The Agricultural Sector in the Macroeconomic Environment: An Empirical Approach for EU

Nikolaos Dritsakis*

Abstract

This paper attempts to examine the relationship between the agricultural sector and the macroeconomic environment with a special mention in the way of prices formation in the agricultural sector. In the empirical analysis of this study a multivariate cointegration technique is applied in conjunction with Granger causality tests. The results of this analysis provide indications for the existence of significant causal relationships between the variables that characterize the macroeconomic environment and the indicators of the agricultural sector.

Keywords: *agricultural sector, macroeconomic environment, cointegration, error correction model, E.U.*

Introduction

The agricultural policy has been a field of study for many researchers focused on agriculture. More specifically, the study of the effects of the agricultural policy on agriculture, on the broader agricultural sector as well as on the economy in general, have always been in the front line of agricultural economic research. On the other hand, the effects of the wider macroeconomic policy that usually affects all sectors of economic activity in the agricultural sector have not been taken any consideration by the most researchers who are interested in it.

Agricultural sector usually consists the most "secluded" sector of the economic activity in developed countries and especially in EU countries. During the last years some very important changes have taken place in both EU level and international level. Indicatively, the well-known reform of common agricultural policy (CAP) at a European level is reported. The most important feature of this reform is the significant decrease in intervention prices (for some products) and the compensation of the producers through subsidies that are not related with the level of production. In an international level there has been an agreement in the G.A.T.T. frameworks for the

* University of Macedonia, Economics and Social Sciences, Department of Applied Informatics, 156 Egnatia Street, P.O box 1591, 540 06 Thessaloniki, Greece, FAX: (031) 891290, e-mail: drits@macedonia.uom.gr

limitation of the support degree of agriculture, particularly through the measures that constraint the operation of international market of agricultural products.

An article by Schuh (1974) has been the starting point, which initiated the interest on the effects of macroeconomic policy for agriculture. This article focused on foreign exchange rates, which were considered to be as a mean of macroeconomic policy transmission to agriculture. The adoption of euro as a common currency in EU will do away with foreign exchange rates fluctuations in intra-community trade. Nevertheless, in trading with third countries the role of foreign exchange rates remains unchanged.

The abandonment of the significant role of exchange rates currencies in intra-community trade will amplify the role of some other means of macroeconomic policy such as interest rates, Zanias (1996). The level of interest rates is involved in the borrowing cost of farmers and in estimating of the usage cost of fixed capital.

Another equally important factor of influence of macroeconomic policy in agriculture is the increasing instability in agricultural product prices, as a result of macroeconomic instability.

Finally, the existence of a non-neutral relationship between the general level of prices and the level of agricultural prices could be explained through a series of models, Fischer (1981), Zanias (1992), in which the case of the unexpected inflation holds a significant place.

There is a large number of empirical studies, which have recorded the relationships of macroeconomic variables and agricultural sector. The studies of Han, Jansen and Penson (1990), Robertson and Orden (1990) are evidential of the impact of monetary policy on the agricultural sector. Similarly, the studies of Kost (1976), Groenewegen (1986), Orden (1986), Saghaian, Reed and Marchant (2002), were focused on exchange rates, which were considered as a mean of influence from the macroeconomic policy to the agricultural sector. Finally, we have the studies of Tweeten (1980), Grennes and Lapp 1986, Daouli and Demoussis (1989), Zanias (1994, 1999), Loizou, Mattas, and Pagoulatos, (1997), Tabakis (2001), that were focused on the relationship between the general level of prices and the level of agricultural prices.

In this paper, an effort is made to examine the relationship between the agricultural sector and the macroeconomic environment in relation to the prices formation in the EU field. In this empirical analysis for the EU we use monthly data for the time period from 1982:1 to 2000:12 for all variables[1] and we apply Granger causality tests and also the Johansen cointegration technique.

The Section 2 of this paper applies the Dickey – Fuller tests and investigates the stationarity of the used data. The multivariate cointegration analysis between the used variables is implied in Section 3. Section 4 reports the estimations of error correction models, while Section 5 deloys the Granger causality tests. Finally, Section 6 presents the conclusions of this study.

Data stationarity tests

According to the Robertson and Orden's (1990) paper, as well as the Moss's (1992) paper, we have used monthly data for the time period between 1982:1 and 2000:12 for the following variables: Price Production Indicator (PP), Price Market Indicator (PM), Price Consumer Indicator (PC), Gross National Product (GNP)[2], Exchange rate Parity (PE), and Money supply (M1). In order to determine the change rate of the above-mentioned variables we estimated the natural logarithms of the related time series and their first differences respectively. At this point we would like to note that letters *L* and *D* preceding each variable name, indicate the natural logarithms and their first differences respectively.

Examining the stationarity of the mentioned variables we have used the Dickey – Fuller (DF) and Augmented Dickey – Fuller (ADF) tests (1979, 1981). The results of these tests appear in Table 1. The minimum values of the Akaike (1973) and Schwartz (1978) statistics have provided the better structure of the ADF functions, as well as the relative numbers of time lags, under the indication "Lag". As far as the autocorrelation disturbance term test is concerned, the Lagrange Multiplier LM(1) test has been used.

Table 1. DF/ADF unit root tests

Variable	**In levels**			**In 1st differences**		
	Lag	**Test statistic (DF/ADF)***	**LM (1)****	**Lag**	**Test statistic (DF/ADF)**	**LM(1)**
LPP	3	-1,4778	4,165[0,001]	12	-3,0969	1,745[0,192]
LPM	2	-1,8417	5,834[0,000]	1	-6,3755	2,034[0,159]
LPC	5	-1,6395	4,876[0,000]	5	-2,9991	0,967[0,256]
LGNP	4	-2,3549	4,442[0,001]	9	-5,4185	0,867[0,337]
LPE	3	-1,9749	3,987[0,017]	1	-9,9762	1,675[0,177]
LM1	5	-1,2753	4,657[0,007]	4	-4,8629	1,248[0,275]

* Critical values: -2.8751

** Numbers in brackets indicate significant levels

The results of Table 1 suggest that the null hypothesis of a unit root in the time series cannot be rejected at a 5% level of significance. Therefore, no time series appear to be stationary in variable levels when the test is applied on the logarithms of the data. However, when the logarithms of the series are transformed into first differences they become stationary and consequently the related variables can be characterized integrated order 1, I(1*)*. Moreover, for all variables the LM(1) test first differences shows that there is no correlation in the disturbance terms.

Cointegration Analysis

Since it has been determined that the variables under examination are integrated order 1, we then proceed by defining the number of cointegrating vectors between the variables, using the Johansen (1988) maximum likelihood procedure, Johansen and Juselious (1990, 1992). This approach tests for the number of cointegrating vectors between all variables. It also treats all variables as endogenous, avoiding thus the arbitrary choice of a dependent variable. Finally, it provides a unified frame for the estimation and testing of cointegration relations, in the framework of the vector error-correction model. The Johansen and Juselious estimation method presupposes the estimation of the following relationship:

$$\mathbf{\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots\ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + u_t}$$

where:

Y_t is a 6X1 vector containing the variables.
μ is the 6X1 vector of constant terms
Γi (i=1,2…p-1) is the 6X6 matrix of coefficients.
Π is the 6X6 matrix of coefficients
u_t is the 6X1 vector of the disturbance terms coefficients

Given the fact that in order to apply the Johansen technique a sufficient number of time lags is required, we have followed the relative procedure which is based on the calculation LR (Likelihood Ratio) test statistic (Sims 1980). The results showed that the value ρ=5 is the appropriate specification for the above relation-ship. Further on we determine the cointegration vectors of the model, under the condition that matrix Π has an order r < n (n=6). The procedure of calculating order r is related to the estimation of the characteristic roots (eigenvalues), which are the following:

$\widehat{\lambda}_1 = 0{,}23890$ $\widehat{\lambda}_2 = 0{,}16954$ $\widehat{\lambda}_3 = 0{,}07768$

$\widehat{\lambda}_4 = 0{,}06846$ $\widehat{\lambda}_5 = 0{,}04592$ $\widehat{\lambda}_6 = 0{,}01802$

The results that appear in Table 2 suggest that the number of statistically significant cointegration vectors is equal to four. The results are the following:

LPP=0,97592LPC – 0,26525LPM – 0,07142LPE + 0,66536LGNP – 0,18992LM1 (1)

LPP = -1,6244LPC + 0,31601LPM – 0,17125LPE + 2,7623LGNP + 0,38276LM1 (2)

LPP = 0,17777LPC + 1,4478LPM – 0,32272LPE – 1,3716LGNP + 0,20142LM1 (3)

LPP = -0,83291LPC - 0,2921LPM + 0,16281LPE + 0,97893LGNP – 0,4706LM1 (4)

Table 2. Johansen and Juselious Cointegration Tests
Variables LPP, LPM, LPC, LGNP, LPE, LM1

Eigenvalues			Critical Values	
Null	Alternative	Eigenvalue	95%	90%
r = 0	r = 1	60,8783	39,8300	36,8400
r = 1	r = 2	41,4276	33,6400	31,0200
r = 2	r = 3	28,0326	27,4200	24,9900
r = 3	r = 4	25,8146	21,1200	19,0200
r = 4	r = 5	10,4829	14,8800	12,9800
r = 5	r = 6	4,0550	8,0700	6,5000
Trace Statistic			Critical Values	
Null	Alternative	Eigenvalue	95%	90%
r = 0	r > 0	150,6911	95,8700	91,4000
r ≤ 1	r > 1	89,8128	70,4900	66,2300
r ≤ 2	r > 2	48,3852	48,1800	45,7000
r ≤ 3	r > 3	30,3526	31,5400	28,7800
r ≤ 4	r > 4	14,5380	17,8600	15,7500
r ≤ 5	r = 6	4,0550	8,0700	6,5000

According to the signs of the vector cointegration components and based on the basis of economic theory and the studies of Orden (1986), Robertson and Orden (1990), Moss (1992), Tabakis (2001), the relationship (4) can be used as an error correction mechanism in a VAR model.

The VAR model with an error-correction model

After determining that the logarithms of the model's variables are cointegrated, we must estimate a VAR model with an error correction model (EC). The error-correction model is based on the long-run cointegration relationship and has the following form:

$$\mathbf{DLX_t = \mu + \Gamma_1\, DLX_{t-1} + \Gamma_2\, DLX_{t-2} + \ldots\ldots + \Gamma_4\, DLX_{t-4} + A\, EC_{t-5} + u_t}$$

where:

DLX_t are the first logarithmic differences of all variables.

EC is the error correction term estimated from the long-term relationship.

Table 3 presents the estimations of error correction term for all variables. The negative sign of the coefficients of the EC term is consistent to the hypothesis that this term corrects the deviations from the long-run equilibrium relationship. Also, in Table 3 we can see the significance of the coefficients of error correction mechanisms for all variables.

Table 3. Estimation of Error Correction Model Coefficients

Endogenous Variables	Estimates of EC Coefficient terms	t-statistic	P-Value
DLPP	- 0,2417	3,7646	0,017
DLPM	- 0,1785	2,2865	0,038
DLPC	- 0,3571	1,4537	0,126
DLGNP	0,1107	2,9750	0,014
DLPE	- 0,0772	2,0324	0,049
DLM1	0,1755	1,2855	0,212

From Table 3 we can infer that the coefficients of the error correction mechanisms are statistically significant in the functions of the Price Production Indicator, Price Market Indicator, Gross National Product and Exchange rate Parity.

Granger causality tests

The model that was estimated in the previous section was used in order to examine the Granger causal relationships between the variables under examination. As a testing criterion the F statistic was used. With the F statistic the hypothesis of statistic significance of specific groups of explanatory variables was tested for each separate function. The results relating to the existence of Granger causal relationships between the variables: Price Production Indicator (PP) and Price Market Indicator appear in Table 4.

The results of Table 4 suggest the following for the changes in PP:

There is a bilateral causal relationship between PP and PM indicators.

There is a bilateral causal relationship between PP and PC indicators.

There is a unidirectional causal relationship between PP indicator and GNP, with direction from GNP to PP indicator.

There is a bilateral causal relationship between PP indicator and PE.

There is a unidirectional causal relationship between PP indicator and Money supply, with direction from PP indicator to Money supply

The results of table 4 suggest the following for the changes in PM:

There is a bilateral causal relationship between PM and PC indicators.

Table 4. Granger Causality Tests

Dependent variable	Hypothesis Tested	F1	F2
DLPP	DLPM there is a bilateral relationship (DLPP ⇔ DLPM)	127,2	198,6
	DLPC there is a bilateral relationship (DLPP ⇔ DLPC)	56,71	102,3
	DLGNP there is an unidirectional relationship (DLPP ⇐ DLGNP)	36,86	2,11
	DLPE there is a bilateral relationship (DLPP ⇔ DLPE)	44,12	86,07
	DLM1 there is an unidirectional relationship (DLPP ⇒ DLM1)	2,31	115,5
DLPM	DLPC there is a bilateral relationship (DLPM ⇔ DLPC)	46,23	83,26
	DLGNP there is an unidirectional relationship (DLPM ⇒ DLGNP)	1,96	66,34
	DLPE there is a bilateral relationship (DLPM ⇔ DLPE)	73,12	45,82
	DLM1 there is a bilateral relationship (DLPM ⇔ DLM1)	107,7	89,93

critical value: 3.09

There is a unidirectional causal relationship between PM indicator and GNP, with direction from PM to GNP.
There is a bilateral causal relationship between PM indicator and PE.
There is a bilateral causal relationship between PM indicator and Money supply.

Conclusions

In this paper we have tried to examine the short-run and long-run dynamic relationships between the prices in the agricultural sector and some variables of the macroeconomic environment. In the frameworks of empirical analysis we have applied the cointegration analysis, and then we have specified an error correction model. Finally, we have examined the existence of causal relationships of the variables in use. The cointegration analysis indicated that there is a long-run relationship between the examined variables, while using the error correction model we find deviations from the long-run equilibrium relationship. The results have shown the existence of significant bilateral causal relationships between variables of the macroeconomic environment and those that refer to the way of prices formation in the agricultural sector. These results further stress the fact that macroeconomic policy decisions are strongly reflected on the agricultural sector and thus they perform a very important role in any effort towards price stability in this sector. This ascertainment advocates that there is a close causal relationship between the macroeconomic policy and the agricultural sector. Therefore, it is essential that a new agricultural policy is traced in the EU; an agricultural policy that is coordinated with the macroeconomic policy and which will operate as a counterbalance to any undesirable effects caused by the macroeconomic policy to the agricultural sector.

Notes

1. The time series used in the empirical analysis come from the Eurostat and Main Economic Indicators database measured in constant 1995-year base. For the estimations and the necessary calculations the MICROFIT 4.0 econometric software package was used.
2. Instead of GNP the variable industrial production has been used, since there are no monthly data available for the EU GNP.

References

Akaike, H. (1973). Information Theory and an Extension of the Maximum Likelihood Principle, In: Petrov, B. and Csake, F. (eds) 2nd International Symposium on Information Theory. Budapest: Akademiai Kiado.

Daouli, J and Demoussis, M. P (1989). The Impact of Inflation on Prices Received and Paid by Greek Farmers. Journal of Agricultural Economy, 40(2): 232 – 239.

Dickey, D.A and Fuller, W.A (1979). Distributions of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association, 74, 427 – 431.

Dickey, D.A and Fuller, W.A (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. Econometrica, 49, 1057 – 1072.

Fischer, S. (1981). Relative Shocks, Relative Price Variability, and Inflation. Brooking Papers on Economy Activity 2: 381 – 431.

Grennes, T. and Lapp, J (1986). Neutrality of Inflation in the Agricultural Sector. Journal of International Money and Finance, 5: 231 – 243.

Groenewegen, J. (1986). Exchange Rates and the Canadian Grain Sector. Working Paper, 1/86. Agricultural Canada.

Han, D. B, Jansen, D. W, and Penson, J. B (1990). Variance of Agricultural Prices, Industrial Prices, and Money. American Journal of Agricultural Economics, 72: 1066 - 1073.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. Journal of Economic Dynamics and Control, 12: 231 – 254.

Johansen, S., and K. Juselius, (1990), Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money, Oxford Bulletin of Economics, 52: 162 - 210.

Johansen, S., and K. Juselius, (1992), Testing Strustural Hypotheses in a Multivariate Cointegration Analysis at the Purchasing Power Parity and the Uncovered Interest Parity for the UK, Journal of Econometrics, 53, 211 – 244.

Kost, W. (1976). Effects of an Exchange Rate Change on Agricultural Trade. Agricultural Economics Research, 28, 99 – 106.

Loizou, E., Mattas, K. and Pagoulatos, A. (1997) Macro-monetary effects on agricultural prices: the case of Greek agriculture. Applied Economic Letters, 4, 397-401.

Moss, B. C. (1992). The Cost – Price Squeeze in Agriculture: An Application of Cointegration. Review of Agricultural Economics, 14(2), 205 – 213.

Orden, D. (1986). A Critique of Exchange Rate Treatment in Agricultural Trade Models: Comment. American Journal of Agricultural Economics, 68, 990 – 993.

Robertson, J. C, and Orden, D. (1990). Monetary Impacts on Prices in the Short and Long Run: Some Evidence from New Zealand. American Journal of Agricultural Economics, 72, 160 – 171.

Saghaian, S., Reed, M., and Marchant, M., (2002). Monetary impacts and overshooting of agricultural prices in an open economy, American Journal of Agricultural Economics, 84(1), 90-103

Schuh, G. E (1974). The Exchange Rate and U.S. Agriculture. American Journal of Agricultural Economics, 56, 1 – 13.

Schwarz, R. (1978). Estimating the Dimension of a Model. Annuals of Statistics, 6, 461 – 464.

Sims, C. A. (1980). Macroeconomics and Reality. Econometrica, 48, 1 – 48.

Tabakis, N., (2001). A multivariate model for the relationship between agricultural prices and inflation uncertainty: evidence using Greek data, Agricultural Economics Review, 2(1), 28-38.

Tweeten, L. G. (1980). Macroeconomics in Crisis: Agriculture in an Underachieving Economy. American Journal of Agricultural Economics, 62, 853 – 865.

Zanias, G. P (1992). Farm Price Movements and the Adjustment Problem in Greek Agriculture. Oxford Agrarian Studies, 20, 63 – G.P

Zanias, G. P (1994). Inflation, Agricultural Prices and Economic Convergence in Greece. Under revision in the European. Review of Agricultural Economics.

Zanias, G, P, (1996), Macroeconomic Policy and Agriculture. State ans Agricultural Sector. 3rd Greek Conference of Agricultural Economy, page 21-33, Athens 1994, Papazisis.

Zanias, G, P, (1999), Seasonality and spatial integration in agricultural (product) markets, Agricultural Economics, 20, 253-262