ASSESSING THE PRICE RISK ON THE ROMANIAN AGRICULTURAL MARKET: ANALYSES AND IMPLICATIONS

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ABSTRACT

In any sector of activity, the uncertainty of price evolution poses challenges to producers, consumers, traders and investors, from private to national level. Moreover, the strategic importance of agricultural sector makes the issue of price volatility in this field an even more important matter both for private and governmental persons. Lately, the global economy struggled with profound turbulences and events that augmented the volatility context on the commodity markets in general and implicitly on those for agricultural ones. The substantial increase of volatility led to major debates regarding what has driven these developments and what new implications emerge from the price risk perspective. Romania, due to its sensitivity to external shocks, experienced in a severe manner the international commodity turmoil but it also has been affected by other factors that augmented the internal volatility and risk context. This paper intends to model and analyze the volatility of prices occurred in the recent years on the Romanian market for some agricultural crops. After calculating the econometric models and comparing the estimated conditional variance, the paper will aim at drawing some implications and recommendations from the perspective of price risk exposure.

JEL Classification: E30, E37, Q02.

Keywords: price volatility, price risk, agricultural commodity markets, Romanian market, conditional variance.

INTRODUCTION

Regardless of the sector of activity, the uncertainty of price evolution poses challenges to producers, consumers, traders and investors, from private to national level. More, the strategic importance of agricultural sector, from the view of food security in the context of global population growth trend, makes the issue of price volatility in this field an even more imperative matter. The commodity price volatility is definitely not a new concern, but it remains a permanently current one mainly in a present troubled economic environment. Price fluctuations tend to have sources that go beyond market fundamentals, adding to supply and demand shocks a large variety of factors, a list nearly impossible to conclude if all the links were to be considered. The recent global turbulences offered new perspectives in the analysis of volatility and instigated major debates regarding the factors driving these developments and the new implications emerged from the price risk standpoint. Romania, due to its sensitivity to external shocks, sensitivity caused by the processes it is traversing in the recent decades – post-communist transformations, globalization and European Union integration - experienced in a severe manner the international turmoil, being also affected by other factors that augmented the internal volatility context.

This paper models and analyzes the volatility of prices occurred in the recent years on the Romanian market for some agricultural crops and it draws some implications and recommendations from the perspective of price risk exposure. The rest of the paper is structured as follows. The second section depicts the agricultural commodities price volatility on international and domestic markets, presenting a literature review supported by empirical evidences. The third section illustrates the price volatility recently experienced by two of the traditionally cultivated cereals in Romania (wheat and maize) and compares it with the situation registered on the international market, using the GARCH models to express the conditional variances. Hence, this section offers a methodology description and an empirical illustration in which the econometric models are applied for the analysis of the price series of the aforementioned cereals. In accordance with the obtained results, we formulated some conclusions, implications and recommendations that finalize the paper.

THE PRICE VOLATILITY OF AGRICULTURAL COMMODITIES: LITERATURE RE-VIEW AND EMPIRICAL EVIDENCES

After the spike experienced during the food crisis of the 1970s, the agricultural prices on international market were characterized by a low and stable 25-year trend (Blein & Longo; 2009, 1). However, with the beginning of the new millennium, the prices started to increase, moderately in 2004-2005 and in a more accelerated manner between the end of 2007 and the middle of 2008. Between October 2006 and June 2008, commodity prices tripled for rice, and reached double levels for wheat and corn. Very soon, by the second semester of 2008, the prices for rice and wheat fell 55% and corn fell 64%. In January 2009 the prices restarted to increase slightly but consequent falls and raises followed. In August 2010, the prices rose sharply again, due to crop production shortfalls in key producing regions and resurging economic growth in developing and emerging economies. With a rebound in crop production, stocks have improved fairly and markets in 2012 appeared less turbulent. Yet, price volatility remains a concern, with weather-related yield variability and low stocks as the main threats. (OECD-FAO, 2008, 2009, 2010, 2011, 2012).

Agricultural prices are notoriously volatile on reasons explainable by the economic theory through price elasticities and the slopes of the supply and demand curves, both demand and supply being inelastic. However, the recent trends on the international commodity markets are regarded by analysts as structural changes which will create tensions and most likely increase the volatility of prices over the next decade (OECD-FAO; 2008, 26). To the instability of the recent years some factors contributed significantly (Blein & Longo; 2009, 1): the impacts of climate change on agriculture; demographic dynamics; degradation of land due to unsustainable agricultural practices; increased use of agricultural outputs for biofuels; negative long-term impacts of short-sighted agricultural public policies; the "financiarization" of commodity markets for portfolio diversification; etc.

With regard to domestic markets, a fundamental pre-condition for sustainable development and growth resides in the capacity of a country to grow or to buy food products at affordable prices (OECD-FAO; 2011, 53). Price volatility in domestic markets depends on the policy environment. Governments attempt to stabilize internal markets in order to protect producers and consumers and thus the instability is exported to international markets. This tendency acts as a vicious circle because as world markets become more volatile, governments seek to stabilize domestic

markets even more, thus augmenting the international instability. Furthermore, international price trends are transmitted to domestic markets depending on the relative shares of domestic demand satisfied by food imports (Blein & Longo; 2009, 4).

The results of analyses comparing price volatility on domestic and global markets for the previous decade generally show that the volatility of domestic prices is greater if compared to the volatility of international prices. The exception is the period 2004-2008, during which global price volatility is higher. This feature confirms the incomplete transmission of price moves and a partial disconnection of domestic price trends from international markets (Blein & Longo; 2009, 5). These results are confirmed also for the Romanian market, by empirical studies made recently by Rovinaru et al. (2012) for the food market.

OVERVIEW OF THE ROMANIAN CEREAL MARKET FROM THE PRICE VOLATILITY PERSPECTIVE

In order to analyze the Romanian agricultural price instability, we chose to model the price volatility of two of the cereals most cultivated here: wheat and maize. In Romania, more than 60% in total arable land is cultivated with cereals, from which almost 90% is cultivated with corn, sorghum and wheat, while the rest of around 10% is occupied by barley, oats and an insignificant area by rice (Ionel; 2005, 2).

1. METHODOLOGY

The necessity of an accurate measurement of price volatility comes especially from the high level of risk and uncertainty it causes to producers, consumers and policymakers worldwide. Numerous methods for estimating price volatility and price risk can be identified in the economic literature, from rather simple ones (like unconditional standard deviation or the coefficient of variation) to more complex ones (such as the ARCH model and its extensions). The methodology followed in this article is the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model introduced by Bollerslev (1986).

Numerous authors, as for example Jordaan et al. (2007), Figiel and Hamulczuk (2010), Pop and Ban (2011), Apergis and Rezitis (2011), argue in favor of GARCH models on the grounds that they have the merit of accounting for both the predictable and unpredictable components in the price process, being also capable of capturing various dynamic structures of conditional variance and of allowing simultaneous estimation of several parameters under examination. Studies using ARCH model and its extensions are commonly encountered in stock market price modeling. With regard to commodity prices, Jordaan et al. (2007) measured and compared the conditional volatilities for the prices of some crops traded on the SAFEX; Figiel and Hamulczuk (2010) tested for conditional volatility analyzing monthly wheat procurement prices in Poland; Apergis and Rezitis (2011) used GARCH and GARCH-X to examine food price volatility in Greece and the impact of macroeconomic factors, while Figiel et al. (2012) used weekly milling wheat price series for nine selected EU countries to evaluate volatility and to examine the sensitivity of the results to spatial aggregation of the price data. Regarding the Romanian market, Pop and Ban (2011) used EGARCH for modeling the price of wheat to estimate the volatility and the price risk on Romanian and international market.

In its general form, a GARCH(p,q) model includes two equations: one for the conditional mean (1) and the other for the conditional variance (2).

$$X_{t} = \mu + \varepsilon_{t}$$

$$\sigma_{t}^{2} = \omega + \sum_{i=1}^{p} \alpha_{i} \cdot \varepsilon_{t-i}^{2} + \sum_{j=1}^{q} \beta_{j} \cdot \sigma_{t-j}^{2}$$
(2)

The coefficients of ARCH-terms (α_i) reveal the volatility of previous periods of time, measured with the aid of squared residuals from the equation of mean, and the coefficients of GARCH-terms (β_j) show the persistence of passed shocks on the volatility. For the price series that we analyzed, we observed that the asymmetrical GARCH models perform better compared to the symmetrical ones. This conclusion is also consistent with the findings of Pop and Ban (2011). The extended asymmetrical model EGARCH also accounts for the leverage effect with the aid of the coefficient γ_i . Consequently, the AR(k)-EGARCH(p,q) model that we used, elaborated by Nelson (1991), has the following structure:

$$X_{t} = \pi_{0} + \sum_{i=1}^{k} \pi_{i} \cdot X_{t-i} + \varepsilon_{t}$$

$$\log\left(\sigma_{t}^{2}\right) = \omega + \sum_{i=1}^{p} \alpha_{i} \cdot \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}} - E\left(\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right)\right| + \sum_{i=1}^{r} \gamma_{i} \cdot \frac{\varepsilon_{t-i}}{\sigma_{t-i}} + \sum_{j=1}^{q} \beta_{j} \cdot \log\left(\sigma_{t-j}^{2}\right)$$

$$(4)$$

where the residuals from (3), \mathcal{E}_t , follow a GED or a normal distribution.

2. EMPIRICAL RESULTS

In our empirical investigation, we analyzed the evolution of price indices of wheat and maize for Romanian market, offered by the Romanian National Institute of Statistics (RNIS). In order to provide a comparison basis, we also used the price indices of wheat and maize at the international level, from the International Monetary Fund (IMF), Primary Commodity Prices Database. We used monthly data between January 2004 – December 2012, and we performed the analysis in *Eviews 7.1*.

A series of steps required by the statistical analysis of time series were initially implemented. We eliminated the seasonal component using the multiplicative moving average method. Further, we constructed and operated with the logarithmic price ratios $(\ln(P_t/P_{t-1}))$, due to their better statistical properties. The descriptive analysis of all the series revealed that volatility is not constant in time, indicating the presence of heteroscedasticity. In order to detect the serial autocorrelation, we analyzed the ACF and PACF estimated for a number of lags varying from 12, 24 to 36 considering the calculated Q-statistics. Table 1 presents some descriptive statistics, which show especially that the log returns of prices do not follow a Gaussian distribution.

Measure	LN_WHEAT_RO_SA	LN_MAIZE_RO_SA	LN_WHEAT_IN_SA	LN_MAIZE_IN_SA
Mean	4.437508	4.495097	4.924231	4.999089
Median	4.346633	4.555729	4.873747	4.965105
Maximum	5.140846	5.108145	5.559492	5.695129
Minimum	3.669657	3.746142	4.444229	4.375954
Std. Dev.	0.368787	0.388171	0.306913	0.397821
Skewness	0.033846	-0.468228	0.146556	0.103505
Kurtosis	2.201056	2.147711	1.777796	1.813530
Jarque-Bera	2.893019	7.215055	7.108640	6.527542
Probability	0.023539	0.027119	0.028601	0.038244

Table 1. Descriptive Statistics of Wheat and Maize Price Indices

Source: Authors' calculations in Eviews 7.1.

Then, we tested the non-stationarity of the time series, in order to not obtain spurious regressions. In Table 2 we showed the results of ADF test. As the calculated value of t-Statistic showed that the logarithmic series were not stationary, we constructed the first order differences which proved to be stationary. Table 2. Testing the Non-Stationarity of Wheat and Maize Price Indices

Level	t-Statistic	Prob.*	1 st difference	t-Statistic	Prob.*
LN_WHEAT_RO_SA	-0.340643	0.9140	DLN_WHEAT_RO_SA	-8.794297	0.0000
LN_MAIZE_RO_SA	-0.554752	0.8748	DLN_MAIZE_RO_SA	-9.933326	0.0000
LN_WHEAT_INT_SA	-0.593592	0.9470	DLN_WHEAT_INT_SA	-8.176446	0.0000
LN_MAIZE_INT_SA	-0.522317	0.8815	DLN_MAIZE_INT_SA	-8.466719	0.0000

Null Hypothesis: the series has a unit root

*MacKinnon (1996) one-sided p-values.

Source: Authors' calculations in Eviews 7.1.

Afterwards, we estimated the models for each variable. Equations were estimated using the maximum likelihood. Based on the information criterion minimization (especially Schwarz) and on the residual test, we chose the appropriate number of lags. Combined models ARIMA-EGARCH with a GED distribution were selected.

For the Romanian wheat prices, we considered the most appropriate model to be the following (the z-Statistics and the probabilities are given in parentheses):

$$d \ln wheat_{ko,r=} = 0.382 \cdot d \ln wheat_{ko,r=1} + 0.150 \cdot d \ln wheat_{ko,r=5} - 0.135 \cdot d \ln wheat_{ko,r=12} + \varepsilon_{r}$$
(5)

$$[3.85] [2.84] [-2.16] (0.000) (0.000) (0.000)$$

$$log \left(\sigma_{r}^{2}\right) = -5.101 + 1.016 \cdot \left|\frac{\varepsilon_{r=1}}{\sigma_{r=1}}\right| - 0.278 \frac{\varepsilon_{r=1}}{\sigma_{r=1}} - 3.907 \cdot log \left(\sigma_{r=1}^{2}\right)$$
(6)

$$[-2.54] [3.26] [-1.69] [5.08] (0.006)$$

For the Romanian maize prices, the appropriate model is: $d \ln maize \underset{Ro,r}{maize} = 1.369 \cdot d \ln maize \underset{Ro,r-1}{maize} + 2.5194 \cdot d \ln maize \underset{Ro,r-6}{maize} + \varepsilon,$ $[1.64] \qquad [60.56] \qquad (0.000)$ (7)

$$\log \left(\sigma_{t}^{2}\right) = -9.958 + 0.839 \cdot \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + 0.415 \cdot \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - 4.792 \cdot \log \left(\sigma_{t-1}^{2}\right)$$

$$\begin{bmatrix} -51.94 \end{bmatrix} \begin{bmatrix} 2.53 \end{bmatrix} \begin{bmatrix} 0.346 \end{bmatrix} \begin{bmatrix} -11.93 \end{bmatrix}$$

$$(0.000) \quad (0.001) \quad (0.07) \quad (0.000)$$
(8)

Based on the estimated equations, we generated the series of conditional volatility, in order to compare the instability for the two agricultural products. The results are given in Figure 1, both for the conditional volatility of wheat and maize. Moreover, we estimated the models for the international market in order to provide a comparison basis for the Romanian market. Figure 1. Wheat and Maize Price Volatility, Monthly Data from January 2004 – December 2012 (2004=100)



Source: Authors' calculations and illustrations in Eviews 7.1.

Examining the results obtained, there are some descriptions regarding the price volatility that we can make for the grain market in Romania. Both prices of wheat and maize experienced significant volatility in the last decade, but they experienced it in a different manner. The wheat market has been characterized by a lower but permanent volatility, combined with very acute spikes in moments of significant turmoil at international level (e.g. in 2008 in the midst of the economic crisis or in 2011 during the Euro Area turmoil). After 2007, these spikes appeared with a lag of two-three months after the international wheat market experienced a significant fluctuation. With regard to the maize, we noticed a permanent higher level of volatility, but the spikes do not reach such soaring levels. Also, the maize market volatility does not appear to be evidently connected to the international market one, not even after 2007 when Romania joined the EU. Consequently, for both markets we detected a mix of imported and domestic volatility, the imported volatility being more evident on the wheat market and the domestic turbulences on the maize market.

Analyzing the equations for the Romanian market, we observed that the current volatility depends more on passed shocks than on passed volatility. Thus, the current volatility context has its origins on the shocks and transformations Romanian market in general, and the agricultural sector in particular, experienced in the recent period. Six years after joining the EU, the Romanian agricultural sector is confronted with many difficulties whose effects are reflected on its performance and competitiveness. Romania has a significant agricultural potential, and in early 1930s it has been an main exporting country on the world cereals market. But following the past policies and restructuring of agriculture into a centralized sector, Romania lost its advantage and transformed in the 1990s from a net exporting into a net importing country.

Grain markets in Romania are in a state of transition. The basic reforms have been completed, state controls have been removed and international and domestic trade is unrestricted. Since 1990, this sector has experienced development fluctuations, owed to structural changes like privatization, restitution of land, and other external influences and transformations due to the processes of market liberalization and of alignment to the requirements of the European Community. The excessive fragmentation of land cumulated with inadequate funding, is obstructing the achievement of an adequate level of performance necessary to cope with the increasingly competitive pressures. Due to the structure of ownership, over 85% of the cultivated areas with cereals are concentrated in the private sector and a significant proportion is worked on small exploitations, which dispose of limited financial resources. In Romania, there is still a very strong felling of the individualism, keeping in memory the previous communist agricultural cooperatives for production, which did not offer anything for the farmers' work; thus, although aware of the benefits of cooperation, the farmers resent the idea of grouping (Ionel; 2005, 3). Small farmers do not have information regarding the prices of the future crops and they produce cereals as a rule, without having a firm contract with a potential buyer. Having reduced irrigation facilities, they are also highly exposed to weather risks and very few insure crops. Consequently, the grain market system is characterized by high risk for participants.

CONCLUSIONS AND IMPLICATIONS

Romania's current volatility context is a mixture between imported volatility, internal instability and lack of maturity of the market structures. As price volatility represents a very complex phenomenon that can be moderated only up to some extent by adjusting market structures and specifying regulatory and fiscal policies, Romania should concentrate on strengthening its internal potential of production in order to reduce the level of imported volatility, while also dealing with the problem through price risk management strategies – contractual, market-based, insurance schemes etc. The Romanian producers are adapting with high difficulty to a market environment characterized by a high volatility of prices, especially in the context of the recent economic and financial turmoil. Investments in this sector – through the absorption of EU and state funds, banking products and other alternatives that the market economy offers – could contribute to increased productivity, better internal results and, in time, lower import levels. To encourage investment in agriculture, the full set of technical, economic, institutional, environmental and marketing risks that actors in this sector face, must be addressed simultaneously.

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