AGRICULTURAL PRICE VOLATILITY – EFFECTS ON FOOD SECURITY

CECILIA ALEXANDRI[1]

[1] ***Institute of Agricultural Economics, Bucuresti, Romania, e-mail: cecilia@eadr.ro***

Abstract: *The paper presents the causes of agricultural price volatility and the volatility effects on food security. In this context, it builds upon the idea that agricultural price volatility differently influences the consumers and the farmers, at the same time affecting the population's food security, limiting the access to food mainly for the poor population. The second part of the paper evaluates the agricultural price volatility in Romania, using the monthly price series in the period 2006-2014, from the National Institute of Statistics. The obtained results reveal that throughout the investigated period, the agricultural prices had higher volatility in sunflower, potatoes, soybean and wheat, among the crop products, and in eggs and mutton as animal products. At the same time, consumer prices were more stable excepting vegetables and fruit.*

Key words*: agricultural price volatility, food security, Romania*

INTRODUCTION

Price volatility appears when prices fluctuate. This process can take place on short term (on a daily, weekly or monthly basis), while the evolution of prices can be rather stable on the long term. Yet the most dangerous are the unexpected evolutions, for instance sharp price increases for several months, which can induce crises and can affect the food security indicators.

Volatility is defined by the changes in intensity and frequency of the agricultural commodity prices, around the average level [4]. Price volatility is different within the markets from the agri-food chain and at the same time it is not high on all the markets. There are markets where the supply and demand are stable from one year to another, although both the demand elasticity and the supply elasticity may be high. Price fluctuations appear when there are instability conditions at the level of demand or supply. For most agricultural commodities there are fluctuations related to seasonality, leading to significant price increases on short term, and then prices decrease to pre-crisis level. The supply variation effects are amplified by the inelasticity of demand for agricultural products. When the demand elasticity is low, the equilibrium point on the market is reached through significant price adjustments, as on short term the modification of the transacted volume can take place only to an insufficient extent. Agricultural price volatility can be amplified by the speculators' activity, who anticipate the prices on the futures markets and through the stock mechanism [2].

Volatility affects the population's food security, limiting the access to food, mainly for the poor population. Price volatility impacts household incomes and the purchasing power. It may result in the population from the vulnerable categories acquire the undernourished status and adversely impacts household welfare.

The linkage between price volatility and food security is the subject of many papers. Thus, [1] investigates the implications of the agricultural price increase and of their volatility on the food and nutrition security indicators. Practically these influence the population's access to food. There is also a subjective perception, as in the face of high price volatility conditions, the population feels more vulnerable, although the population segment affected by food insecurity decreased worldwide. At the same time, the increase of food prices is stronger in the poor countries, where the share of food consumption expenditures in total consumption expenditures is high. According to the above-mentioned

study, the food prices in the countries with average incomes under 2000 USD/capita at the purchasing power parity is almost double than that in the countries with incomes of over 10000 USD/capita. At the same time, it was estimated that the food price crisis from 2006-2007 resulted in 105 million people under the poverty threshold of one dollar per day [1]. According to FAO estimates, the people with a food intake less than 1810 calories/day are considered to be in the food insecurity situation. Out of this reason, there is an opinion that the FAO indicators on food security would not be relevant in a high volatility situation.

The volatility/poverty relationship indicates that high price volatility determines the shift of the population under the poverty threshold at a faster rate. At the same time, the people's perception that they are affected by food insecurity increases when prices are unstable, although in reality, according to statistics, the number of people under food insecurity incidence decreases with the economic development.

In the recent years, increasingly numerous experts have brought to the core of debates the importance of agricultural markets stability and of food and agricultural price volatility for the population's food security. The agricultural process has featured higher volatility in the latest years, with a complex effect on food consumption. The high prices are not good as they significantly affect the purchasing power of households and their food security implicitly; the low prices are not good either, as they affect the poor farmers' incomes, mainly in the case of those farmers who buy more food products than they produce and sell on the market [3]. In fact the volatility affects both consumers and farmers. When food prices fluctuate, even though these variations are not very high and are even tolerable for most social categories, the shocks experienced by the poor consumers and small farmers on the short term may be very harmful, as they affect the economic situation of certain extremely vulnerable social categories, which can be trapped into poverty at any moment. The price instability for the basic foodstuffs has much deeper effects than the price instability for other agricultural raw products. Among the basic agricultural products, we mention rice, wheat, maize and potatoes. These products are important both for the poor consumers, as they represent quite a high share in their food budget and for farmers, as farmers mainly grow these crops on their small land areas. Price instability deeply affects the low-income countries, as the farming sector resilience to crises is lower, the support possibilities from the state are more limited, and the technical advance investments in the sector are much lower and even absent. At the same time, food price instability has a deeper influence upon poor consumers, and the effects of food scarcities upon certain vulnerable categories (children, for instance) can be mostly serious, affecting their physical and mental development.

MATERIALS AND METHODS

Volatility is investigated using the time series of agricultural prices. In the statistical literature on the economic analysis of time series, the changes produced in the time series are classified into trends, cyclical, seasonal and irregular changes. Hence, according to [2], we have:

- a trend that describes the long-term movements of the series averages;
- seasonality effects described as cyclical fluctuations throughout a year;
- cycles that contain other cyclical fluctuations that are not linked to the annual evolutions;
- irregular, residual variations, generated by random or systematic causes.

The simplest measure to measure price volatility is the standard deviation and the variation coefficient (VC). This represents the standard deviation of prices, in a time interval, divided by the price average in the same time interval. This indicator makes it

possible to compare the volatility in different countries in a certain time interval. However, the variation coefficient utilization may distort the results, in the case when there are strong trends in the data series, as these will be included in the calculation of volatility. There are no accepted methods for the removal of trend influence. As alternatives, the economists often use the standard deviation of price change logarithm.

Agricultural and food price volatility in Romania: For the investigation of price volatility, the nominal price index series, monthly time series, with fixed base, 2005=100, from the period 2006 – 2014 were analyzed.

The following were analyzed:

a) Monthly agricultural price series, for the crop and livestock agricultural products.
b) Monthly consumer price series, for the main groups of food products.

The following formula was used for the calculation of volatility:

Vol = Var (log (p_t/p_{t-1}))^0.5

The main objectives for this study are to assess the volatility of agricultural prices on the Romanian agricultural markets, as well as the transmission of this phenomenon to the final consumer. This approach attempts to address the question to what extent the volatility and the instability of agricultural markets affect farmers, consumers and their incomes.

RESEARCH RESULTS

a) Agricultural prices

Agricultural price volatility was strongly influenced by the component represented by the prices of crop products. In the investigated period, these experienced three moments of significant growth, namely the period 2006-2008, when prices increased more than twice, the period 2010-2011, when these increased more than 2.5 times and the period 2012-2013, when these prices increased more than 3 times (more exactly in May 2013), compared to their levels in 2005. All these excessive price increases were the result of extreme weather conditions, i.e. the drought in the south and south-eastern part of Romania, which is the main area for the production of cereals and oil crops.

Among the crop products, the highest price increases were found in maize, wheat, soybean, potatoes, sunflower, and onions. Practically, the prices of cereals, oil crops and vegetables were highly volatile mainly in the last 5 years, in the context of a general increasing trend of prices for these products (Table 1).

The animal products experienced a much milder price increase, with the geometric mean of price increase throughout the entire period of 33.5% as against 77.4% (the geometric mean of crop products). At the same time, for certain products such as beef, mutton and poultry meat, in certain periods of several months, prices were down under the reference level of the year 2005 (Table 1).

Among the animal products, poultry meat and pork had the lowest average increase, i.e. 4.2% and 12.2% respectively, in the period 2006-2014, as against 2005, while milk and honey had the highest average increase, i.e. 53.4% and 40.7% respectively.

The empirical analysis of the monthly price index series presented in Table 1 indicates extremely large monthly variations for the crop products in particular; yet the products whose price variations affect the consumers' food security are mainly the staple foodstuffs, i.e. cereals and potatoes. The cereals also affect consumers through the chain of animal products, as they (mainly maize) have a significant share in the composition of animal feed and hence may induce price increases and volatility in animal products. But cereals are only a part of the feed used for animals. The feed prices used in our country

largely depend on the prices of protein feed, based on soybeans, which are generally imported.

Table 1

Statistical indicators of the monthly agricultural price indices series, 2006-2014

Number of observations =108, 2005=100%

	Minimum value	**Maximum value**	**Geometric mean 2006-2014**
Agric. products	**105.8**	**254.8**	**160.5**
Crop products	**108.5**	**314.5**	**177.4**
Wheat	81.3	311.0	180.3
Barley and two-row barley	81.1	286.1	189.2
Maize	93.4	340.4	217.3
Beans	106.4	315.5	188.7
Sunflower	76.2	296.3	160.3
Soybeans	82.7	405.9	186.8
Potatoes	61.9	317.4	156.7
Dry onion	117.6	264.6	180.5
Carrots	101.0	227.8	156.6
Animal products	**89.2**	**173.4**	**133.5**
Beef	69.8	168.8	127.7
Pork	76.0	146.9	112.2
Mutton	41.1	261.1	120.0
Poultry meat	83.8	152.0	104.2
Eggs for human consumption	66.0	228.3	136.7
Cow milk	98.3	197.4	153.4
Bee honey	97.0	217.6	140.7

Source: author's calculations based on the information from the Statistical Bulletins of Prices, 2006-2014. NIS.

The volatility coefficients of the farm gate agricultural prices, as presented in Table 2, were calculated for three periods, which include the excessively dry years that induced volatility, namely the year 2007 from the period 2006-2008, the year 2010 from the period 2009-2011 and the year 2012 from the period 2012-2014. In this context, we can notice that one year in a 3-4 year period is droughty; this should be taken into consideration when making decisions on investments in the irrigation systems at the level of the great agricultural areas of the country. The obtained results indicate that the period with the most volatile prices was the recent period 2012-2014, under the background of the drought in the year 2012 (Table 2). We can notice again that the crop products have a much higher price volatility compared to the animal products, for all the investigated periods. For the period 2012-2014, the price volatility for the crop products was 10.87 as against 2.46 for the animal products.

The volatility differences between the two categories of products derive from the different characteristics of the production processes. Crop production includes certain natural factors among the production factors, which cannot be controlled, such as temperature and rainfall, which result in significant fluctuations of yields and harvests. The low level of cropping technologies used on most Romanian farms, i.e. lack of quality seeds, of fertilizers or herbicides amplify the harmful effects of weather excesses. Such

weather excesses can be noticed in all the countries from our geographical area, but the agricultural production has the highest volatility in Romania, as against the volatility of other countries like Poland or Hungary.

Among the crop products, the highest volatilities were noticed in sunflower, soybeans, potatoes, wheat and maize in the period 2006-2014.

Table 2

Agricultural price volatility in Romania (%)

	Period			
	2006-2008	2009-2011	2012-2014	2006-2014
Agric. products	**5.17**	**6.06**	**7.60**	**6.27**
Crop products	**9.60**	**8.67**	**10.87**	**9.62**
Wheat	10.60	7.47	5.52	7.99
Barley and two-row barley	9.43	7.12	5.32	7.44
Maize	6.69	8.94	5.41	7.13
Beans	2.58	0.99	2.64	2.25
Sunflower	11.98	7.94	13.19	11.12
Soybeans	12.68	13.82	11.79	12.62
Potatoes	25.46	12.00	10.08	16.96
Dry onion	6.24	7.29	5.77	6.37
Carrots	10.42	8.57	8.66	9.13
Animal products	**3.85**	**2.62**	**2.46**	**2.99**
Beef	8.59	4.27	3.37	5.75
Pork	4.32	3.27	3.14	3.57
Mutton	22.56	22.37	13.84	19.72
Poultry meat	9.51	10.61	7.60	9.20
Eggs for human consumption	11.61	9.46	9.86	10.19
Cow milk	2.96	2.27	1.36	2.27
Bee honey	2.19	1.25	1.13	1.58

Source: author's calculations based on the information from the Statistical Bulletins of Prices, 2006-2014. NIS.

The animal products feature much lower volatility, due to a more controlled production process, with much more predictable results at the level of yields, where the production level can be relatively easy planned in time. However, here too we have two products with higher volatility, due to the strong production seasonality. This is the case of eggs for human consumption (10.19 volatility) and mutton (9.20), in the period 2006-2014.

b) Consumer prices

Consumer prices have a much more attenuated growth compared to agricultural prices. However, for certain groups of products, where the agricultural production has a seasonal character, and the products have a low processing level, such as the fruit and vegetables, the agricultural price variability is almost fully transferred to the final consumer.

In Table 3 we can see that the products with the widest range of final consumer price variation are also the crop products, i.e. vegetables, fruits, cereal-based products, as these products have a low processing level or contain a raw crop product as raw material, the price of which has increased variability. The group milk, cheese and eggs also appear

to have high price variability; this can be the effect of high variability and seasonality of egg production on the farm.

Table 3

Statistical indicators of the monthly consumer price index series, 2006-2014

Number of observations =108, 2005=100%

	Minimum value	**Maximum value**	**Geometric mean 2006-2010**
Total consumer goods	**105.0**	**155.4**	**132.2**
Foodstuffs	**101.8**	**145.2**	**124.7**
Milling and baking products	100.1	142.2	124.8
Meat and preparations	100.0	128.7	114.3
Fish and canned fish	101.9	126.7	114.2
Milk, cheese and eggs	99.7	154.0	130.8
Fruit	99.6	160.8	124.7
Vegetables, potatoes and other edible roots included	93.2	187.9	132.6

Source: author's calculations based on the information from the Statistical Bulletins of Prices, 2006-2014. NIS.

The volatility coefficients calculated for the final consumer prices reveal a much lower variability, compared to that of agricultural prices (Table 4). At the same time, it can be noticed that out of the three investigated periods, the period with the most volatile final consumer prices is also the most recent period, i.e. 2012-2014, and in the groups of products, the fruit and vegetables stand out. At the same time, we can notice the extremely low price volatility for Meat and meat preparations. Another group with relatively low price volatility is Milling and baking products, i.e. 1.09% for the period 2006-2014, compared to the high farm gate price volatility for cereals (7.99%, for the same period). This is on one hand the effect of price fluctuation attenuation that takes place as the product goes through the chain to the final consumer. Furthermore, a food product also includes other inputs besides the agricultural raw material, and the extent to which the price of the latter influences the final food price depends on its share in the cost of the product. At the same time, the processors from the milling and baking chain generally stock the products in their silos, so as to avoid the excessive prices in the period March-June each year. On the other hand, bread is a stable food in the population's diet and its price is a benchmark for the food security of the poor categories of population in particular. Out of this reason, the bread price variations are under the focus of social players and authorities, and in the recent years the bread price has even decreased under the effect of VAT diminution and consumption decrease.

Table 4

Consumer price volatility in Romania (%)

	Period			
	2006-2008	2009-2011	2012-2014	2006-2014
Foodstuffs	0.76	0.92	0.97	0.89
Milling and baking products	0.69	0.52	1.59	1.09
Meat and meat preparations	0.43	0.36	0.45	0.41
Fish and canned fish	0.17	0.21	0.17	0.19
Milk, cheese and eggs	1.73	0.80	1.28	1.32
Fruit	2.72	3.28	3.18	3.05
Vegetables, potatoes and other edible roots included	3.44	5.32	5.27	4.73

Source: author's calculations based on the information from the Statistical Bulletins of Prices, 2006-2014. NIS.

The stability of consumer prices, mainly in the case of staple foods, represents an important element in the marketing strategy of the great retailers, as these know very well that consumers are sensitive to the too frequent price increases. That is why they do not lower the prices (or they lower the prices less) when the agricultural prices collapse, keeping profit margins that they use when the agricultural prices practically explode, maintaining a relative stability of prices at the level of consumers. In any case, the agricultural markets, mainly the markets for crop products, due to the inelastic supply, amplify the transmission of scarcity of products in the prices of these products. This phenomenon was known for a longer time (so-called King effect), but the intensity of weather variations has greatly vulnerabilized the stability of agricultural supply and prices in the recent years, both at world and European level. That is why, under the current Common Agricultural Policy, mechanisms were envisaged for risk insurance, as a result of climate change, for the stabilization of markets and ensuring food security for the population in terms of supply availability and access to food.

CONCLUSIONS

- ***The agricultural prices are volatile***. In the last years, the agricultural prices experienced several price increase cycles and then price decrease cycles. The strong volatility began in the years 2006-2008 and grew in the next years. The calculations made led us to the conclusion that 2012-2014 was the period with most volatile agricultural prices in Romania.
- ***There are numerous causes that produce volatility:*** low elasticity of agricultural supply on short term, low level of investments in agriculture, use of certain agricultural products for non-food purposes, for bio-fuel production, low level of stocks of products, energy and oil prices, exchange rate, etc.
- As regards the price series volatility, the results indicate that the prices on the agri-food chains have a higher volatility in the primary stage of chains (agriculture), while in the processing and consumer stage this volatility is attenuated. For instance, in the entire investigated period 2006-2014, in Romania, the agricultural price volatility was 6.27%, while the consumer food price volatility only 0.89%.
- ***The prices of crop products are much more volatile compared to the prices of animal products.*** This because the crop production includes certain natural factors among the production factors, which cannot be controlled, out of which the most important are

temperature and rainfall, which produce significant fluctuations of yields and obtained harvests.

- ***In the investigated agricultural products,*** in the period 2006-2014, ***the most volatile prices were found*** in sunflower (11.12%), soybeans (12.62%), potatoes (16.96%), mutton (19.72%), eggs for consumption (10.19%) and poultry meat (9.20%).
- ***In the food products,*** in the period 2006-2014, the products with the most volatile prices were the vegetables (4.75%) and fruits (3.05%)

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