be prepared for EU membership (Us, 2010).

The total meat production has been steadily increasing in Turkey since 2011. Meat production was 776 thousand tons in 2011 and it reached around 1 million tons, increasing by 30.6 % due to the rise in both animal number and yield per head, in 2015 (Gül ve Uzun, 2014; TurkStat, 2015). Government targeted to increase purebred cattle to 48% by 2017. For this purpose, it was stated by the Turkish Ministry of Food, Agriculture and Livestock that the government would continue to subsidize credit for livestock purchased in its Strategic Plan for 2013-2017 to promote dairy and beef production. Total import

changed based on demand in the meat market. While meat import was 6.3 thousand tons in 2013, it was 17.8 thousand tons in 2015. Although annual meat consumption per capita in Turkey increased from 10.8 kg in 2010 to 14.85 kg in 2015, it is still considerably low compared to developed and EU countries (34.01 kg) (ESK, 2015; TRMD, 2014).

Although Turkey has potential and favorable features for any animal product, meat supply has become insufficient. Since meat prices increased considerably, especially in the late 2000s, the government started to import meat to decrease meat prices (Arısoy and Bayramoglu, 2015, p. 30). The Turkish meat sector was protected by relatively high import tariffs in the 1999-2009 period. The Turkish govern-

Table 1 - Total numbers of bovine animals, sheep and goats in 2003-2015.

Years	Total	Cattle	Buffalo	Sheep	Goat
2003	42,104,672	9,788,102	113,356	25,431,539	6,771,675
2004	41,984,338	10,069,346	103,900	25,201,155	6,609,937
2005	42,453,194	10,526,440	104,965	25,304,325	6,517,464
2006	43,232,086	10,871,364	100,516	25,616,912	6,643,294
2007	42,870,109	11,036,753	84,705	25,462,293	6,286,358
2008	40,514,391	10,859,942	86,297	23,974,591	5,593,561
2009	37,688,958	10,723,958	87,207	21,749,508	5,128,285
2010	40,837,450	11,369,800	84,726	23,089,691	6,293,233
2011	44,793,487	12,386,337	97,632	25,031,565	7,277,953
2012	49,804,866	13,914,912	107,435	27,425,233	8,357,286
2013	53,042,643	14,415,257	117,591	29,284,247	9,225,548
2014	55,830,115	14,223,109	121,826	31,140,244	10,344,936
2015	56,051,937	13,994,071	133,766	31,507,934	10,416,166

Source: TurkStat, 2016b.

⁴ See Uysal P., 2012. *Asymmetric price behavior in Turkish milk and beef market*. Akdeniz University, Faculty of Economics and Administrative Science, Department of Economics, Master Thesis, Antalya, Turkey.

Years	Slaughtered cattle	Production, tons
2007	2,003,991	575,622
2008	1,736,107	482,458
2009	1,502,073	412,621
2010	2,602,246	780,718
2011	2,571,765	776,915
2012	2,791,034	915,844
2013	3,430,723	996,125
2014	3,712,281	1,008,272
2015	3,765,077	1,014,926

Source: TurkStat, 2016b.

ment intervened in the price of meat by issuing import licenses for imported red meat and livestock. Government has started to decrease the tariff rates in meat and livestock to hold down the meat prices rising above the general inflation since 2010. In August 2015, to mitigate the pressure of meat prices on the inflation rate, import tariffs of bovine animals and carcasses from EU countries were cut to zero (Official Gazette, 2015a, Official Gazette, 2015b).

There has been an increase in Turkey's animal assets since the 2000s. However, animal husbandry has not developed to the desired level due to management structure, insufficient feed and breeding policy, health, producer and marketing organization problems, unsustainable animal husbandry policies in Turkey (Arsoy and Bayramoglu, 2015, p. 30). The Turkish Republic Ministry of Development (hereafter TRMD) projected that the total gap in meat production would be around 248 thousand tons in Turkey in 2018 (TRMD, 2014). As a result of supply conditions, meat prices rose significantly in Turkey in the last decade. As mentioned before, the meat prices increased by 160 percent between 2007 and 2015. In the same period, retail sheep meat prices increased by 158 percent in the 2007-2015 period (TurkStat, 2015). The sharp increase in retail prices led to almost 30% decrease in per capita red meat consumption in this period. This rapid price increase attracted the interest of both press and policy makers in Turkey (Özertan *et al.*, 2012; Saghalian *et al.*, 2014). The Republic of Turkey Ministry of Food, Agriculture and Livestock decided to impose a price ceiling for red meat to control recent price increases in February 2016. According to the new regulations, the maximum price for a kg of ground meat is 32 TL (around \$11) and the maximum price of a kg of diced meat is 34 TL and these prices will be reviewed after five to six months.

⁵ For further information about the price spikes in the Turkish meat sector, see Ozertan *et al.*, 2012.

While the producer price of red meat in Turkey in January 2016 was around 20.8 TL per kg, the retail price of meat was nearly 2 times the producer prices (around 38.50 TL per kg) in the same period. This difference between the producer and retail prices poses important problems for consumer welfare, if it is due to significant market power in the meat sector. TRMD underlined that the winners are not the producers but the holders of the later stages of the marketing chain, such as middlemen, wholesalers or retailers. This also means that the real acquirers of the subsidies are the holders of the last stages in the supply chain (TRMD, 2014). Since the red meat prices increased by more than the rate of inflation, some concerns about monopoly power abuse in the meat sector came forward in the agenda. Consumers and non-governmental organizations claim that these price increases are closely related to oligopolistic behaviors of the dominant buyers in the meat market (Ozertan *et al.*, 2012). Upon the raised claims, TCA prepared a specific report on the Turkish meat sector. TCA decided that there was no need to prosecute an action in the meat sector. Even if TCA underlined that the high price margin was due to high costs and long marketing chain, it also highlighted that the meat producers were small-scaled and unorganized against the big buyers in the meat marketing chain. Moreover, TCA emphasized that the bargaining power increased considerably in favor of food processors and retailers in the food supply chain.

Red meat prices are expected to continue to increase in the following years in the absence of structural enhancements in the meat supply. There are some structural reasons behind these price spikes, such as high production costs, restricted access to credit, high energy cost and the suspicion of oligopolistic behavior in the meat sector⁵. It is underlined by the TCA report (TCA, 2012) that retailers would rather work with a small number of major suppliers to reduce the transaction costs and would be able to impose their own standards of quality and quantity. Most of the suppliers accept the mandated conditions of retailers to conserve or place their goods on the shelves. The big retail chains impose extra costs upon them, such as list cost, shelf fee, announcing fee, advertising fee, promotion fee and “end of the year” cost. These applications can be attributed to monopoly power abuse in the meat supply chain. Consequently, this pressure on the suppliers is transmitted to suppliers via prices (Koç *et al.*, 2010; Bor *et al.*, 2014). Given the links between feed, milk and beef markets in the country, this study analyzes the price transmission and speeds of price adjustments between producer and retail prices of meat in Turkey. By using Gregory-Hansen co-integration method, this study will try to shed light on how the players interact and how the prices adjust along the marketing chain.

3. Methods

3.1. Identifying Asymmetry in Price Transmission

The majority of the studies addressing the asymmetry issue have involved the use of variations of econometric specification introduced by Wolfram (1971) and later modified by

Houck (1977) and Ward (1982). These approaches require the series to be stationary to avoid spurious regression (Acquah and Dadzie, 2010). The response of the retail prices (RMP, retail meat prices) to shocks in farm prices (FMP, farm meat prices) was calculated by estimating the following equation:

$$\sum_{t=1}^n \Delta RMP_t = \beta_0 + \beta^+ \sum_{t=1}^n \Delta FMP_t^+ + \beta^- \sum_{t=1}^n \Delta FMP_t^- + \varepsilon_t, \quad (1)$$

where Δ indicates first differences, and

$$\text{if } FMP_t - FMP_{t-1} \geq 0, \Delta FMP_t^+ = FMP_t - FMP_{t-1} \quad \text{otherwise } 0,$$

$$\text{if } FMP_t - FMP_{t-1} < 0, \Delta FMP_t^- = FMP_t - FMP_{t-1} \quad \text{otherwise } 0.$$

In equation 1, β_0 , β^+ and β^- are the parameters to be estimated, t is current time and ε_t is the random error term. ΔFMP_t^+ and ΔFMP_t^- are the increases or decreases in farm meat prices, respectively. From equation (1), the null hypothesis of symmetric price transmission ($H_0 : \beta^+ = \beta^-$) can be tested against the alternative of asymmetry hypothesis ($H_1 : \beta^+ \neq \beta^-$) using the F-Test. If the price series were stationary, equation (1) would be adequate to test for asymmetry in price transmission. Specifications that use some variations of the Wolfram (1971) method have been criticized because they ignore the time-series properties of the data. In particular, price levels often exhibit non-stationary covariance, which may lead to first-order autocorrelation problems that is generally symptomatic of spurious regression in the asymmetric price response function (von Cramon Taubadel, 1998; Serra and Goodwin, 2003).

3.2. The Asymmetric Error Correction Representation

Asymmetric error correction model (ECM) is motivated by the fact that the variants of the Houck approach are not consistent with co-integration between the price series. As mentioned before, spurious regression issue is avoided if the analyzed variables are co-integrated. If the RMP and FMP prices are co-integrated, then Error Correction Model (ECM) can be incorporated (Engle and Granger, 1987). The original Engle-Granger (1987) that contains only one Error Correction Term (ECT is the residuals from the co-integrating relationship between RMP and FMP) takes the following form:

$$\Delta RMP_t = \beta_0 + \beta_1 \Delta FMP_t + \beta_2 ECT_{t-1} + \beta_3(L) \Delta RMP_{t-1} + \beta_4(L) \Delta FMP_{t-1} + \varepsilon_t \quad (2)$$

where *Error Correction Term*- $ECT_{t-1} = RMP_t - \beta_0 - \beta_1 FMP_t$, and $\beta_3(L)$ and $\beta_4(L)$ are lag polynomials.

Granger and Lee (1989) improve the equation (2) to test asymmetric transmission between co-integrated variables. Authors propose a modification to (2) that makes it possible to segment the ECT into positive and negative components. Further improvements were made by von Cramon-Taubadel and Loy (1999) to allow the incorporation of ΔFMP_{t-1} results in the asymmetric error correction model being expressed as:

$$\Delta RMP_t = \beta_0 + \beta_1 \Delta FMP_t + \beta_2^+ ECT_{t-1}^+ + \beta_2^- ECT_{t-1}^- + \beta_3(L) \Delta RMP_{t-1} + \beta_4(L) \Delta FMP_{t-1} + \varepsilon_t \quad (3)$$

The ECT measures the deviation from the long-run equilibrium between the RMP and FMP, and including it in the ECM allows RMP not only to react to changes in FMP but also to correct any deviations from the long-run equilibrium that may be left over the previous periods. Splitting the ECT into positive and negative components makes it possible to test the asymmetric price transmission in the supply chain. APT is present if the null hypothesis that the estimated coefficients of the respective positive and negative variable are equal, is rejected by the F-test (Goetz *et al.*, 2008).

If the dummy variables are included and Equation 3 is rewritten, we obtain the equation as follows:

$$\Delta RMP_t = \beta_0 + B_1 \Delta FMP_t + \beta_2^+ ECT_{t-1}^+ + \beta_2^- ECT_{t-1}^- + \beta_3(L) \Delta RMP_{t-1} + \beta_4(L) \Delta FMP_{t-1} + \beta_5(L) D \cdot \Delta FMP_{t-1} + \varepsilon_t \quad (4)$$

In the Equation 4, the dummy variable representing the structural change is as follows:

$$D = \begin{cases} 0, & \text{if } t \leq T_b \\ 1, & \text{if } t > T_b + 1 \end{cases} \quad T_b = \text{timing of shift}.$$

The expression in equation (3) or (4) gives long-run or cumulative effect of falling or rising farm-retail price transmission along the supply chain.

3.3. Test of Structural Breaks in a Co-integration Regression for APT

To estimate the ECM, the Engle-Granger (1987) two-step approach has been followed which requires the time series to be co-integrated. The system is co-integrated if the errors are $I(0)$. First, the long-run equilibrium relationship between the retail prices and farm prices of meat is estimated as follows:

$$RMP_t = \beta_0 + \beta_1 FMP_t + \varepsilon_t \quad \text{with } t = 1, \dots, T. \quad (5)$$

The price data are expressed in the logarithmic form; therefore β_1 corresponds to the price transmission elasticity, indicating the percentage price change in RMP if FMP changes by 1%. If price changes are transmitted completely, then $\beta_1 = 1$. If there is no price transmission, β_1 is not significantly different from zero. The residual vector ε_t represents the short-run deviations from the long-run equilibrium. The estimated residuals are lagged by one period. Moreover, the relationship between RMP and FMP is set up both in short-run and long-run (Goetz *et al.*, 2010).

Within the conventional Engle-Granger (1987) test for co-integration, the static equation (5) is first estimated using Ordinary Least Squares (OLS), and stationary of residuals of this relationship is tested using Augmented Dickey Fuller (ADF) test.

ECM is estimated as follows:

$$\Delta RMP_t = \sum_{i=0}^p \beta_i \Delta FMP_{t-i} + \sum_{j=1}^p \phi_j \Delta RMP_{t-j} - \delta \hat{\varepsilon}_{t-1} + u_t \quad (6)$$

$$\text{Where ; } \hat{\varepsilon}_{t-1} = ECT_t = RMP - \hat{\beta}_0 - \hat{\beta}_1 FMP_{t-1} \quad (7)$$

Standard Engle-Granger (1987) test for co-integration requires that co-integrating vector is time-invariant. If the co-integrating vector changes during the observed period, the

results of these tests might be misleading (Gregory and Hansen, 1986). Gregory and Hansen (1986) proposed a test that allows not only to identify a structural break in the co-integration relationship but also to determine its timing and type (Goetz and von Cramon-Taubadel, 2007). In this test, the null hypothesis of no co-integration is tested against the alternative hypothesis of co-integration in the presence of regime shift and structural break within three models:

Level shift model-C :

$$RMP_t = \mu_1 + \mu_2\varphi_t + \alpha^T FMP_t + e_t, \quad t=1, \dots, n. \quad (8a).$$

Level shift model with trend - C/T

$$RMP_t = \mu_1 + \mu_2\varphi_t + \beta t + \alpha^T FMP_t + e_t, \quad t=1, \dots, n. \quad (8b).$$

Regime shift model - C/S

$$RMP_t = \mu_1 + \mu_2\varphi_t + \alpha_1^T FMP_t + \alpha_2^T FMP_t\varphi_t + e_t, \quad t=1, \dots, n. \quad (8c).$$

Regime shift model with trend-C/S/T

$$RMP_t = \mu_1 + \mu_2\varphi_t + \beta_1 t + \beta_2 t\varphi_t + \alpha_1^T FMP_t + \alpha_2^T FMP_t\varphi_t + e_t, \quad t=1, \dots, n. \quad (8d).$$

Where RMP_t is real valued and FMP_t is an m -vector of $I(1)$ variables, e_t is $I(0)$. The parameters μ and α describe the m -dimensional hyperplane that the vector process $yt = (RMP_t, FMP_t)$ converges over time. Let the dummy variable φ_{τ} be defined as,

$$\varphi_{\tau} = \begin{cases} 0, & \text{if } t \leq [\tau] \\ 1, & \text{if } t > [\tau] \end{cases}$$

where $\tau \in (0,1)$ is the unknown parameter which denotes the timing of the breakpoint and $[\]$ denotes the integer part (Clark *et al.*, 2011).

Model C represents a level shift in the equilibrium relationship. Model C/T includes a trend to the previous model and model C/S entails regime shift by adding a change in the slope coefficients. In these tests, the residuals of the individual co-integration regressions in the equations for all possible breakpoints are tested by an ADF test. If the standard ADF test does not reject the null hypothesis of no co-integration, but the ADF statistic of the Gregory-Hansen (1996) test does, the test result is interpreted as evidence of a structural break in the co-integration regression. The point of the time of structural break corresponds to the possible break dates of the co-integration regression for which the ADF statistic is lowest. The authors provided asymptotically critical values for both the ADF test and the Philips *et al.* (1988), Z_{α} and Z_t statistics (Götz and Kachel, 2008; Carraro and Stefani, 2010).

4. Data and Empirical Results

Methodologies presented in section 3 were applied to examine whether asymmetric price transmission between producer (farm gate) and retail prices of beef existed. First, price series of meat and meat products have been checked for stationary. Second, co-integration analysis has been carried out to assess the robustness of the empirical results found. Moreover, to identify the break dates in our series, Bai and Perron

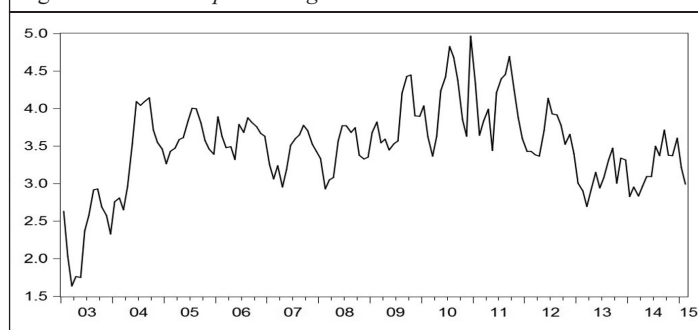
(1998, 2003) procedure has been applied. Finally, the long-run price relationships have been analyzed within each regime and the coefficients of the ECT have been interpreted for asymmetry in the supply chain.

Data

Datasets on farm and retail monthly prices for beef have been compiled from TurkStat and National Council of Red Meat. The dataset covers the period from January 2003 to February 2015 for the retail and producer prices of beef. Prices are monthly series and are expressed in TL per Kg. Retail beef prices have been deflated by the Consumer Food Price Index and producer beef prices have been deflated by the Producer Food Price Index. All series have been transformed in natural logarithms, because otherwise, with trending data, the relative error might decline over time and this is inappropriate (Tiffin and Dawson, 2000).

Figure 1 gives the changes in red meat price margins. The price margin between the retail meat price and producer price of carcasses started to increase in 2004. Price margin reached the maximum level (around 5) in 2009 and then started to decrease. While the retail price ratio compared to producer price of carcasses was around 1.4-1.6 in 2003, this ratio nearly doubled in 2009.

Figure 1 - Red meat price margins.



This widening margin between the retail and producer prices of meat has been underlined in some studies (see Bölük and Koç, 2008; Erdogan *et al.*, 2012; Saghaian *et al.*, 2012; Uysal, 2012). These price margin increases brought some concerns about market power abuse in the meat market in Turkey. Consumer groups and non-governmental organizations claimed that the price increases were the result of monopoly/monopsony power of major buyers in the meat supply chain. Upon concerns about oligopolistic behavior of food retailers, the Turkish Competition Authority (TCA) examined the food retail sector by a specific report in 2012. TCA (2012) reported that market share of super-market shares in total consumer food expenditures increased and buyer power of food retailers raised against the producers and/or suppliers over the last decades.

5.2. Empirical Results

Since Engel-Granger (1987) and Gregory-Hansen (1996a, 1996b) co-integration tests require the same order of integration of non-stationary series, unit root tests were implemented

using ADF and Perron tests⁶ in the presence of structural breaks. Moreover, to take into account possible shifts in regime in the unit root test, Perron (1997) test was employed. Therefore, it has been concluded that the price series are $I(1)$ ⁷.

5.3. Cointegration Analysis

Unit root tests justify that since the retail and producer beef prices have unit roots, they are not stationary. At the first stage, to test the long-run relationship between two price series, the two stages Engle-Granger (1987) procedure has been employed and it has been concluded that there is long-run relationship between the two price series⁸.

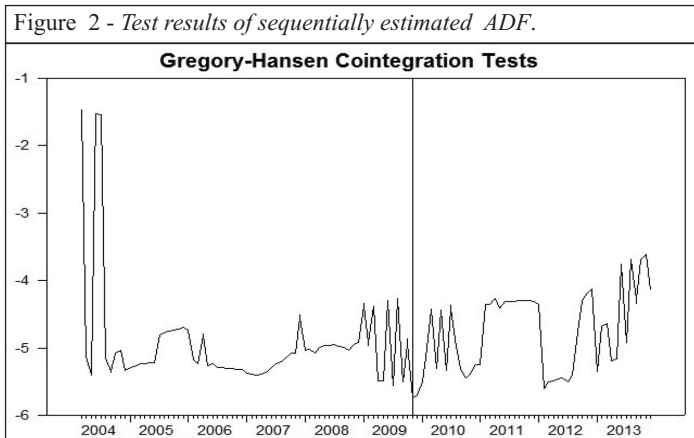
However, since standard cointegration tests like Engle-Granger (1987) require that co-integrating vector is time-invariant and may be misleading, to test whether there is a long-run relationship between the prices in the presence of structural break, Gregory-Hansen (1996) co-integration test has been employed (Goetz and Cramon, 2007). (See Table 3).

Table 3 - Gregory-Hansen (1996) cointegration test.

Model	Lag (k)	Break date	Test Statistic	Critical Value 5%
Level Shift	3	2012:07	-5.037	-4.610
Level Shift with trend	3	2012:07	-5.894	-4.990
Regime shift	3	2009:11	-5.238	-4.950
Regime shift with trend	3	2009:11	-5.734	-5.500

Since ADF statistics exceed the 5% critical values in four cases, the null hypothesis is rejected and it means that the two price series are co-integrated. Gregory-Hansen (1996) indicates that there is a breakpoint at the end of 2009 (2009: 11) in regime shift and regime shift with trend models. As stated before, because of the drought in 2007, there was a sharp increase in feed prices (roughage) over the 2007-2008 period in Turkey. In the following year, since the weather conditions were convenient for the cultivation, feed prices considerably decreased in favor of the stockbreeders. However, since government decreased the premiums in animal husbandry, producers were negatively affected in economic terms. Moreover, since meat export started to Iraq and Middle East markets and raw milk producers were not able to produce milk effectively because of high feed prices in 2008, many head of dairy cows were sent to slaughterhouses (around 1,5 million). However, decreasing animal population in 2009, consequently led a hike in meat prices. Figure 2 shows the ADF test statistics for the regime shift with trend model. Based on the ADF test statistics of sequentially estimated model, t-values are minimized in 2009:11. This date indicates the regime shift with trend. Figure 2 depicts the results of the sequential ADF test results.

Gregory-Hansen (1996a) cointegration test has been conducted using regime shift with trend model. Cointegration vector of Gregory is as follows:



$$\ln BEEF_t = 1,404 - 0,377\varphi_{tr} + 0,001t - 0,002t\varphi_{tr} + 0,461\ln CARC_t + 0,310\ln CARC_t\varphi_{tr} + \varepsilon_t$$

t-value (9,200) (-1,426) (3,565) (-5,577) (6,033) (2,581) $R^2 = 0,714$

The values in parenthesis are t-statistics. It was seen that the elasticity of producer beef price increased after the regime shift. An increase in the elasticity of producer beef price has been observed after the regime shift.

4.4. Asymmetric Error Correction Model

The regression estimates of asymmetric representations are presented in Table 4. The lags in the test have been determined by AIC. As indicated before, the test of the asymmetric price transmission is conducted by the F-test.

Table 4 - Results of Asymmetric Error Correction Model.

Dependent Variable: Retail Beef Price ($\Delta BEEF$)				
Variables	Coefficient	St, Error	t-statistics	p
C	-0,001	0,003	-0,308	0,758
ECT_{t-1}^-	-0,371	0,102	-3,645	0,000*
ECT_{t-1}^+	-0,214	0,097	-2,202	0,029**
$\Delta CARC$	0,243	0,071	3,411	0,001*
$\Delta BEEF(-1)$	0,232	0,076	3,052	0,003*
$\Delta BEEF(-2)$	0,134	0,079	1,692	0,093***
$\Delta BEEF(-3)$	0,170	0,077	2,205	0,029**
$\Delta BEEF(-4)$	-0,167	0,075	-2,231	0,027**
R²	0,33	Akaike information criterion	-4,761	
F-statistics	9,473	LM Test		0,772
Prob(F-statistics)	0,000	Durbin-Watson statistics	2,031	
P (J-B)	0,366	P(Heteroscedasticity ARCH)		0,325
Hypothesis	Long-run	Long-run symmetry results		
Symmetry	$\beta_2^+ = \beta_2^-$	F(1,133) = 0,875		
Asymmetry	$\beta_2^+ \neq \beta_2^-$	P-value=(0,351)		

ECT_{t-1}^- and ECT_{t-1}^+ show the negative and positive deviations from the long-run equilibrium. The error correction terms (ECT_{t-1}^- and ECT_{t-1}^+) have the right (negative) sign and ECT_{t-1}^- causes a slightly greater change in the retail beef price than ECT_{t-1}^+ . F-test, however, concludes that the long-run symmetry null hypothesis cannot be rejected, indicating long-run price transmission symmetry in beef supply chain. Results indicate that the change in price of farm meat with no lag is lower than unity, positive and statistically significant at 1%. Taking into account the data frequency, this result indicates that retail meat prices react to farm meat prices within a month.

⁶ Perron P., 1997. Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics*, 80(2): 355-385.

⁷ Test results are available upon request from the authors.

⁸ Test results are available upon request from the authors.

The formal test of symmetry hypothesis is conducted using joint F-test. F-test indicates that the null hypothesis of symmetric transmission cannot be rejected at 5% level. When the absolute value of ECT_{t-1}^- is greater than ECT_{t-1}^+ , it means that when the margin is below the long-run equilibrium, retail prices react faster and to a greater extent than when margins are above the long-run equilibrium. In other words, when margins are squeezed, they react faster than when they are stretched (Cutts and Kirsten, 2006). As shown in Table 4, the absolute value of ECT_{t-1}^- is greater than the ECT_{t-1}^+ and this indicates that retail beef prices react faster and to a greater extent than when margins are above the long-run equilibrium in the beef supply chain. However, since asymmetry hypothesis has been rejected, intuitively, negative and positive components of the ECM and the decreasing and increasing components of the producer beef price cannot be interpreted separately in the model.

Model results show that unlagged farm meat prices react to retail meat prices in the short term. The value F-statistics of null hypothesis ($H_0 = \Delta \text{CARC}_t = 0$) is 11,636 (p:0,00). In other words, the unlagged farm prices affect the retail meat prices, and farm meat prices are also affected by the lagged retail prices in the short term. Moreover, retail meat prices are affected by its own value with a lag of about four months.

To check the presence of normal distribution, heteroscedasticity and autocorrelation, some tests have been conducted. Jarque-Bera test indicates that residuals are normally distributed. LM test and ARCH tests show that there are no autocorrelation and heteroscedasticity issues in the model.

5. Conclusion

This study examined how retail beef price was formed and how price transmission worked in the Turkish meat sector. The long-run relationship between retail prices and farm-gate prices for beef in Turkey was analyzed. The vertical price transmission of the meat supply chain was investigated in the cointegration framework, using Gregory-Hansen cointegration technique that allows cointegration in the presence of structural breaks. Results indicate that the retail and farm gate prices in beef supply chain move together in the long run. In other words, they were cointegrated with a structural break in November, 2009 in the Turkish meat market. As mentioned before, since the government lowered the premiums in animal husbandry, producers were negatively affected in economic terms. Moreover, since the premature slaughter of cows and almost no import led to a sharp decrease in the supply of cattle, there was a significant increase in beef prices in 2009. Based on the Asymmetry test, contrary to common belief, the farm-retail price transmission of meat was found to be symmetric by using ECM approach implying that a change in farm price of meat explained a similar change in retail price of meat in Turkey. The Turkish beef sector has been proved to be symmetric, and retailers tend to

quickly pass on both increasing and decreasing price movements to the producer prices. Hence, market power or non-competitive market conditions do not seem to explain the price increases in the Turkish beef market.

No evidence of market inefficiency or failure was found. However, competitiveness of the producers in the market should be improved. Since producers are small-scaled, they need to be organized against the big retailers/wholesalers to have bargaining power. Moreover, there is also need for a code of good practices in transactions between the suppliers and retailers in the market.

To protect the consumer from high and volatile meat prices, other factors that affect the price need to be addressed in a wider perspective. In this context, the structural problems remain to be solved in agricultural markets. For instance, the price of feed should be decreased, productivity should be increased at farm level, small-scale enterprises should be transformed into large-scale facilities etc... Moreover, as underlined by TCA (2011), transportation and energy costs should be lowered in the marketing chain. Low retail meat prices primarily depend on cheaper production.

As pointed out in previous studies⁹, price asymmetry can arise because of government interventions in the market. The price ceiling brought by the government in red meat at retail level may cause negative price asymmetry in the future. Moreover, based on the TurkStat (2016a, 2016b) data, meat prices have not been significantly affected by meat and live cattle import that began in 2010. As underlined by Duyum (2015), this import caused many businesses to leave the sector in 2010. Therefore, further research is necessary to examine whether the asymmetric behavior exists both in the meat sector and other agricultural markets in Turkey.

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⁹ See Gardner (1975) and Kinnucan and Forker (1987).

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