AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Investigating the Price Transmission Mechanism of the Greek Fresh Tomato Market with a Markov Switching Vector Error Correction model

***Anthony N. Rezitis*[1] *and Dimitris N. Pachis*[2]**

Abstract

The present study investigates the price transmission mechanism between producer and consumer prices in the Greek fresh tomato market, using monthly price data from January 1995 to May 2011. The estimation is carried out by applying a Markov Switching Vector Error Correction model. The results indicate that there are causality and leadership relationships between producer and consumer prices in the short and in the long run. Finally, a multinomial logit model is utilized in order to determine the factors that affect the switching of the price transmission mechanism.

Keywords: *price transmission, tomato, Greece, Markov, logit.*

1. Introduction

Price is vital for every market, as it can coordinate efficiently the decisions of producers and consumers. The transactions in a market take place according to the price of the market while producers try to maximize their profit and consumers their utility. Moreover, when conditions of perfect competition exist in a market, the price mechanism leads to optimal allocation of scarce resources. On the contrary, when imperfect competition is observed, the most powerful participants of the market benefit by acquiring part of the surplus of the rest of the participants in the market (Brummer et al, 2009).

In this paper, the price transmission mechanism between producer and consumer in the Greek fresh tomato market will be examined. Tomatoes have been selected as they comprise one of the most important agricultural products in Greece. Between 1995 and 2006, fresh tomato production accounted for about 20% to 23% of Greek vegetable production. Moreover, fresh tomatoes are produced throughout Greece. Most tomatoes (60 to 65%) are grown in the open, whereas 35% to 40% are grown in greenhouses. Peloponnesus constitutes the biggest producer of fresh tomatoes grown in the open, whereas Crete is the biggest producer of fresh tomatoes grown in the greenhouse. Dur-

[1] Professor, Department of Business Administration of Food and Agricultural Enterprises, University of Patras, 2 G. Seferi Str, Agrinio 30100, Greece.
Email: arezitis@upatras.gr, tel: 302641074139

[2] PhD Candidate, Department of Business Administration of Food and Agricultural Enterprises, University of Patras, 2 G. Seferi Str, Agrinio 30100, Greece.
Email: pachisdim@gmail.com, tel: 302641074139

ing the period under examination, a decrease in the production of tomatoes in the open can be observed in contrast to an increase in the production of tomatoes in greenhouses. Moreover, in 1997, the greenhouse production of Crete surpassed the production of Peloponnesus tomatoes grown in the open for the first time. For the rest of the period, the production of Crete remained larger than the production of Peloponnesus. At the same time, from 1995 to 2006, exports of fresh tomatoes did not surpass the 1% of the total fresh tomato production and remained stable. On the other hand imports were observed to be increasing, from 1% in 1995 to 3% in 2006. However, it can be said that the Greek tomato market is self sufficient. With regard to consumers, tomatoes are of great importance, as they constitute an essential element of their nutrition. Tomatoes are consumed throughout the year, even during winter. So, their price matters for consumers as much as it matters for producers.

A wide range of empirical methods have been developed in order to study price transmission and market integration. Following Brummer et al. (2009) the empirical methods developed so far can be divided into three categories. The first category includes the study of the correlations between the price series. The second category includes the co-integration methods which gave economists the opportunity to distinguish the spurious from the non spurious relationships between the price series. The third category includes non linear models that allow for state specific behavior in the price transmission mechanism according to the state of a transition variable. The non linear models are: 1) The Threshold Vector Error Correction (TVEC) models, in which the state shifts are determined by the size of the error correction term relative to the value of a threshold. 2) The Asymmetric Price Transmission (APT) models where the state shifts depend on whether prices are increasing or decreasing. 3) The Switching Regression models which allow for state specific behavior in the co-integrating vector. 4) The Parity Bounds models (Baulch, 1997) where it is supposed that the observations of each state represent different distributions. Finally, 5) the Markov Switching Vector Error Correction (MSVEC) models where the Markov chain is represented by an unobserved state variable that signals the states that the price transmission mechanism undergoes. The unobserved variable depicts variables like transaction costs, expectations or policy implementation. The main characteristic of these variables is that they cannot be observed directly or it is difficult to be measured reliably.

There have been many research papers that have investigated the price transmission mechanism of agricultural products especially of tomatoes as they comprise one of the most important agricultural products worldwide. The model that is mainly used for the investigation of the price transmission mechanism is the Asymmetric Price Transmission model. More specifically, the Greek tomato market is explored by Reziti (2005) with an APT model which shows that in the long run the price of the consumer causes the price of the producer. In the same fashion, Bakucs et al (2007) found that in the Hungarian tomato market Granger causality runs from retailer to producer. The same findings are presented by Worth (1999) for the US tomato market. Thus, retailers have enough market power to increase the markup pricing burden for producers. On the other hand, Zheng et al (2008) by investigating the US tomato market with an APT model found that causality runs from producer to consumer. Moreover, Girapunthong et al (2004) investigated the US fresh tomato market using an APT model and found that in the short run a change in the price set by producer Granger caused a change in the price

of consumers. Also, Aguiar and Santana (2002) found that, for the Brazilian tomato market, the causal relationship runs from the farm gate to the retailer. In this paper, the authors point out that variables like expectations can lead to asymmetric price transmission, even if variables like market concentration or product storability are not present. This observation indicates that more elaborate econometric techniques should be taken into consideration like the TVEC models or the MSVEC models that account for exogenous variables like expectations, transaction costs or policy interventions.

Indeed, nowadays, there is an accumulation of studies applying either the Threshold Vector Error Correction or the Markov Switching Vector Error Correction representations in the investigation of the price transmission mechanism of agricultural products. A recent study by Brummer et al (2009) examines the price transmission mechanism between wheat and flour under policy changes in Ukraine with a MSVEC model and demonstrated that the price transmission mechanism had been affected by the policy interventions of the Ukrainian government. In the same way, Busse et al (2010) investigated the price transmission mechanism between fossil fuels and vegetable oil in Germany and Busse and Ihle (2009) studied the price mechanism between German rapeseed oil and biodiesel. In both cases, it was found that the price transmission mechanism was severely affected by policy interventions. On the other hand, the TVEC model has been utilized more often for the study of the price transmission mechanism of agricultural products than the MSVEC model. A recent investigation of the spatial price transmission in the tomato markets in Ghana with a TVEC model came from Amikuzuno (2009). Hassan and Simmioni (2001)'s investigation of the French tomato market found that causality runs from producer to retailer and that retailers did not allow producers to influence retail prices beyond their cost fluctuations. Moreover, Goodwin and Harper (2000) by studying the US pork market, found that the transmission of shocks in the marketing channel is unidirectional and that information flows from producer to consumer. On the other hand, Ben–Kaabia and Gil (2007) explored the Spanish lamp market and observed that retailers benefit from shocks that affect the marketing channels for lamps. Vavra and Goodwin (2005), using a TVEC model, examined the price transmission mechanism of beef, chicken and eggs in the US.

Both of these representations, TVEC and MSVEC, account for variables like transaction costs. However, they have two major differences that make them appropriate for different settings of application. The first difference is that in the MSVEC model the transition variable is inherent to the model whereas in the framework of the TVEC model the transition variable is determined by the researcher. The second difference is that in the TVEC model the error correction term is the main force behind the existence of the different states of the price transmission mechanism, while in the MSVEC model an unobserved exogenous variable is supposed to create the different states of the price mechanism (Ihle and von Cramon – Taubadel, 2008).

In Greece, economy is characterized by rigidities in the product markets as well as in the services markets. Therefore, it is plausible to expect that transaction costs would play an important role in the price transmission mechanism. On the one hand, transaction costs are small but present in every transaction, therefore it is difficult to observe or measure them. On the other hand, one might allege that transaction costs might be less important in a product like a fresh tomato that is lightly processed before it reaches the consumer. However, what is crucial is not the size of transactions costs but rather their

importance relative to changes in other variables that affect price transmission mechanism, as stated by Fackler and Goodwin (2001). Therefore, in the case of the Greek fresh tomato market it seems that the most appropriate representation of the price transmission mechanism is the MSVEC model. Since the Greek economy is characterized by rigidities, it is plausible to suppose that an unobserved variable such as transaction costs, that is difficult to measure, would govern the price transmission mechanism. Moreover, such a variable would be exogenous to the price mechanism. Furthermore, the fact that the researcher does not choose the transition variable himself, as it is inherent to the model, removes the probability of an incorrect specification of the model. Finally, in order to better understand the behavior of the unobserved state variable, a multinomial logit model is used to investigate the factors that affect it.

The rest of the paper is structured in the following way. In Section 2 the Markov Switching Vector Error Correction model is presented as well as the causality tests in the short and in the long run. Section 3 presents the data that were used for the analysis. Section 4 contains the empirical results and finally Section 5 presents the conclusions.

2. Econometric Methodology

2.1 The Markov Switching Vector Error Correction model

The Markov Switching Vector Error Correction model was first introduced by Krolzig (1997) and was a generalization of Hamilton's model (1989). As it has been mentioned already, the idea behind MSVEC model is that the price transmission mechanism goes through different states according to an unobserved transition state variable. Let us assume that $Y_t = (y_{1t},\ldots,y_{kt})$ is the vector of the variables of interest and $S_t = i(i=1,\ldots,M)$ is the M state unobserved variable that follows a first order ergodic Markov Chain. The number of the states of the unobserved variable is countable. The Markov Chain undergoes transitions from one state to another with a specific probability, the transition probability. The matrix of transition probabilities is given below:

$$P = \begin{bmatrix} p_{11} & \cdots & p_{M1} \\ \vdots & \ddots & \vdots \\ p_{1M} & \cdots & p_{MM} \end{bmatrix} \quad \text{with} \quad \sum_{j=1}^{M} p_{kj} = 1 \quad \text{and} \quad p_{kj} \geq 0,\ \forall\ k,j \in \{1,\ldots,M\} \tag{1}$$

The MSVEC model is formulated by letting $\Delta Y_t = (\Delta y_{1t},\ldots,\Delta y_{kt})'$ be the k dimensional vector of the variable of interest where $t = 1\ldots T$ and T the sample size. A p_{th} order MSVEC model will be written as:

$$\begin{aligned} \Delta Y_t &= A_0(s_t = i) + A_1(s_t = i)\Delta Y_{t-1} + \ldots + \\ &\quad + A_p(s_t = i)\Delta Y_{t-p} + B(s_t = i)ect_{t-1} + u_t, u_t \sim NID(0, \Sigma(s_t = i)) \end{aligned} \tag{2}$$

where: s_t is the M state unobserved variable, $A_0(s_t)\ldots A_p(s_t)$ the state dependent autoregressive coefficient matrices, $B(s_t)$ the state dependent coefficient matrix of the error correction term ect_{t-1} and u_t is the state dependent error term of the equation.

The MSVEC model is estimated using a two stage maximum likelihood procedure. In the first stage, cointegration analysis is implemented as it was proposed by Johansen

and Juselius (1990). The aim of this procedure is to estimate the number of the cointegrating relationships that represent the long run relationship between producer and consumer prices. In the second stage the price transmission mechanism is modeled with the following MSVEC model:

$$\begin{aligned}\Delta P_t^p = {\alpha_0}^p(s_t = i) + \sum_{k=1}^{K} \alpha_{1,k}^p(s_t = i)\Delta P_{t-k}^p + \\ + \sum_{k=1}^{K} a_{2,k}^p(s_t = i)\Delta P_{t-k}^c + \beta^p(s_t = i)ect_{t-1} + u_t^p(s_t = i)\end{aligned} \tag{3}$$

$$\begin{aligned}\Delta P_t^c = {\alpha_0}^c(s_t = i) + \sum_{k=1}^{K} \alpha_{1,k}^c(s_t = i)\Delta P_{t-k}^p + \\ + \sum_{k=1}^{K} a_{2,k}^c(s_t = i)\Delta P_{t-k}^c + \beta^c(s_t = i)ect_{t-1} + u_t^c(s_t = i)\end{aligned} \tag{4}$$

where: $\Delta P_t^p\,(\Delta P_t^c)$ are the first differences of producer (consumer) price at period t, ${\alpha_0}^p(s_t)({\alpha_0}^c(s_t))$ is the state dependent intercept term of producer (consumer) equation, $\Delta P_{t-k}^p\,(\Delta P_{t-k}^c)$ are the lags of producer (consumer) price, ect_{t-1} is the error correction term at period $t-1$ and $u_t^p(s_t)(u_t^c(s_t))$ is the state dependent error term of the estimated equation of producer (consumer).

Next, the model is estimated with the Maximum Likelihood procedure with the use of the Expectation Maximization algorithm developed by Krolzig (1996). Apart from the estimation of the parameters of the MSVEC model this procedure gives as a result the filtered and smoothed probability of the price transmission mechanism being in state i at period t. The filtered probabilities are estimated based on information up to the previous period $t-1$. On the other hand, the smoothed probabilities are estimated based on information that are available for the whole period.

2.2 Testing the causality and "dominance" between the variables of interest

In the framework of the price transmission mechanism, testing for causality and "dominance" between the price of producer and consumer offers a deeper insight in the function of the price transmission mechanism. More specifically, when there is causality from producer's price to consumer's price or vice versa, this means that the price of the producer and the price of the consumer will be integrated. This would produce the result that a change in the price of the producer would lead to a change in the price of the consumer or that a change in the price of consumer would lead to a change in the price of the producer. The causality tests are run for each state in the short and in the long run, allowing for the identification of possible changes in price "leadership" as shifts in the states of the unobserved variables take place (Kanas and Tsiotas, 2005). The price of producer or the price of consumer is considered to "lead" the marketing channel when it "dominates" the setting of the price of its counterpart. In the short run, the Granger causality (Granger, 1969) between producer and consumer price is examined by testing the statistical joint significance of the lags of the price of producer and consumer. Specifi-

cally, the null hypothesis of the Granger causality from producer to consumer for state i is given by $H_0 : \alpha_{1,k}^c(s_t = i) = \ldots = \alpha_{1,k}^c(s_t = i) = 0, (i = 1, \ldots, M)$ which indicates that a change in producer price does not Granger cause a change in consumer price. Correspondingly, the null hypothesis of the Granger causality from consumer to producer for state i is given by $H_0 : \alpha_{2,k}^p(s_t = i) = \ldots = \alpha_{2,k}^p(s_t = i) = 0, (i = 1, \ldots, M)$ which indicates that a change in consumer price does not Granger cause a change in the producer price. The Granger causality tests take place with a Wald test. In the long run, the causality tests take place by examining the statistical significance of the estimated parameter of the error correction term of producer's and consumer's equation. The null hypothesis for producer is that $H_0 : \beta^p = 0$ and for consumer is that $H_0 : \beta^c = 0$. If $H_0 : \beta^p \neq 0$ and $H_0 : \beta^c \neq 0$ then there is interaction between producer and consumer price. In this case both prices are considered endogenous. If $H_0 : \beta^p = 0$ and $H_0 : \beta^c \neq 0$ then a change in the producer price causes a change in the consumer price. In this case the producer price is exogenous whereas the consumer's price is endogenous. Finally, if $H_0 : \beta^p \neq 0$ and $H_0 : \beta^c = 0$ then a change in the price of the consumer causes a change in the price of the producer. In this case, the price of the consumer is exogenous whereas the price of the producer is endogenous.

3. Data

The data set comprises the monthly prices of fresh tomatoes for producers as well as for consumers from January 1995 to May 2011. The number of observations is 197. The monthly prices of fresh tomatoes are created by the monthly price indices of fresh tomatoes for producers and consumers which are published by the Hellenic Statistical Authority. The prices of producers are recreated with the use of annual prices at the producer lever from the Hellenic Ministry of Rural Development and Food. The prices of consumers are recreated with the use of weekly prices at the consumer level from the Hellenic Ministry of Development and Competitiveness. The monthly prices of fresh tomatoes are nominal and are transformed into natural logarithms for the purpose of the analysis. For the estimation of the multinomial logit model the consumer price index was also acquired from the Hellenic Statistical Authority. Table 1 shows the descriptive

Table 1: *Descriptive Statistics*

	Mean	***Standard Deviation***	***Skewness***	***Kurtosis***
$\ln P_t^p$	-0.584	0.325	-0.197	2.197
$\ln P_t^c$	0.244	0.279	-0.567	3.204
$\Delta \ln P_t^p$	0.003	0.210	-0.249	3.685
$\Delta \ln P_t^c$	0.004	0.157	-0.284	3.853

statistics of the natural logarithms of the prices of producer $(\ln P_t^p)$ and consumer $(\ln P_t^c)$ as well as the descriptive statistics of the first differences of the natural logarithms of the producer $(\Delta \ln P_t^p)$ and the consumer $(\Delta \ln P_t^c)$.

4. Empirical Results

4.1 Unit Root tests and Cointegration Analysis

Prior to the first stage of the estimation of the MSVEC model, unit root tests are performed so that the stationarity of the price series of producer and consumer can be tested. In this study, two unit root tests are used, the Augmented Dickey – Fuller test (ADF) (1979) and the Kwiatkowski et al test (KPSS) (2002). The tests showed that the natural logarithms of the prices of both producer and consumer are not stationary, whereas the initial differences in the prices are stationary, as shown in Table 2.

Table 2: *Results of the unit root tests*

	ADF			***KPSS***		
	test statistic	***specification***	***5% c. v***	***test statistic***	***specification***	***5% c. v***
$\ln P_t^p$	-1.897**	11 lags	-1.943	0.203***	4 lags, trend	0.146
$\ln P_t^c$	0.033***	10 lags	-1.943	0.171***	4 lags, trend	0.146
$\Delta \ln P_t^p$	-9.050***	10 lags	-1.943	0.066***	28 lags, trend	0.146
$\Delta \ln P_t^c$	-10.475***	9 lags	-1.943	0.060***	28 lags, trend	0.146

[a]1% level of significance ***. [b]5% level of significance **. [c]10% level of significance *.

Next, the first stage of the estimation of the MSVEC model, i.e. the co-integration analysis, is applied as it was proposed by Johansen and Juselious (1990). The first step of the analysis takes place with the utilization of the trace test. The trace test defines the number of co-integrating relationships between producer and consumer prices. The implementation of the test leads to the conclusion that one long run relationship between producer and consumer prices exists, as shown in Table 3.

Table 3: *Results of trace test*

number of co-integrating relationships	***test statistic***
0	40.732*** (0.000)
1	7.177 (0.120)

[a]P – value is reported in the parenthesis. [b]1% level of significance ***.
[c]5% level of significance **. [d]10% level of significance *.

In the second and last step of the analysis, a reduced rank vector error correction model is estimated for the derivation of the cointegrating relationship between producer

and consumer prices that consists of 6 lags and 12 centered seasonal dummies. The result of the cointegration analysis was that the producer and consumer prices are cointegrated in the long run and their relationship was given by the equation: $ect_t = \ln P_t^c \underset{(-22.740)}{-0.752} \underset{(-16.695)}{-0.876} \ln P_t^p$, where the numbers in brackets represent the t statistics. Finally, the analysis of the residuals of the model shows that it was well specified as there are not any signs of autocorrelation or heteroskedasticity and they were normally distributed.

4.2 The Markov Switching Vector Error Correction Model

In the second stage of the estimation of the MSVEC model, the coefficients of the parameters are estimated, along with the probability of the price transmission mechanism being in a specific state at period t. The choice of the best model took place according to the information criteria of Bayes (BIC), Akaike (AIC) and Hannan – Quinn (HQIC) as well as with Likelihood Ratio tests. The model that is chosen is characterized by three states and consists of the error correction term, i.e. the co-integrating relationship, and of the eight lags of producer and consumer prices. The states of the price transmission mechanism are three: The high volatility state (state 1), the medium volatility state (state 2) and the low volatility state (state 3). The estimated model is presented below for each one of the three states.

High volatility state (state 1):

$$\Delta P_t^p = \alpha_0{}^p(s_t=1) + \sum_{k=1}^{8} \alpha_{1,k}^p(s_t=1)\Delta P_{t-k}^p + \sum_{k=1}^{8} a_{2,k}^p(s_t=1)\Delta P_{t-k}^c + \beta^p(s_t=1)ect_{t-1} + u_t^p(s_t=1)$$

$$\Delta P_t^c = \alpha_0{}^c(s_t=1) + \sum_{k=1}^{8} \alpha_{1,k}^c(s_t=1)\Delta P_{t-k}^p + \sum_{k=1}^{8} a_{2,k}^c(s_t=1)\Delta P_{t-k}^c + \beta^c(s_t=1)ect_{t-1} + u_t^c(s_t=1) \quad (5)$$

Medium volatility state (state 2):

$$\Delta P_t^p = \alpha_0{}^p(s_t=2) + \sum_{k=1}^{8} \alpha_{1,k}^p(s_t=2)\Delta P_{t-k}^p + \sum_{k=1}^{8} a_{2,k}^p(s_t=2)\Delta P_{t-k}^c + \beta^p(s_t=2)ect_{t-1} + u_t^p(s_t=2)$$

$$\Delta P_t^c = \alpha_0{}^c(s_t=2) + \sum_{k=1}^{8} \alpha_{1,k}^c(s_t=2)\Delta P_{t-k}^p + \sum_{k=1}^{8} a_{2,k}^c(s_t=2)\Delta P_{t-k}^c + \beta^c(s_t=2)ect_{t-1} + u_t^c(s_t=2) \quad (6)$$

Low volatility state (state 3)

$$\Delta P_t^p = \alpha_0{}^p(s_t=3) + \sum_{k=1}^{8} \alpha_{1,k}^p(s_t=3)\Delta P_{t-k}^p + \sum_{k=1}^{8} a_{2,k}^p(s_t=3)\Delta P_{t-k}^c + \beta^p(s_t=3)ect_{t-1} + u_t^p(s_t=3)$$

$$\Delta P_t^c = \alpha_0{}^c(s_t=3) + \sum_{k=1}^{8} \alpha_{1,k}^c(s_t=3)\Delta P_{t-k}^p + \sum_{k=1}^{8} a_{2,k}^c(s_t=3)\Delta P_{t-k}^c + \beta^c(s_t=3)ect_{t-1} + u_t^c(s_t=3) \quad (7)$$

The estimated coefficients of the parameters of the price transmission mechanism for

each state are given in Table 4. Moreover, Table 4 presents the variance of the error terms of the producer and consumer equations ($\sigma_{11}(s_t = i)$, $i = 1,2,3$ and $\sigma_{22}(s_t = i)$, $i = 1,2,3$ respectively), the covariance of producer and consumer ($\sigma_{12}(s_t = i)$, $i = 1,2,3$), the duration of each state of the price transmission mechanism in months (d_i, $i = 1,2,3$), the probability of the price transmission mechanism to remain in the same state

Table 4. *Estimations of the MSVEC model*

State 1		***State 2***		***State 3***	
parameters	***estimations***	***parameters***	***estimations***	***parameters***	***estimations***
$\alpha_0^p(s_t = 1)$	-0.058***(-4.117)	$\alpha_0^p(s_t = 2)$	0.267***(23.845)	$\alpha_0^p(s_t = 3)$	0.115***(14.203)
$\alpha_{1,1}^p(s_t = 1)$	-0.026(-0.146)	$\alpha_{1,1}^p(s_t = 2)$	0.889***(5.311)	$\alpha_{1,1}^p(s_t = 3)$	-0.360***(-4.465)
$\alpha_{1,2}^p(s_t = 1)$	-0.287**(-2.118)	$\alpha_{1,2}^p(s_t = 2)$	-0.140(-0.942)	$\alpha_{1,2}^p(s_t = 3)$	-0.659***(-8.881)
$\alpha_{1,3}^p(s_t = 1)$	-0.123(-0.738)	$\alpha_{1,3}^p(s_t = 2)$	-0.751***(-6.380)	$\alpha_{1,3}^p(s_t = 3)$	-0.406***(-6.457)
$\alpha_{1,4}^p(s_t = 1)$	-0.024(-0.305)	$\alpha_{1,4}^p(s_t = 2)$	-0.506***(-6.034)	$\alpha_{1,4}^p(s_t = 3)$	0.081(0.967)
$\alpha_{1,5}^p(s_t = 1)$	-0.387***(-3.041)	$\alpha_{1,5}^p(s_t = 2)$	-0.068(-0.728)	$\alpha_{1,5}^p(s_t = 3)$	0.280***(3.580)
$\alpha_{1,6}^p(s_t = 1)$	-0.060(-0.692)	$\alpha_{1,6}^p(s_t = 2)$	-0.485***(-6.128)	$\alpha_{1,6}^p(s_t = 3)$	0.484***(6.933)
$\alpha_{1,7}^p(s_t = 1)$	-0.305**(-2.389)	$\alpha_{1,7}^p(s_t = 2)$	-0.358***(-5.013)	$\alpha_{1,7}^p(s_t = 3)$	0.598***(9.392)
$\alpha_{1,8}^p(s_t = 1)$	0.237**(2.282)	$\alpha_{1,8}^p(s_t = 2)$	-0.541***(-6.934)	$\alpha_{1,8}^p(s_t = 3)$	-0.325***(-5.751)
$\alpha_{2,1}^p(s_t = 1)$	-0.220(-0.951)	$\alpha_{2,1}^p(s_t = 2)$	-1.619***(-8.704)	$\alpha_{2,1}^p(s_t = 3)$	0.455***(4.317)
$\alpha_{2,2}^p(s_t = 1)$	-0.319*(-1.781)	$\alpha_{2,2}^p(s_t = 2)$	0.298*(1.698)	$\alpha_{2,2}^p(s_t = 3)$	0.652***(7.862)
$\alpha_{2,3}^p(s_t = 1)$	-0.353(-1.583)	$\alpha_{2,3}^p(s_t = 2)$	0.686***(5.273)	$\alpha_{2,3}^p(s_t = 3)$	0.517***(6.083)
$\alpha_{2,4}^p(s_t = 1)$	-0.522***(-3.654)	$\alpha_{2,4}^p(s_t = 2)$	0.436***(4.071)	$\alpha_{2,4}^p(s_t = 3)$	-0.031(-0.263)
$\alpha_{2,5}^p(s_t = 1)$	0.105(0.635)	$\alpha_{2,5}^p(s_t = 2)$	0.195*(1.716)	$\alpha_{2,5}^p(s_t = 3)$	-0.371***(-3.904)
$\alpha_{2,6}^p(s_t = 1)$	-0.397***(-2.680)	$\alpha_{2,6}^p(s_t = 2)$	0.556***(5.951)	$\alpha_{2,6}^p(s_t = 3)$	-0.064(-0.820)
$\alpha_{2,7}^p(s_t = 1)$	-0.110(-0.642)	$\alpha_{2,7}^p(s_t = 2)$	0.461***(4.751)	$\alpha_{2,7}^p(s_t = 3)$	-0.370***(-4.979)
$\alpha_{2,8}^p(s_t = 1)$	-0.552***(-4.073)	$\alpha_{2,8}^p(s_t = 2)$	0.849***(8.154)	$\alpha_{2,8}^p(s_t = 3)$	0.803***(11.992)
$\alpha_0^c(s_t = 1)$	-0.020*(-1.896)	$\alpha_0^c(s_t = 2)$	0.192***(17.086)	$\alpha_0^c(s_t = 3)$	0.025***(3.974)
$\alpha_{1,1}^c(s_t = 1)$	-0.248(-1.246)	$\alpha_{1,1}^c(s_t = 2)$	0.175(0.924)	$\alpha_{1,1}^c(s_t = 3)$	-0.106(-1.556)
$\alpha_{1,2}^c(s_t = 1)$	-0.249(-1.473)	$\alpha_{1,2}^c(s_t = 2)$	-0.521***(-3.338)	$\alpha_{1,2}^c(s_t = 3)$	-0.407***(-6.555)

State 1		State 2		State 3	
parameters	***estimations***	***parameters***	***estimations***	***parameters***	***estimations***
$\alpha_{1,3}^{c}(s_t=1)$	-0.297(-1.510)	$\alpha_{1,3}^{c}(s_t=2)$	-0.700***(-5.895)	$\alpha_{1,3}^{c}(s_t=3)$	-0.369***(-7.208)
$\alpha_{1,4}^{c}(s_t=1)$	-0.078(-0.521)	$\alpha_{1,4}^{c}(s_t=2)$	-0.513***(-6.132)	$\alpha_{1,4}^{c}(s_t=3)$	-0.161***(-2.826)
$\alpha_{1,5}^{c}(s_t=1)$	-0.451***(-3.505)	$\alpha_{1,5}^{c}(s_t=2)$	0.020(0.220)	$\alpha_{1,5}^{c}(s_t=3)$	-0.011(-0.176)
$\alpha_{1,6}^{c}(s_t=1)$	-0.014(-0.109)	$\alpha_{1,6}^{c}(s_t=2)$	-0.274***(-3.370)	$\alpha_{1,6}^{c}(s_t=3)$	0.179***(3.219)
$\alpha_{1,7}^{c}(s_t=1)$	-0.209(-1.609)	$\alpha_{1,7}^{c}(s_t=2)$	-0.335***(-4.582)	$\alpha_{1,7}^{c}(s_t=3)$	0.291***(5.740)
$\alpha_{1,8}^{c}(s_t=1)$	0.084(0.827)	$\alpha_{1,8}^{c}(s_t=2)$	-0.236***(-2.949)	$\alpha_{1,8}^{c}(s_t=3)$	-0.137***(-2.997)
$\alpha_{2,1}^{c}(s_t=1)$	0.324(1.421)	$\alpha_{2,1}^{c}(s_t=2)$	-0.605***(-2.910)	$\alpha_{2,1}^{c}(s_t=3)$	0.024(0.261)
$\alpha_{2,2}^{c}(s_t=1)$	-0.244(-1.236)	$\alpha_{2,2}^{c}(s_t=2)$	0.764***(4.206)	$\alpha_{2,2}^{c}(s_t=3)$	0.452***(6.569)
$\alpha_{2,3}^{c}(s_t=1)$	-0.008(-0.033)	$\alpha_{2,3}^{c}(s_t=2)$	0.558***(4.290)	$\alpha_{2,3}^{c}(s_t=3)$	0.266***(3.883)
$\alpha_{2,4}^{c}(s_t=1)$	-0.346*(-1.991)	$\alpha_{2,4}^{c}(s_t=2)$	0.257**(2.430)	$\alpha_{2,4}^{c}(s_t=3)$	0.213***(2.865)
$\alpha_{2,5}^{c}(s_t=1)$	0.095(0.641)	$\alpha_{2,5}^{c}(s_t=2)$	0.183(1.587)	$\alpha_{2,5}^{c}(s_t=3)$	-0.196**(-2.528)
$\alpha_{2,6}^{c}(s_t=1)$	-0.322*(-1.879)	$\alpha_{2,6}^{c}(s_t=2)$	0.355***(3.723)	$\alpha_{2,6}^{c}(s_t=3)$	0.112*(1.842)
$\alpha_{2,7}^{c}(s_t=1)$	0.025(0.143)	$\alpha_{2,7}^{c}(s_t=2)$	0.232**(2.327)	$\alpha_{2,7}^{c}(s_t=3)$	-0.395***(-6.369)
$\alpha_{2,8}^{c}(s_t=1)$	-0.477***(-4.111)	$\alpha_{2,8}^{c}(s_t=2)$	0.360***(3.335)	$\alpha_{2,8}^{c}(s_t=3)$	0.427***(7.438)
$\beta^{p}(s_t=1)$	0.386**(2.232)	$\beta^{p}(s_t=2)$	0.363*(1.881)	$\beta^{p}(s_t=3)$	0.475*** (4.298)
$\beta^{c}(s_t=1)$	-0.228(-1.094)	$\beta^{c}(s_t=2)$	-0.64***(-2.976)	$\beta^{c}(s_t=3)$	-0.206**(-2.165)
$\sigma_{11}(s_t=1)$	0.018***(7.257)	$\sigma_{11}(s_t=2)$	0.002***(3.989)	$\sigma_{11}(s_t=3)$	0.001*** (3.775)
$\sigma_{22}(s_t=1)$	0.011***(7.380)	$\sigma_{22}(s_t=2)$	0.002***(3.887)	$\sigma_{22}(s_t=3)$	0.001***(4.310)
$\sigma_{12}(s_t=1)$	0.007***(4.735)	$\sigma_{12}(s_t=2)$	0.001***(3.167)	$\sigma_{12}(s_t=3)$	0.001***(3.468)
d_1	6.452	d_2	2.197	d_3	2.443
obs_1	110	obs_2	36	obs_3	42
p_{11}	0.845	p_{22}	0.545	p_{33}	0.591
BIC			-9.881		
AIC			-8.891		
HQIC			-9.881		

[a]T–statistics are reported in the parenthesis. [b]1% level of significance ***.
[c]5% level of significance **. [d]10% level of significance *.

$(p_{kj} \forall k = j \in \{1,2,3\})$, the number of observations in each state $(obs_i,\ i = 1,2,3)$ and the information criteria (BIC, AIC and HQIC).

From Table 4, it can be observed that when there is high volatility the price transmission mechanism remains in state 1 for 6.452 months on average whereas when there is medium and low volatility it remains at state 2 and 3 for 2.197 and 2.443 months on average. The state of high volatility is observed for 110 months whereas the states of medium and low volatility are observed for 36 and 42 months, correspondingly. Moreover, the probability of price transmission mechanism remaining in state 1 is about 0.845, in state 2 about 0.545 and in state 3 about 0.591.

The results of the Wald tests show that in the short run there is a Granger causality relationship from the producer to the consumer as well as from the consumer to the producer for all three states of the price transmission mechanism, as is evident from Table 5. Thus, it can be concluded that neither producer nor consumer "leads" one another.

Table 5: *State dependent Wald causality test in the short run*

	State 1	***State 2***	***State 3***
$H_0: a^c_{1,1}(s_t = i) = \ldots$ $\ldots = a^c_{1,8}(s_t = i) = 0$	27.840*** (0.000)	172.039*** (0.000)	164.460*** (0.000)
$H_0: a^p_{2,1}(s_t = i) = \ldots$ $\ldots = a^p_{2,8}(s_t = i) = 0$	33.547*** (0.001)	327.170*** (0.000)	269.450*** (0.000)

[a]P – value is reported in the parenthesis. [b]1% level of significance ***.
[c]5% level of significance **. [d]10% level of significance *.

The results of the causality tests for the long run show that, when there is high volatility the coefficient of the error correction term of the consumer's equation, $\beta^c(s_t = 1)$ is not statistically significant, indicating that the consumer price is exogenous. On the contrary, the coefficient of the error correction term of the producer's equation, $\beta^p(s_t = 1)$ is statistically significant and therefore endogenous. Consequently, only the price of the producer adjusts to the long run equilibrium, indicating that the market of the consumer "leads" the market of the producer. When there is medium or low volatility, the coefficients of the error correction term of the producer's equation as well as that of the consumer's equation are statistically significant and therefore both prices are endogenous. Thus, in these cases the equilibrium in the market is achieved by the adjustment of both producer and consumer prices, indicating that neither the price of producer nor the price of consumer "dominates" one another.

Figures 1, 2 and 3 represent the smoothed probability of the price transmission mechanism in combination with the values of the Relative Markup pricing of the retailer[3].

---

[3] The relative markup pricing is given by $RM = \dfrac{P^c - P^p}{P^c}$.

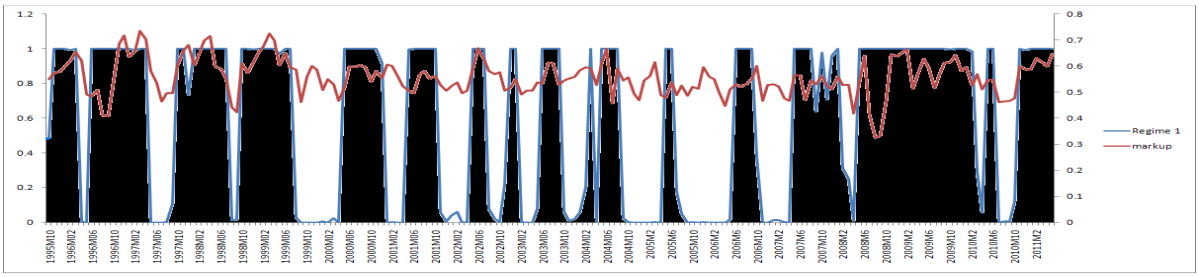

Figure 1. *The smoothed probability of state 1 of the price transmission mechanism*

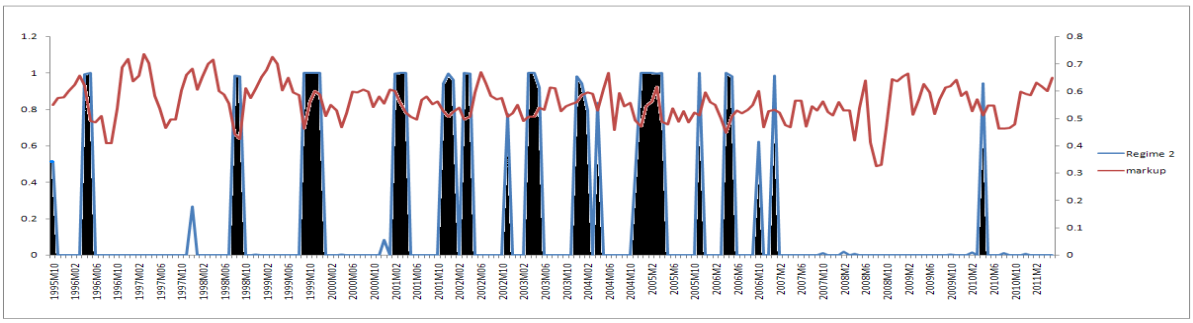

Figure 2. *The smoothed probability of state 2 of the price transmission mechanism*

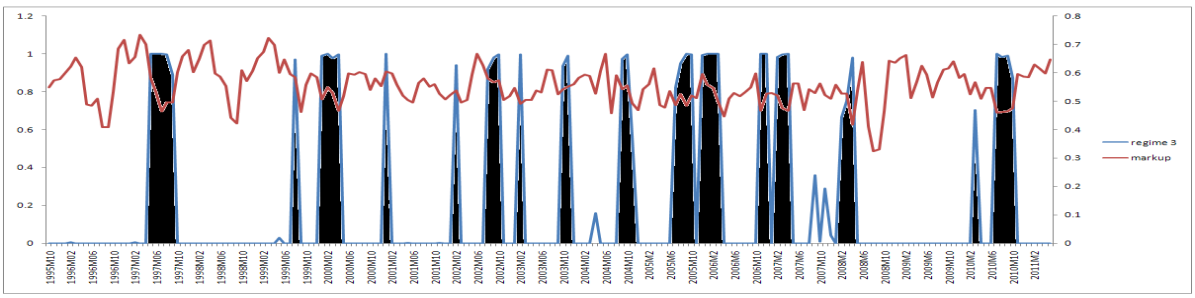

Figure 3. *The smoothed probability of state 3 of the price transmission mechanism*

From the Figures it can be observed that when there is high volatility the relative markup rises. In contrast, when there is medium or low volatility the relative markup declines. Furthermore, the classification of each observation (month) according to the state it appears, shows that, when there is high volatility usually it is summer or winter. However, when there is medium volatility it is usually spring and when there is low it is usually autumn. In the high volatility state, the classification reveals two periods during which the seasonal pattern is not followed ("breaks"). Thus, the change of season does not cause a switch in the state of the price transmission mechanism and the high volatility state persists. These periods expanded between January 1995 and December 2000 (period 1) and between May 2007 and February 2010 (period 2). During period 1 (January 1995-December 2000), the cause of the persistence of the high variance state and the disruption of the seasonal pattern was the change in the Common Agricultural Policy (CAP) of the European Union (EU). More specifically, during this period the aim of the CAP was to reduce the price gap between EU's agricultural products and the competitive products of other countries so that EU's production becomes more competitive worldwide (European Commission, 2012). This policy change accomplished its purpose and reduced the export subsidies that the EU had to pay to farmers. Also, this policy

was adopted by the EU as a consequence of the Agricultural Agreement achieved during the Uruguay Round of the General Agreement on Tariffs and Trade, which was brought into force in January 1995, accompanying the establishment of World Trade Organization. This agreement obliged the participating countries to reduce subsidies that distort trade, reduce export subsidies to agricultural products and to open their markets to imported agricultural products (WTO, 2012). During the same period, another factor that could have played a role in the increased volatility could be the entrance of Greece to the Exchange Rate Mechanism (ERM) of the European Monetary Union. The Bank of Greece had adopted a policy of increased interest rates which led to the appreciation of the national currency (Drachma) (Bank of Greece, 1998). Greece was part of ERM for 9 months from March 1998 to December 1998. After that, the Drachma became a member of the new ERM and continued being appreciated towards its merger with the central currency that was established in the EU. During period 2 (May 2007-February 2010) the main cause of the high volatility could be attributed to the financial crisis that began in the USA in 2008. Moreover, during this period high volatility in oil and fertilizer prices was also observed.

Finally, in order to shed more light on the factors that led to a switch in the state of the price transmission mechanism, a multinomial logit model is utilized. A categorical variable is used as the dependent variable of the logit model. The dependent variable consists of three categories which correspond to the three states of the price transmission mechanism. Each observation t is classified in category $i=1,2,3$ if it has smoothed probability over 50%, to be at state $i=1,2,3$. In other words, the observations that are classified to the high volatility state are labeled as category 1. The observations that are classified to the state of medium volatility are labeled as category 2 and lastly the observation that are classified to the low volatility state are labeled as category 3. The independent variables that are investigated for their impact on the switching of the state of the price transmission mechanism are: the Greek Consumer Price Index[4] (CPI), the Relative Markup pricing of the retailer (RM) and the seasons of summer (SM), winter (WN) and spring (SN), which are represented by three dummy variables that achieve the value of 1 for the months of the specific season and 0 for the rest. Finally, a dummy variable (DM) is created, which takes the value 1 for periods 1 and 2 (January 1995-December 2000 and May 2007-February 2010) when seasonality pattern "breaks" and the value will be 0 for the rest of the period. The results of the estimation are given in table 6.

The results of the estimation show that the variables that affect the probability the price transmission mechanism to be in state 1 relative to state 3 are: the Relative Markup pricing of the retailer (RM), the Greek Consumer Price Index (CPI), the season of summer (SM) and the dummy variable (DM). More specifically, a one unit increase in relative markup pricing or in CPI increases the probability of the price mechanism being in state 1 relative to state 3, given that the other variables in the model are held constant. The probability of the price transmission mechanism being in state 1 relative to state 3 is higher during the summer. Moreover, during the periods January 1995–December 2000 and May 2007–February 2010 when the seasonal pattern "breaks", the price transmission mechanism has a higher probability of being in state 1 relative to

[4] The natural logarithm of the Greek Consumer Price Index is used.

Table 6. *The results of the multinomial logit*

	state 1		***state 2***	
RM	17.453***	(0.000)	-2.318	(0.627)
CPI	3.019*	(0.072)	-6.602**	(0.011)
WN	-0.461	(0.441)	0.363	(0.576)
SN	-0.041	(0.948)	1.036	(0.102)
SM	1.144*	(0.052)	-1.977*	(0.089)
DM	2.000***	(0.000)	-1.253*	(0.087)
constant	-23.150***	(0.005)	30.356**	(0.014)

[a]State 3 is the base outcome. [b]P – value is reported in the parenthesis.
[c]1% level of significance ***. [d]5% level of significance **.
[e]10% level of significance *.

state 3. Finally, the variables that impact the probability of price mechanism being in state 2 relative to state 3 are: the Greek Consumer Price Index (CPI), the season of summer (SM) and the dummy variable (DM). More specifically, a one unit increase in CPI decreases the probability of price mechanism being in state 2 relative to state 3. During the summer, the probability of the price mechanism being in state 2 relative to state 3 is lower. Lastly, the "breaking" of the seasonal pattern has a lower probability of being observed in state 2 relative to state 3.

In the literature, the investigation of the price transmission mechanism of fresh tomatoes can be classified into two categories according to the direction of the causality relationship. In the first category, the empirical results show that a change in producer price causes a change to consumer price, whereas in the second category a change in consumer price causes a change to producer price. This study can be roughly classified in the second category as the empirical results show that, in the long run, in the high volatility state, the consumer price "leads" the producer price. Moreover, this result confirms the findings of Reziti (2005) that in the fresh Greek tomato market, in the long run the causality relationship runs from consumer to producer. However, the present paper applies a MSVEC model which distinguishes three different states of the price transmission mechanism. For each state, in the short and in the long run, the causality relationship is investigated. What is more, a multinomial logit model is used with the aim of investigating the factors that affect the transition of the price transmission mechanism between the three states. In general, the price transmission literature about fresh tomatoes is inconclusive and presents contradictory results, even under the same settings as in the case of the US fresh tomato market (Girapunthong et al, 2004; Worth, 1999). Therefore, more studies are needed in order to understand the underlying principles of the price transmission mechanism in tomato markets more fully as well as in the general agricultural markets.

5. Conclusions

This paper investigates the price transmission mechanism of the Greek fresh tomato market for the period from January 1995 to May 2011. The analysis takes place under the assumption that the price transmission mechanism switches between different states according to an unobserved state variable.

The results of the analysis show that when high volatility is observed the relative markup pricing of the retailer increases. As a consequence, it can be claimed that in periods of high volatility the retailer exercises some degree of market power. More specifically, the causality test in the long run shows that, when there is high volatility only the producer price is adjusted towards the long run equilibrium. So, in the long run the price of retailer "leads" the price of the producer when there is high volatility. The logit estimation confirms that the price transmission mechanism has increased probability to be in the state of high volatility when the relative markup pricing of retailer increases. On the contrary, when there is medium or low volatility, the relative markup pricing of the retailer decreases. Consequently, the retailer does not exercise any degree of market power in the cases of medium or low volatility. Furthermore, causality tests in both the short and long run shows that both consumer and producer adjust their prices so as to achieve equilibrium indicating that neither consumer nor producer dominates one another in the case of medium and low volatility states. Moreover, when a policy change in the agricultural sector or an economic crisis takes place, the probability of the price transmission mechanism remaining in **a** state of high volatility is increased. The high volatility state is characterized by high relative markup pricing of the retailer and by the price "leadership" of the consumer to the price of producer. Finally, an increase in inflation leads to the increased probability of the price mechanism to be found at the high volatility state.

Acknowledgements:

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

European Union
European Social Fund
OPERATIONAL PROGRAMME
EDUCATION AND LIFELONG LEARNING
investing in knowledge society
MINISTRY OF EDUCATION, LIFELONG LEARNING AND RELIGIOUS AFFAIRS
MANAGING AUTHORITY
NSRF 2007-2013
programme for development
EUROPEAN SOCIAL FUND
Co- financed by Greece and the European Union

We would like to thank Anastasia Ntinou for her assistance in an initial version of this paper.

Bibliography

Aguiar, D.R.D., Santana, J.A., 2002. Asymmetry in farm to retail price transmission: Evidence from Brazil. Agribusiness. 18(1), 37–48.

Amikuzuno, J., 2009. Spatial price transmission and market integration in agricultural markets after liberalization in Ghana: Evidence from fresh tomato markets. PhD dissertation, Goettingen. Germany.

Bakucs, L.Z., Ferto, I., Szabo, G.G., 2007. Price transmission in the Hungarian vegetable sector. Studies in Agricultural Economics. 106, 23–40.

The Bank of Greece, 1998. Report on monetary policy 1997 – 1998. Athens – Greece.

Baulch, B., 1997. Transfer costs, spatial arbitrage and testing for food market integration. American Journal of Agricultural Economics. 79, 477–487.

Ben–Kaabia, M., Gil, J.M., 2007. Asymmetric price transmission in the Spanish lamp sector. European Review of Agricultural Economics. 34(1), 53–80.

Brummer, B., von Cramon-Taubadel, S., Zorya, S., 2009. The impact of market and policy instability on price transmission between wheat and flour in Ukraine. European Review of Agricultural Economics. 36. 203–230.

Busse, S., Ihle, R., 2009. German rapeseed oil and biodiesel pricing under changing market conditions: A Markov switching vector error correction model approach. Contributed paper prepared for presentation at the International Association of Agricultural Economists conference, Beijing, China, August 16-22.

Busse, S., Brummer, B., Ihle, R., 2010. The pattern of integration between fossil fuel and vegetable oil markets: The case of biodiesel in Germany. Selected paper prepared for presentation at the Agricultural and Applied Economics Asociation – AAEA, CAES, WAEA joint annual meeting, Denver, Colorado, July 25-27.

Dickey, D. A., Fuller, W. A., 1979. Estimators for autoregressive time series with a unit root. Journal of the American Statistical Association. 74, 427–431.

European Commission – Agriculture and Rural Development, 2012. The Common Agricultural Policy Explained. http://ec.europa.eu/agriculture/publi/capexplained/cap_en.pdf. Last accessed in 12/03/2012.

Fackler, P. L., Goodwin, B. K., 2001. Spatial price analysis, in: Gardner, B., Rausser, G., (Eds.), Handbook of Agricultural Economics, Vol. 1B. Elsevier, Amsterdam, pp 971–1024.

Girapunthong, N., VanSickle, J., Renwick, A., 2004. Price asymmetry in the United States fresh tomato market. Journal of Food Distribution Research. 34(3), 51–59 .

Goodwin, B.K., Harper, D.C., 2000. Price transmission, threshold behavior and asymmetric adjustment in the US pork sector. Journal of Agricultural and Applied Economics. 32(3), 543–553.

Granger, C.W.J., 1969. Investigating causal relations by econometric models and cross spectral methods. Econometrica. 37, 424– 438.

Hamilton, J. D., 1989. A new approach to the economic analysis of nonstationary time series and the business cycle. Econometrica. 57, 357–384.

Hassan, D., Simioni, M., 2001. Price linkage and transmission between shippers and retailers in the French fresh vegetable channel. Institut National de la Recherche Agronomique. Toulouse – France.

Ihle, R., v. Cramon-Taubadel, S., 2008. A Comparison of Threshold Cointegration and Markov Switching Vector Error Correction Models in Price Transmission Analysis. Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting and Market Risk Management. St. Louis, MO. http://www.farmdoc.uiuc.edu/nccc134. Last accessed in 15/06/2012.

Johansen, S., Juselius, K., 1990. Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxford Bulletin of Economics and Statistics. 52, 169–210.

Kanas, A., Tsiotas, G., 2005. Real interest rates linkages between the USA and the UK in the postwar period. International Journal of Finance and Economics. 10, 251–262.

Krolzig, H.M., 1997. Markov switching vector autoregressions: modelling, statistical inference and application to business cycles Analysis. Springer – Verlang: Berlin.

Krolzig, H.M., 1996. Statistical analysis of cointegrated VAR processes with Markovian regime shifts. SFB 373 Discussion Paper 25/1996. Humboldt Universitat zu Berlin.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y., 1992. Testing the null of stationarity against the alternative of a unit root: how sure are we that the economic time series have a unit root? Journal of Econometrics. 54, 159–178.

Reziti, I., 2005. An investigation into the relationship between producer, wholesale and retail prices of Greek agricultural products. Centre of Planning and Economic Research. Athens – Greece.

Vavra, P., Goodwin, B.K, 2005. Analysis of price transmission along the food chain. OECD Food, Agriculture and Fisheries Working Papers, No. 3. OECD Publishing. doi: 10.1787/752335872456.

World Trade Organization. 2012. Uruguay round agreement – agreement on agriculture. http://www.wto.org/english/docs_e/legal_e/14-ag_01_e.htm. Last accessed in 15/03/2012

Worth, T., 1999. The f.o.b – retail price relationship for selected fresh vegetables. Economic Research Service – USDA / Vegetables and Specialties / VGS–279.

Zheng, S., Miller, D., Wang, Z., Kai, S., 1998. Meta–evidence of asymmetric price transmission in US agricultural markets. Journal of the Faculty of Agriculture of Kyushu University. 53(1), 349–356.