World Applied Sciences Journal 28 (11): 1694-1700, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.28.11.1676

Price Transmission, Threshold Behavior and Asymmetric Adjustment in Iranian Poultry Market (Case Study: Ardebil and East-Azerbaijan Provinces)

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Abstract: Iranian Poultry sector has experienced many significant structural changes in recent years. Such changes have influenced price dynamics and transmitted shocks to the marketing channels especially in the retail markets. This paper investigates Price Transmission, Threshold Behavior and Asymmetric Adjustment in the poultry Sector of Ardebil (AR) and East-Azerbaijan (EA) provinces using weekly price data for the period 1998 to 2008. Threshold cointegration model that permits asymmetric adjustment to the positive and negative price shocks and R software were used to analyze data. Main findings reveal the existence of asymmetry in the price transmission and threshold behaviors for all of the markets. Based on the criterion of minimum sum of squared error, the estimated thresholds for EA-AR markets were 0.38 and 1.217. Also TVECM result led to the same results.

JEL Classification Codes: Q18・C51・C33
Key words: Asymmetric price transmission・Spatial price transmission・Threshold Vector Error Correction Model・Poultry markets

INTRODUCTION

Short production period, small space needed for a poultry breeding house, higher production in area unit and finally the low price of poultry increased governmental supports from the investors in this field after the war between Iran and Iraq. The consumption pattern of Iranian families changed from meat to poultry, influenced by this policy. Based on Iran's customs associate (IRICA), the imports of poultry has raised from 552 tons in 2006 to 19000 tons in 2009. (Ministry of Jihad-e-Agriculture, 2009). Great imports of poultry to support consumers caused expectation of supply in the market, but in the following year (2009), the rate of import suddenly decreased to 9000 tons (Ministry of Jihad-e-Agriculture, 2009). In other words, although government had increased the demand in market, sudden change in the policy and reduction of import made the domestic production responsible to fulfill this demand. Domestic producers could not increase their production suddenly; therefore, market encountered with a shock in price.

Moreover, since most of these inputs cost from foreign markets, any change in the world price of inputs may results in change in cost of product of poultry price as well.

Various studies have been done about the transmission of price, threshold behavior and asymmetric adjustments. Ward [1] studied the asymmetric price in the retail and wholesale in the vegetables markets. He used Wolffram model [2] to study the transmission of prices in the products market system. He concluded that the vertical transmission of the price was asymmetric and the reduction of price in the wholesale market was transmitted more to the retail market than did the increase in the price.

Kinnucan and Forker [3] studied the price transmission from the farm to the retail for four dairy products including butter, cheese, milk and ice cream in the United States using Houck approach [4]. Their findings showed that the process of price transmission from the farm to the retail was asymmetric. Bernard and Willet [5] studied the asymmetric price adjustments in the broiler market in the United States and concluded that the

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increase in the prices in the wholesale was transmitted more quickly and complete to the retail than did the decrease in the price.

Cramon-Taubadel [6] studied the asymmetric price adjustments between the prices of producers and wholesale markets for pork in Germany. Using Wolffram standard model [2], he concluded that the wholesale prices reacted more rapidly to the positive shocks than to the negative shocks originating at the farm level. Goodwin and Holt [7] evaluated the price transmission in the beef markets using asymmetric threshold error correction models. They also studied the price transmission in the pork market.

Goodwin and Harper [8] studied the relationship between farm, wholesale and retail markets in the U.S. pork sector for the period between 1987 and 1998 using weekly price data and threshold cointegration model. Their finding showed that the asymmetry and the price adjustments patterns were determined one-way. Information tended to flow from the farm to the wholesale and retail markets.

Goulven [9] analyzed the pork market in two northern and southern regions of Vietnam. He used approach Houck and error correction in his study and concluded that in the northern region which was a private market, long-term adjustment was not observed between the producer prices and retail prices and the transmission of prices between these levels was asymmetric. However, in the southern region of Vietnam, with a governmental market, although fluctuations in the producer prices did not transmit to the retail market during a week, price adjustment in this market was asymmetric.

Aguiar and Santana [10] studied the mechanism of price transmission in Brazil for three groups of agricultural products including tomato and onion (perishable products traded in the competitive market), coffee powder and milk powder (storable products traded in the monopolistic market) and rice and beans (storable products traded in the competitive market). Using approach Houk, they came to the conclusion that the increase in the tomato, milk powder, coffee powder and beans was asymmetric, but it was symmetric in the cases of the onion and rice.

Girapunthoug *et al*. [11] analyzed the price transmission between producer levels, wholesale and retail in the U.S. fresh tomato market. They concluded that prices were transmitted from producer to the wholesale and then to the retail. Moreover, the wholesale prices were adjusted more rapidly in comparison with the farm prices and also retail prices were adjusted more rapidly in comparison with the increase in the wholesale prices. Capps and Sherwell [12] studied the asymmetry between producer prices and retail for the liquid milk products in seven U.S. states (Atlanta, Boston, Chicago, Dallas, Hartford, Seattle, Louis). They used Houck and error correction methods. Findings revealed the asymmetric transmission of the milk price.

Hansen and Seo [13] developed a maximum likelihood based estimation theory for the multivariate threshold error correction model with the unknown cointegration vector. They also provided statistics and asymptotic theory for testing the existence of a threshold effect in the two-regime ECM. Seo [14] developed a sup-Wald test for the linear no cointegration null hypothesis in a TVECM and derived its null asymptotic distribution.

In spite of importance of cointegration threshold in providing policy information and considerable research attention from researches, there are a few studies on price transmission in Iranian markets. Specifically there are few researches in the poultry market.

Iranian Poultry sector has experienced many significant structural changes in recent years. Such changes have influenced price dynamics and transmitted shocks to the marketing channels especially in the retail markets. This paper investigates price transmission mechanism in the Poultry Sector between two markets (AR& EA) using weekly price data for the period 1998.01 to 2008.52. Data were collected from State Livestock Affairs Logistic (SLAL).

Rest of the paper is as follow. In section 2, provides a description of methodological approach used in the paper. Section 3, the main characteristics of the Iranian poultry sector is described and reports our empirical results. Finally, a brief summary, along with the conclusions drawn from this study, are provided in section 4.

MATERIALS AND METHODS

Threshold cointegration is a kind of linear cointegration that allows price adjustments in the calculation of transaction cost or stickiness of price after deviations out of critical threshold. Moreover, it allows asymmetric adjustments when the positive and negative deviations are not corrected in the same circumstances [15].

Threshold Cointegratition and Asymmetric Price Adjustments: Threshold effects occur when larger shocks (i.e. shocks above some threshold) bring about a different response than do smaller shocks.

Balke and Fomby [16], noting the correspondence between error-correction models representing cointegration relationships and autoregressive models of an error-correction term, extended the threshold autoregressive models to a cointegration framework. Balke and Fomby [16] also showed that standard methods for evaluating unit roots and cointegration work reasonably well when threshold cointegration is present.

Consider a standard cointegration relationship representing an economic equilibrium

$$y_{1t} - ß_1 y_{2t} - ß_2 y_{3t} - ... ß_k y_{kt} = v_t$$

Where

$$v_t = \rho v_{t-1} + e_t \tag{1}$$

Cointegration of the y_{1t} variables depends upon the nature of the autoregressive process for v_t as ρ approaches 1, deviations from the equilibrium become nonstationary and thus the variables are not cointegrated. Balke and Fomby [16] extend this simple framework to the case where v, follows a threshold autoregression:

$$p=\begin{cases} p^{(1)} \text{if} \left|v_{t-1}\right| \le c \\ p^{(2)} \text{if} \left|v_{t-1}\right| > c \end{cases} \tag{2}$$

Where c represents the threshold which delineates alternative regimes. A common case is that of $P^{(1)} = 1$, which implies that the relationship for small deviations from equilibrium is characterized by a random walk (i.e. a lack of cointegration). Balke and Fomby [16] note that this simple framework is easily extended to permit multiple thresholds, implying multiple parametric regimes and thus allowing asymmetric adjustment. In the case of k thresholds, $k + 1$ different regimes are implied, each having a unique set of parameters and implying its own dynamics for the system. Multiple thresholds allow one to model asymmetries in relationships among the variables as different regimes may correspond to positive versus negative shocks. Our analysis considers a case of two thresholds (C_1 and C_2), which implies three regimes. In this case, an equivalent vector error correction representation of the threshold model is given by:

$$\Delta y_t = \begin{cases} \sum_{t=1}^{p} \gamma_i^{(1)} \Delta y_{t-1} + \theta^{(1)} v_{t-1} + \varepsilon_t^{(1)} & if\ v_{t-1} \langle c_1 \\ \sum_{t=1}^{p} \gamma_i^{(2)} \Delta y_{t-1} + \theta^{(2)} v_{t-1} + \varepsilon_t^{(2)} & if\ c_1 \le v_{t-1} \le c_2 \\ \sum_{t=1}^{p} \gamma_i^{(3)} \Delta y_{t-1} + \theta^{(3)} v_{t-1} + \varepsilon_t^{(3)} & if\ v_{t-1} \rangle c_2 \end{cases} \tag{3}$$

where ε_t is a mean zero residual.

Once the presence of threshold effects is confirmed, some parametric estimation strategy must be considered to estimate the threshold. Two-dimensional grid search is used to estimate the thresholds C_1 and C_2 which define the three regimes. Two alternative grid search techniques have been proposed. Obstfeld and Taylor [17] use a grid search to find the threshold which maximizes a likelihood function. Balke and Fomby[16] use a grid search which minimizes a sum of squared error criterion. The latter method is used in this paper. Estimation of the threshold with given cointegrating values is done for 1 and 2 threshold.

Threshold Autoregressive (TAR) model can be written in a usual regression form as:

$$\begin{aligned} y_t &= I_l \left(\mu_L + p_{l,l} y_{t-1} + ... + p_{L,p} y_{t-p} M\right) + \\ & I_M \left(\mu_M + p_{M,l} y_{t-1} + ... + p_{M,p} M y_{t-p} M\right) + \\ & I_H \left(\mu_H + p_{H,l} y_{t-1} + ... + p_{H,p} M y_{t-p} M\right) \end{aligned} \tag{4}$$

where the I_a are dummy functions that take either 0 or 1 depending on if

$y_{t-1} \in a$ Where a= L, M or H:

$$I_a = \begin{cases} 1 & if\ y_{t-1} \in a \\ 0 & otherwise \end{cases}$$

Hence, to obtain an estimator minimizing the sum of squares or maximizing the log-likelihood, an analytical form can't be derived, nor can usual optimization algorithms be used, as the objective function is highly erratic.

A solution is obtained through concentration of the objective function. As the slope estimators given a threshold are OLS, one can reduce the problem by

concentrating out the minimization problem through $\beta(\theta)$ and the corresponding sum of residual squares (θ). The objective function becomes:

$$\hat{\theta} = \arg\min_{\theta} SSR(\theta) \quad (5)$$

Minimization of 5 is done through a grid search: the values of the variable are sorted, a certain percentage of the first and last values is excluded to ensure a minimal number of observations in each regime, the SSR is estimated for each selected value and the one that minimize the SSR is taken as the estimator. This method has received different names in the literature such as concentrated LS, conditional LS.

Threshold Vector Error Correction: Estimation of the threshold and cointegrating parameters could be done in the long-run relationship and those estimates plugged into the TVECM, as the Engle-Granger [15] advocates for the linear case. Balk and Foby [16] mention that the super-convergence of the OLS estimator in the LR still hold when the residuals follow a SETAR process under the condition Rather, Hansen and Seo [13] and Seo [14] study estimators directly based on the TVECM. Hansen and Seo[113] derive a maximum-likelihood (ML) estimator and use a two-dimensional grid search for simultaneous estimation of $\hat{\theta}$ and $\hat{\gamma}$. This two-dimensionality can't be avoided as the parameters can't be expressed as functions each of the other one: for each cointegrating value the ECT will be different. Forθ, the grid is restricted to the existing values of the ECT, with exclusion of the upper and lower ranges. For the cointegrating value, HS suggest to conduct the search based on a confidence interval obtained in the linear model. When the two values are given, the slope and speed adjustment parameters can be concentrated out and the estimator is simply OLS (though HS depict it as MLE, it is only MLE as starting values for the algorithm are based on the linear MLE estimate). This method can be done in a simple bivariate model without intercept in the cointegrated relationship, but becomes intractable with more than two cointegrating relationships. This is called cointegration with threshold effect framework, where an external variable rather than the ECT is taken as transition variable, estimation is highly simplified as the interdependency between the ECT term and the threshold variable is ruled out. Estimation of multivariate VECM with many cointegrating relationships is then feasible, the grid search being conduced only over the threshold parameter space [18].

RESULTS

Variables used in this study included data of the poultry price in two neighbor provinces (Ardebil and East Azerbaijan) in ten years.

Figures 1 and 2 show the changes of poultry weekly price in these two provinces between 1998 and 2007.

Figure 2. Changes of poultry weekly price in East Azerbaijan province between 1998 and 2007

Figures show that each year near the holy month of Ramadan (fasting month of Moslems) and due to the price fluctuations in summer and increase in the consumption demand, there is a need for import. East Azerbaijan province has the fifth rank among the producers of poultry (3.2%) and is considered one of the production poles in Iran (statistics of Jihad-e-Agriculture organization of East Azarbaijan, 2009).Statistics of production of animal products of Ardebil province during 1986-2006 show that the rate of poultry production has increased from 7471 tons to 19139 tons. This is a great success. Poultry production was 21978 tons in 2009 (statistics of Jihad-e-Agriculture organization of Ardebil, 2009).

First, stationary of the price series are tested by Augmented Dickey-Fuller (ADF), Phillips- Perron(PP), Elliot-Rothenberg- Stock point optimal (ERS), Kwiatkowski *et al*. (KPSS), [19] and NG-Perron test and testing for the cointegration relationships are done using Johansen's. A two-dimensional grid search is then conducted to define two thresholds. In particular, the purpose of this research is finding the first threshold between 5 percent and 95 percent of the largest (in absolute value) negative residual. Moreover, the second threshold between 5 percent and 95 percent of the largest positive residual is searched using the same method. The error-correction model is then estimated conditional on the threshold parameters.

Findings of these tests rejected the stationarity hypothesis and the unit root hypothesis is confirmed completely.The tests confirmed the existence of a unit root in the price series under consideration and the entire price series are integrated in order one I (1).

Examining the stationary variables (all the stationary studied time series are integrated in order one I(1) and had the precondition needed for cointegration test), the Johansson cointegration test was done. Findings show that there is a long-run relationship between the poultry markets in the provinces of Ardebil and East Azerbaijan. The poultry price fluctuations in each province are transmitted to the prices in the other studied province.

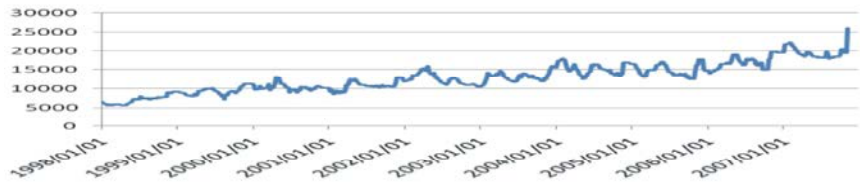

Fig. 1: Changes of poultry weekly price in Ardebil province between 1998 and 2007

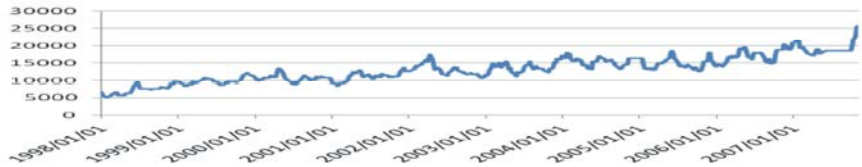

Fig. 2: Changes of poultry weekly price in East Azerbaijan province between 1998 and 2007

Table 1. Unit root tests results

Test Series		AR	EA
Levels	ADF	-1.832	-1.002
	PP	-1.915	-1.265
	KPSS	2.742***	2.749***
	ERS	17.309	21.912
	NG-Perron	-0.592	1.199
First-differences	ADF	-5.986***	-5.484***
	PP	-5.443***	-5.112***
	KPSS	0.084	0.097
	ERS	1.210***	2.286***
	NG-Perron	-75.319***	-49.988***

Note: *** indicate significance at the 1% level

Table 2: Estimated thresholds of SETAR model in regimes between markets under investigation

Market	Regime I	Regime II	Regime III
AR-EA	$(-\infty\langle v_{t-1} \le 0.38)$	$(0/38\langle V_{t-1} \le 1/217)$	$(0/217\langle V_{t-1}\langle\infty)$

Estimation is discussed first in the long-run relationship for the threshold and slope parameters, with first one and then two thresholds.To achieve this goal, R software is used. Percentage of critical values is excluded and research is done between minimum observations in or around determined space. First, the first threshold is examined by two regimes. If the first threshold is admitted, the presence of the second threshold with three regimes is examined. In verifying relationships, maximum autoregression for all regimes is considered 1 and vector of possible threshold delay (the Delay) is considered 1 and trimming parameter indicating the minimal percentage of observations in each regime (trim) is considered 0.15.

As pointed out by Enders [20], a strong threshold effect will result in a sharp U shaped grid search.Once the threshold has been estimated, it can be plugged into the SETAR function. One can thus obtain the slope estimates and their asymptotic p-values [20].

To study Ardebil and East Azerbaijan markets, search is done by 150 possible threshold values in regimes with enough amounts of observation (%15). The ratio of points in low and high regimes was respectively %21.97 and %78.03 of observation.

Admitting the first threshold, two- threshold search is done using SETAR model. Two thresholds 0.38 and 1.217 are determined based on minimum sum of squared error criterion for these two provinces. Table 4 shows findings of estimated thresholds of SETAR model in regimes between markets under investigation.

TVECM function is used to calculate TVECM in R software.

The function of TVECM allows estimating a bivariate TVECM with two or three regimes with the OLS like estimator. It should be emphasized here that there is no difference, except in the starting value, between the OLS and MLE estimator, as conditional on the threshold and the cointegrating value, the MLE estimator is simply LS.

Note that a plot of the search is given automatically as this has proved in practice to be a useful tool, experience showing that the confidence interval of cointegration values is very low and only a local minimum which is easily identifiable in the figure is obtained. Findings obtained from the figure for the markets under investigation show that threshold parameter and the best cointegration values for East Azerbaijan and Ardebil markets are respectively 0.38 and 0.85.

Conclusions and Suggestions: Price transmission, threshold behavior and asymmetric adjustments in the poultry market of Ardebil and East Azerbaijan provinces are studied using threshold cointegartion and R software.

Findings confirm the asymmetric price transmission and threshold behavior in the poultry market in these provinces. Two thresholds (0.38 and 0.217) for East Azerbaijan and Ardebil markets are determined using minimum sum of the squared error criterion. Then threshold error correction vector is estimated and it is concluded that the threshold parameter and the best cointegartion value for East Azerbaijan and Ardebil markets are respectively 0.38 and 0.85.

Investment in poultry industry has good productivity, but due to the great and unexpected fluctuations in the price of its products, production in this sector is always accompanies with a high risk. Therefore, considering relative stationary price and prediction of the price of poultry and its products can have an important role in regulating policy making to control the instability of prices and decreasing the market risk.

Due to the great price fluctuations of poultry in Iran in recent years, the problem should be investigated both in production and distribution sectors. In the supply sector of the meat needed for the market, because animal affairs support corporation of the Ministry of Jihad-e-Agriculture has the responsibility to order and supply the meat needed for the market, it also should accept the responsibility of regulating the market when the market encounters with sudden shocks of demand like during Gorban festival, Shabanie festival and especially during the holy month of Ramadan. It should prevent the noticeable increase in the prices through providing the necessary supply. Moreover, the government should do predictions using statistical economic evaluation and store enough to face these shocks.

In the consumption sectors, society should have a better view of frozen chicken and have interest to buy it. In other words, if people provide part of their needs or their extra daily needs through frozen chicken, they will have an important role in the stabilization of the poultry price and preventing increase it price.

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