EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR AGRICULTURE AND RURAL DEVELOPMENT

Directorate L. Economic analysis, perspectives and evaluations
L.5. Agricultural trade policy analysis

16/07/2009

HISTORICAL PRICE VOLATILITY

1. INTRODUCTION

Prices of agricultural commodities and "volatility" have been in the spotlight since agricultural commodity prices reached their peaks of in late 2007 and early 2008. The problem of price volatility is not new. The issue of how to address the discontinuity of supply in the face of continued demand has been debated for ages. In addition, today's discussion of volatility overlaps with a discussion of greater uncertainty in a rapidly changing economic and natural environment. This paper intends to look at past price volatility of some commodities in order to detect whether volatility has been increasing over time. By comparing price volatility to other economic variables (oil price, stocks, volume of trade in futures markets), this paper also allows one to see whether certain relations can be observed over a given time period. The overall intention is therefore to understand historical price volatility. As to the future, it is clear that much will depend on how variable the determinants of price volatility will be, a question to which there is no definitive answer although medium-term projections may provide an indication of possible trends.

After describing the theoretical aspects of volatility, this paper looks at whether volatility in agricultural commodity markets has increased or not. The final part summarises implications and policy considerations, and draws some conclusions on future prospects.

2. THEORETICAL ASPECTS OF VOLATILITY

Volatility provides a measure of the possible variation or movement in a particular economic variable. Wide price movements over a short period of time typify the term "high volatility". While volatility has been discussed extensively recently, it is not unusual for prices to change as market clearing conditions require supply to be matched with demand. Lack of predictability and uncertainty associated with increased volatility may influence both producers and consumers. High fluctuations in prices may limit the ability of consumers (processors) to secure supplies and control input costs. In macroeconomic terms, while price hikes are beneficial for net exporting countries that benefit from improved balance of payments, they increase the import bill of net importing countries.

Two measures of volatility are used:

1. Historical (realised) volatility, based on observed (realised) movements of price over an historical period. Historical volatility tells us how volatile an asset has been in the past. It represents past price movements and reflects the resolution of supply and demand factors.

2. Implicit volatility[1], Implicit volatility is the markets' view on how volatile an asset will be in the future. It represents the market's expectation of how much the price of a commodity is likely to move and tends to be more responsive to current market conditions.

This paper uses historical volatility and does not refer to implicit volatility.

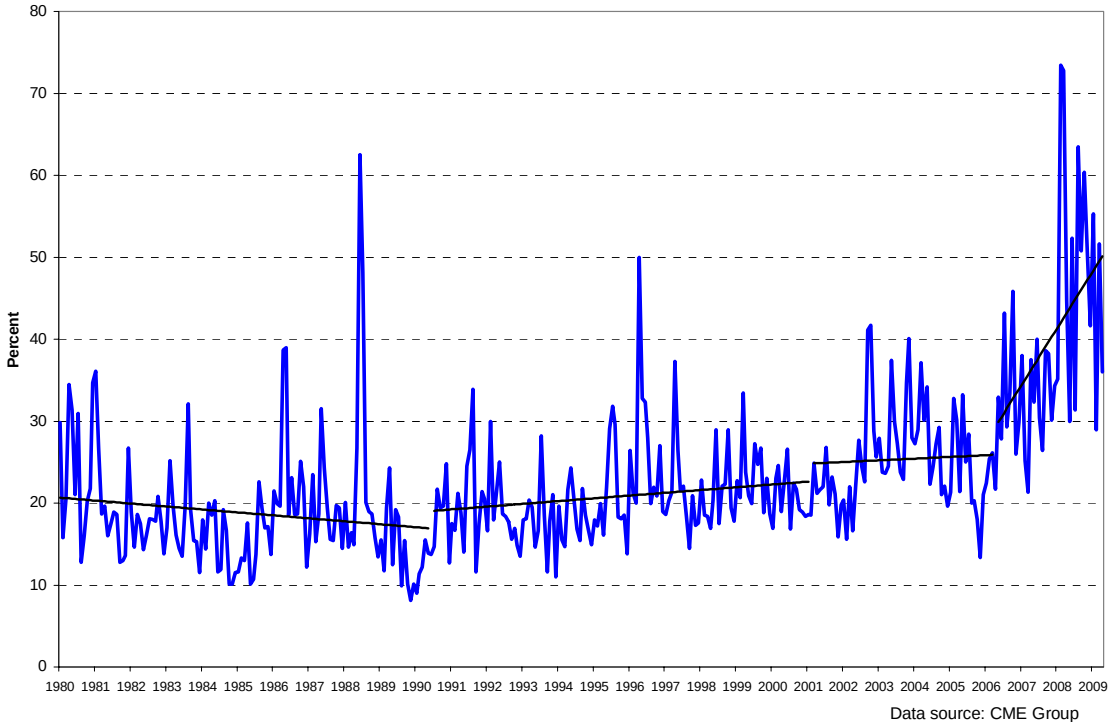
3. ANALYSIS : IS THERE MORE VOLATILITY NOW

Weekly and monthly data are used for monitoring prices on commodity markets. Although they reflect trends in price developments, they also hide more serious volatility issues by averaging daily data. Calculations of meaningful price volatility measures call for daily data which are often not readily available for some commodities. We looked at wheat, maize, rice, oats, soybeans, soybean meal, and soybean oil on the CBOT, and milling wheat and rapeseed on MATIF.

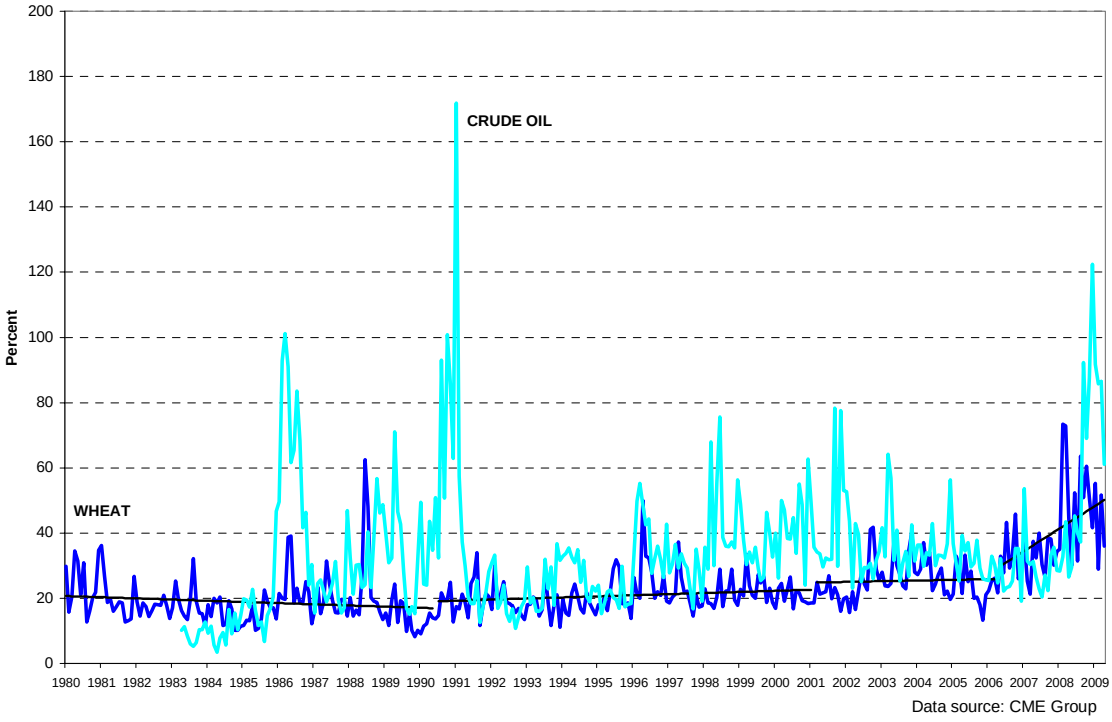
Graph 1 shows historical volatility of **wheat** on **CBOT** on a monthly basis. Volatility of crude oil is added on graph 2. It clearly appears that wheat volatility has had an increasing trend over the observed period, ranging between 30% and 73%. By observing the evolution since 1980, one can divide data into 4 distinct intervals. During the first decade (1980 – 1990) volatility was decreasing while during the second decade it had an increasing trend. Between 2001 and 2006 the trend in wheat volatility was relatively stable although at a level that was higher than in the past. Since May 2006 a linear trend line is showing dramatic increases.

[1] This is calculated from the Black-Scholes formula for the price of a European call option on a stock.

Graph 1 US Wheat, Historical Volatility, Monthly annualised



Graph 2 US Wheat and Crude Oil, Historical Volatility, Monthly annualised

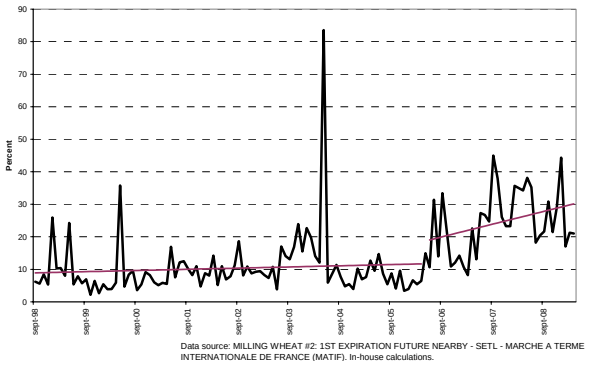


Volatility can also fluctuate in any given period. In case of wheat two peaks can be observed before the period of price hikes of 2007 – 2008. The first one occurred in June 1988 when historical volatility reached 62.5%, the second one in April 1996 when it

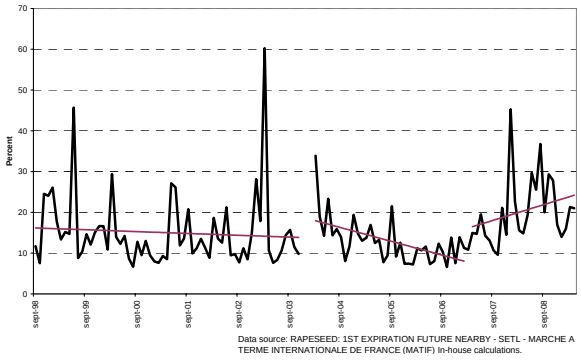
reached 50%. In 1988 and 1996, prices soared due to a shortfall in production. Another additional reason for the peak in spring 1996 may have been speculation on futures contracts that took place in Chicago resulting in wheat price spike. Analyses of other commodities share similarities with the trends observed in wheat volatility. Although increased volatility can occur in any given period, actual peaks differ on the basis of the commodity and developments of their fundamentals.

Commodities traded on European exchanges, although smaller in terms of volume, were not shielded from increased volatility. Graphs 3 and 4 show the development of historical volatility for milling wheat and rapeseed on MATIF.

Graph 3: Wheat – MATIF



Graph 4: Rapeseed - MATIF

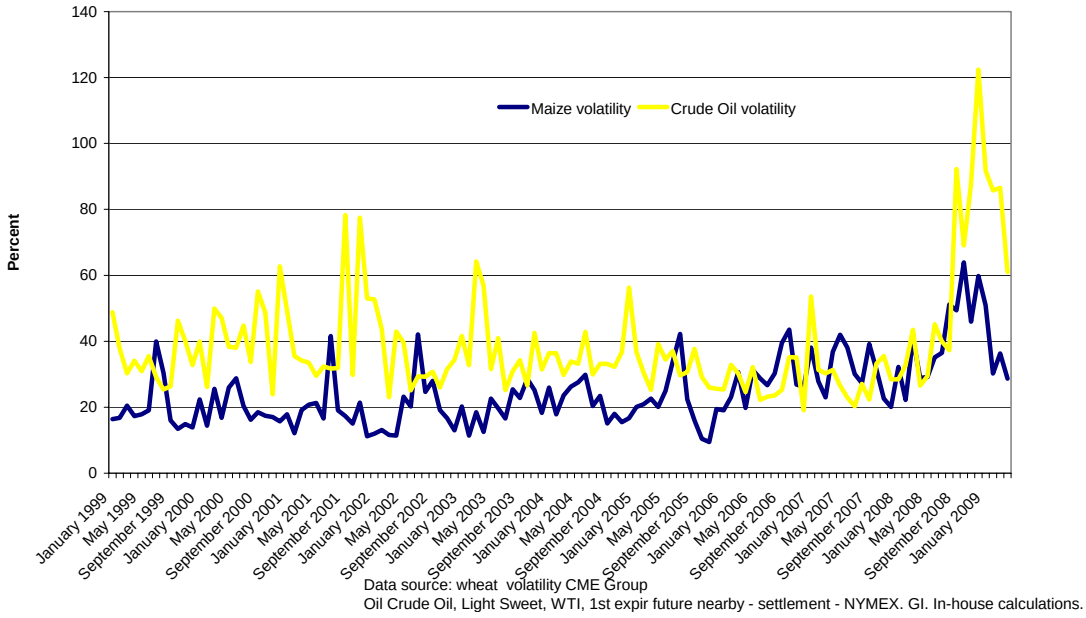


Ignoring the peak of May 2004, MATIF wheat experienced the highest volatility in September 2007 and January 2009 when it reached around 44%. However, in between those peaks, the volatility was as low as 18%, and reached 21 % in April 2009. The yearly average was at its highest in 2008, although so far in 2009 it is decreasing. Although experiencing peaks, wheat volatility on MATIF was relatively stable between 1998 and mid-2006 when it started increasing. The MATIF rapeseed contract dates back only to November 1998 and thus the data might not be sufficient to conclude whether or not volatility increased. However, results indicate that in 2008 volatility stayed above 30% longer than in the past. Trend lines fitted to subsets of data show varying patterns although after 2007 we observe an increasing slope.

3.1 Crude oil volatility and agricultural commodity volatility

Due to increasing and tightening linkages between crude oil and agricultural commodities, it is interesting to look at the relationship between crude oil volatility and commodity volatility. With maize being used as the main ethanol feedstocks, it has been shown that oil prices contributed to increases in maize prices, and that biofuels feedstocks and crude oil prices were correlated. In addition, biofuels use is being driven by government blending mandates which are said to contribute to price stabilisation of feedstocks in a form of guaranteed demand. While the analysis presented in this note does not allow an exploration of the impact of all factors contributing to the relationship between maize and crude oil prices and detect causality, volatility of both graphed on graph 5 has been following similar paths since May 2006.

Graph 5 US Maize and Crude Oil Historical Volatility, monthly annualised



Data source: wheat volatility CME Group
Oil Crude Oil, Light Sweet, WTI, 1st expir future nearby - settlement - NYMEX. GI. In-house calculations.

3.2 Prices, volatility, and stocks

An often cited reason for increased volatility is lack (or lower levels) of physical stocks resulting in limited buffering capacity should increasing demand or short term supply challenges occur. Although data on stocks are considered rather unreliable, stocks serve as a proxy for balance between supply, demand, and trade. Since there is no single answer to the question of "what normal stocks are", we only compare current level of stocks to their historical levels. The analysis ignore many other factors that influence earlier mentioned parameters. The prices in nominal terms are international reference prices.

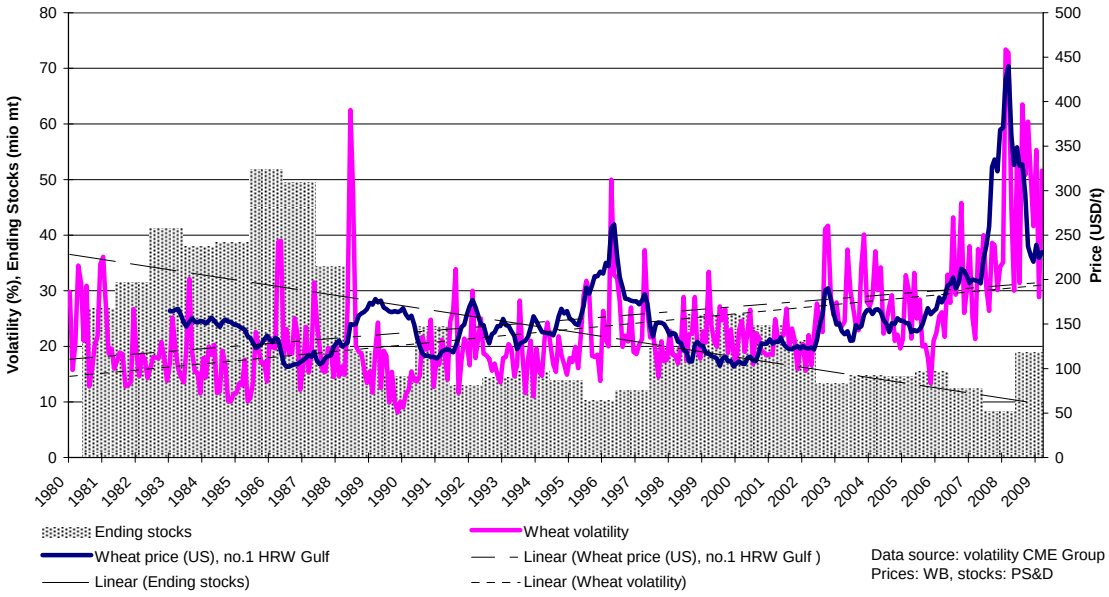
Although some of the CBOT contracts are said to be used as "world" contracts, we did not find a straightforward relationship between the volatility on the CBOT and levels of world stocks. When looking at the relationship between CBOT volatility and the levels of US stocks, it appeared that in some commodities, notably maize and soyabeans, peaks in volatility often coincide with lower stocks, although long-term trends do not show an inverse relation between the two.

Wheat volatility, US ending stocks and price (wheat, US, No.1 HRW Golf) are shown on graph 6.

The trends in relationships between volatility, stocks, and prices are as expected. Trend lines for volatility and price are moving together, although at times the relationship between prices and volatility (higher prices are accompanied by higher volatility) does not hold when looking at monthly data.

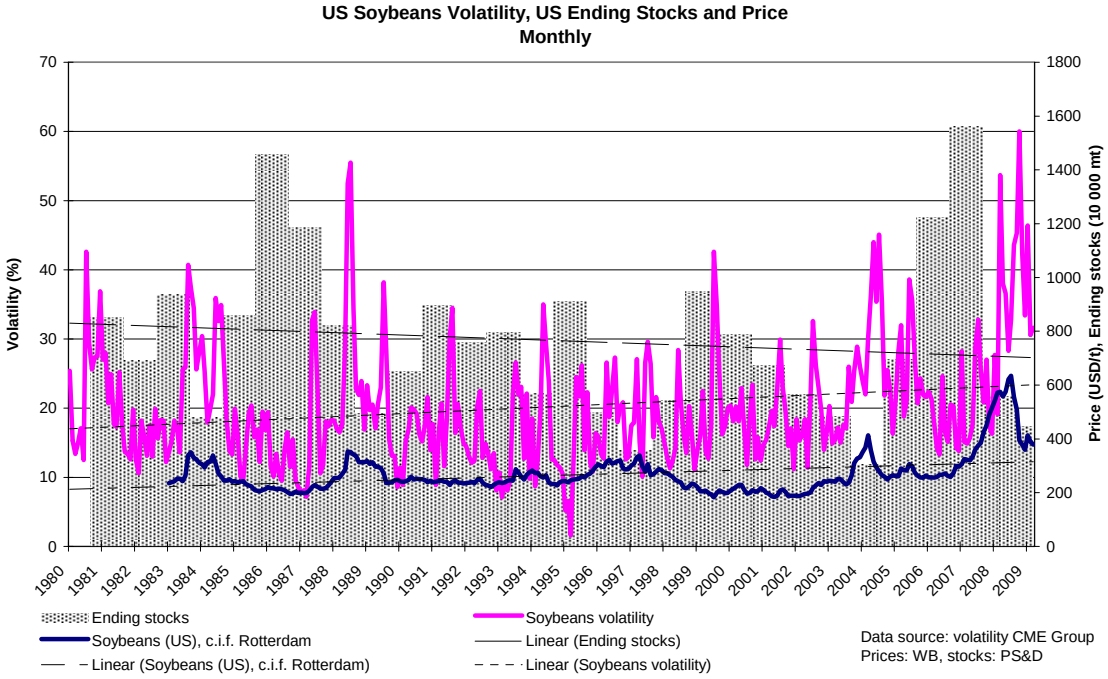
Price peaks seem to coincide with volatility peaks which in turn appear more likely to occur at periods of lower stock levels, such as in May 1996, October 2002 or March 2008. One can also observe an inverse relationship between stocks and volatility, as well as stocks and prices.

Graph 6 US Wheat Volatility, US Ending Stocks and Price Monthly



For **soybeans** (graph 7) we observe an inverse relationship between US ending stocks and volatility. Similar observations can be made for stocks and prices. Although the price used does not correspond to the US market, we note an expected negative trend. Interestingly, although as already mentioned, graph 7 uses Rotterdam price and CBOT volatility, the trend lines of both are moving in parallel, suggesting that increased volatility accompanied higher prices.

Graph 7



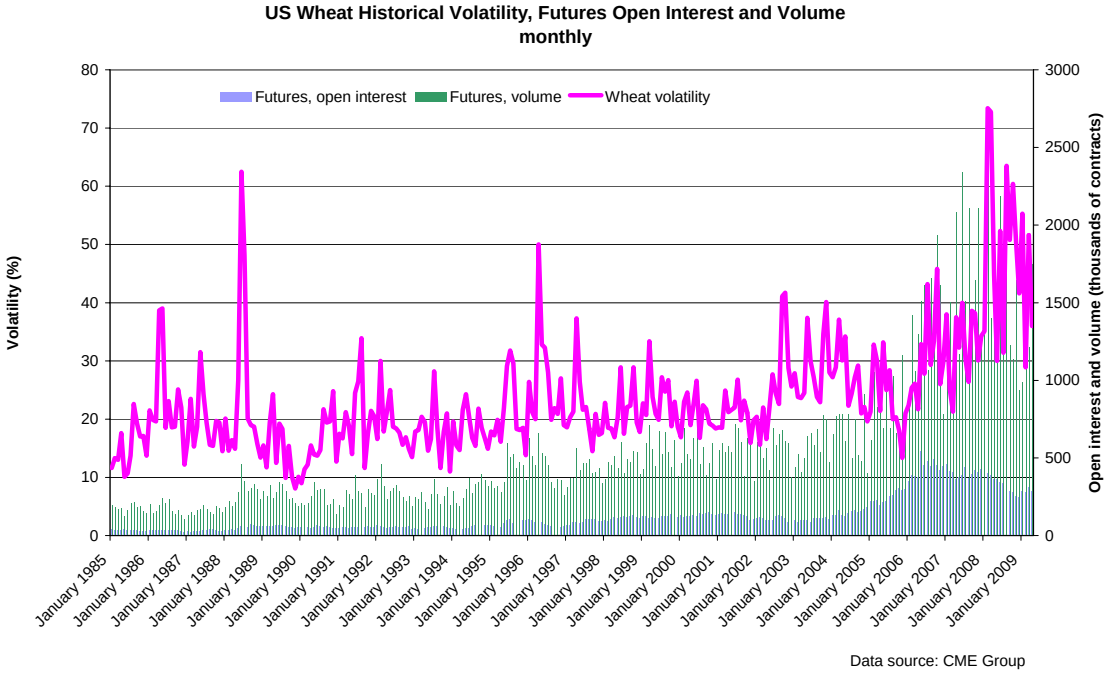
3.3 Volatility and futures market

Graph 8 shows US wheat volatility against **futures open interest and volume** on the CBOT starting from 1985. It appears that increases in open interest starting in July 2005 coincide with increases in volatility on average. It seems that changes in volatility became sharper and changed more dramatically on a month-to-month basis. Similarly, the fall in open interests and volume in the second half of 2008 coexists with a decline in volatility.

The Commission working paper[2] attached to the Commission communication on food prices in Europe did not explore volatility directly but analysed whether there is a speculative bubble in commodity markets. The document did not find evidence for or against a speculative bubble but concluded that the most likely explanation of price increases since the beginning of 2007 to mid-2008 seems to be a combination of economic fundamentals and factors specific to the financial markets, which might have amplified price changes.

[2] SEC(2008) 2971: Is there a speculative bubble in commodity markets?

Graph 8



4. OTHER ANALYSIS

FAO has explored the issue of volatility in its Food Outlook.[3] The FAO product coverage is broader, and covers both historical and implied volatility. The FAO calculated volatility as "the annualised standard deviation of the logarithmic change in monthly prices". Thus, "volatility" in the FAO documents does not correspond to volatility used in this note, and measures variation of monthly prices. Nevertheless, we can still compare the results in qualitative terms although absolute figures are not comparable. In the crops studied in both analyses, volatility increased. The FAO concluded that international wheat prices are more volatile now: our analyses of daily settlement data from CBOT and MATIF confirm increased volatility on the wheat market. In the case of rice, the FAO noted a dramatic increase in volatility. Our analysis indicates an increase in volatility on the US market while recognizing that trading volume and open interests for rice on CBOT are rather low. For maize and soybeans, analysis of monthly data by FAO revealed volatility contained at 30%. Our analysis of daily settlement data indicates much higher values for both commodities. In case of vegetable oil both analysis found a resurgence of volatility.

[3] http://www.fao.org/docrep/010/ah876e/ah876e13.htm

http://www.fao.org/docrep/010/ai466e/ai466e13.htm

5. IMPLICATIONS

Price volatility is driven by a wide variety of factors, such as market fundamentals, stock levels, changing weather patterns and related impacts, cycles in key markets, large purchases by governments, exchange rate movements, oil prices, trade policies and their transmission, investment in agricultural production, etc. These factors coincide with the factors responsible for the price hikes. However, the causality of some of the factors cannot be determined. Commodities for which demand is inelastic (such as agricultural products) tend to be more volatile. Long-term structural changes are also responsible for the increase in price variability, although their effects are not immediate.

Climate change has the potential to impact production variability, and thus market fundamentals. So far on the EU level, no correlation has been established between the warming of the last decades and the level of crop yields, which have generally increased.[4] However, the impact of climate change might be already visible in other, more vulnerable countries.

The on-going financial crisis brings along shortages in credit availability and trade financing and thus influences market fundamentals. In addition, the financial crisis influences the amount of investment capital on commodity exchanges which can influence volatility.

A frequent culprit of increased price volatility is "speculation" based on investing in futures contracts on commodity markets to profit from price fluctuations. The wider and more unpredictable price changes are, the greater the possibility of realizing large gains by speculating on future price movements of the commodity in question. Although a presence of "speculators" on the derivatives markets is a necessary condition for functioning markets and efficient hedging, volatility can attract significant speculative activity and destabilise markets, which are both the cause and effect of increased volatility. In thinly traded markets where only small quantities of physical goods are traded, the value of speculative trades may create false trends and drive up prices for consumers. The likely explanation of price increases since the beginning of 2007 to mid-2008 seems to be a combination of economic fundamentals and factors specific to the financial markets, which might have amplified price changes.

6. CONCLUSIONS

Although volatility has always been a feature of agricultural commodity markets, the evidence suggests that volatility has increased at least in some commodity markets. Based on the relationship between CBOT volatility, US ending stocks and international reference prices, we conclude that in the cases studied it appears that trend lines for volatility and prices have moved together. There also seems to be an overlap between periods of high prices and increased volatility. When US prices were studied such as in the case of wheat and maize, the expected inverse relationship between stocks and prices

[4] Commission Staff Working Document: Adapting to climate change: the challenge for European agriculture and rural areas. SEC(2009) 417.

was confirmed. Volatility peaks also seem to coexist with decreased stocks. As to the link with oil price volatility, we observe that since May 2006 price volatility in maize and oil price volatility move closely together. While other factors and fundamentals are at play and have to be considered, there is a time overlap between increased volatility and increase in open interests on the commodity markets.

In the medium term, projections reviewed in this comparison report indicate stabilisation of stocks which hints at decreasing levels of price volatility on a yearly basis. However, yearly prices changes projected in the baselines are a poor indication of potential volatility since commodities undergo price adjustments daily. In addition, projections assume normal weather conditions and relatively steady economic recovery. Medium term projections are likely to be of less use to investors on the commodity markets benefiting from short-time price changes. However, with increasing biofuels production, a tightened interdependence between crude oil and commodity markets can be expected which could result in increased transmission of crude oil price volatility into agricultural commodity markets.

Although volatility and prices for many commodities decreased recently, it is too early to tell whether decreases are temporary or part of a trend. Persistence of volatility points to uncertainty in developments of market fundamentals. Higher price volatility means higher costs of managing risks (such as higher margins on futures contracts and higher premiums for crop revenue insurance). It is likely that higher cost of risk mitigation would eventually translate into higher consumer prices.

Annex - Definition of historical volatility

For reasons of limited data availability we relied on settlement prices presented by commodity exchanges which are available on a daily basis. The use of nearby futures as a reference price is also justified by frequently using nearby futures as international reference prices. For a large part this chapter relies on already calculated volatility measures by the CME[5] Group. For consistency we used settlement prices and formulae applied in the CME calculations for European exchanges (rapeseed and milling wheat on Euronext Paris[6] MATIF) and oil.

The CME calculation of historical volatility calculation is the annualized standard deviation of the first difference in the logarithmic values of the nearby futures settlement prices. Mathematically,

$$Volatility = STDEV_{Day1}^{DayN}\left(LN\frac{SettlePx\,T}{SettlePx\,T-1}\right)*\sqrt{252}$$

Where 252 is the estimated number of trade days in a year to convert volatility into annualised terms.

[5] Chicago Mercantile Exchange (CME), later referred to as CBOT (Chicago Board of Trade).

[6] Euronext Paris, later referred to as MATIF (Marché à terme International de France)