ANTICIPATING AGRICULTURAL EXTREME PRICE MOVES

LabEx ReFi
POLICY PAPER
December 2017, **No. 3**

Jean-Noël DEPEYROT
Centre d'études et de prospective, Ministère de l'Agriculture

Steve OHANA
ESCP Europe, LabEx ReFi

Founding members of the LabEx ReFi

LabEx ReFi Policy Papers

This work was achieved through the Laboratory of Excellence on Financial Regulation (Labex ReFi), under the reference ANR-10-LABX-0095. It benefitted from a French government support managed by the National Research Agency (ANR) within the project Investissements d'Avenir Paris Nouveaux Mondes (invesments for the future Paris-New Worlds) under the reference ANR-11-IDEX-0006-02.

The findings, interpretations and conclusions expressed herein are those of the authors and do not necessarily reflect the view of the LabEx ReFi

Anticipating agricultural extreme price moves

This paper has been prepared by:

Jean-Noël DEPEYROT
Centre d'études et de prospective, Ministère de l'Agriculture

Steve OHANA
ESCP Europe, Labex Refi [1]

The last decade has been the stage of **wild fluctuations in agricultural prices**. For example, the Agricultural Goldman Sachs Commodity Index (GSCI), representing the dollar-denominated price of a basket of liquidly traded agricultural commodities, has doubled from May 2007 to February 2008, before losing 50% between March and December 2008.

These turbulences are an important source of concerns for operators and policy makers. While brutal price drops may result in a situation of financial distress for farmers, sudden price rises endanger the fiscal, social and political stability of food-importing countries in the developing world. Developing early warning signals of market turbulence thus appear as a crucial and yet still lacking tool for policy makers and international bodies monitoring agricultural markets.

This note presents the key results of a study conducted by B. Guilleminot, J. J. Ohana and S. Ohana in 2016, at the request of the French Ministry of Agriculture, Agrifood and Forestry, to provide **a series of objective indicators** which may help **anticipate extreme agricultural price moves**.

[1] Mail: sohana@escpeurope.eu

The study uncovered a list of **six signals** that have proved predictive (within a 6 to 12 month horizon) or contemporaneous of the extreme price moves over the last decade. Four indicators are based on market prices only: (1) implied volatilities inferred from the US grain option markets; (2) calendar spreads, i.e. price spreads between forward contracts delivering at different maturities; (3) extreme moves observed on short-term horizons in the recent past; and (4) locational/product price spreads across different grain markets. Two other indicators are based on trading volumes or fundamental supply and demand data: (5) break points in the relation between price and stock-to-use (from the monthly United States Department of Agriculture report); and (6) deviations of grain futures markets' trading volumes to their long-run relationship to the prices. The aim of the present note is to present the guiding intuition, construction and potential use of those indicators. All the details may be found in Guilleminot et al. (2016)[2]

1. Identification of the agricultural prices extreme moves over the recent decades

« **Extreme price moves** » are here defined as **price variations that stand as outliers to the rest of the statistical distribution of the GSCI price returns over the considered time horizon**. The authors have developed a systematic methodology to identify these extreme moves on time horizons ranging from 20 to 600 trading days. Applied to the **1990-2014 time period**, this methodology identifies **five extreme moves** (Figure 1), of which only one (the price rise of 2007-2008) has so far garnered significant attention in the literature:

- End of May 2007 – end of February 2008: 3.6 standard deviation move, price rise of 94% ;
- Mid-March 2008 – beginning of December 2008: 4.1 standard deviation move, price fall of 50%;

[2] http://agriculture.gouv.fr/elaboration-dindicateurs-de-suivi-des-marches-financiers-permettant-didentifier-des-periodes-de

- End of June 2010 – beginning of February 2011: 4 standard deviation move, price rise of 90%;
- Mid-June – Mid-July 2012 : 5.5 standard deviation move, price rise of 40%;
- End of July 2012 – end of September 2014: 2.4 standard deviation move, price fall of 45%.

In addition, the drivers of these extreme moves have been analysed in details. The authors show in particular that the fluctuations in input costs and energy prices are not susceptible to explain the within-year variations of cereal prices since 2006. However, their findings lend support to the hypothesis that **biofuel support policies and the ensuing demand shock originating from the biofuel industry** caused the structural price jump observed in 2006-07 on agricultural markets.

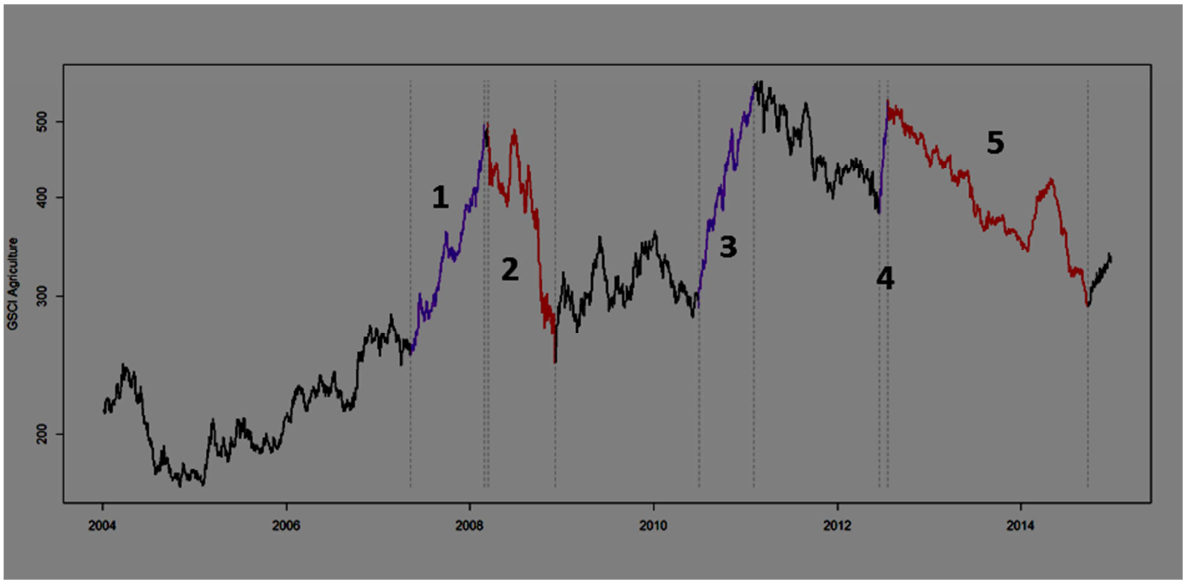

Figure 1: The five extreme moves identified in the GSCI Agriculture Index. The rises are displayed in purple and the falls in red. Source; authors.

2. Price-based signals

2.1 Calendar spreads

The calendar spreads between forward contracts with different delivery dates reflect, for storable commodities, the future storage level as anticipated by market participants.

We use here:

> The “short-term spread”, built as the difference between “first-nearby” and spot prices. The first-nearby price corresponds to the price of the « futures » contract with the shortest maturity quoted on the Chicago Board of Trade (in practice, this maturity ranges from a few days to a few months). This short-term spread can reflect the present storage level perceived by markets participants or alternatively the buying pressure due to financial investors in the futures market;
>
> The “long-term spread”, built as the difference between the price of the contract delivering one year after the first-nearby and the first-nearby futures price. This indicator reflects the perceived end-of-campaign storage level.

We uncovered two possible uses of calendar spreads data for the prediction of extreme agricultural price moves. First, spot and first-nearby prices are linked by a strong long-term relationship, making it possible to define phases of overvaluation and undervaluation of the spot price with respect to the first-nearby price. An undervaluation of the spot price with respect to the first-nearby price on the wheat, corn and soybean markets has been predictive of several extreme moves, in particular the 2007 and 2010 price rises and the 2008 price fall (with an advance of one to several months according to the cases). Second, there generally exists a local negative relation between the spot price and the calendar spread (which reflects the perceived storage level). A break in this relationship may signal a structural shift in price behaviour or in supply and demand fundamentals. As a matter of fact, the authors observed three break points in this relation that have all been predictive or contemporaneous of extreme price movements.

2.2 Implied volatilities

The authors demonstrated the existence of an indicator more efficient than historical volatility (which corresponds to the standard deviation of the daily price returns observed on a sliding window, e.g. 250 trading days) to anticipate extreme events. This

indicator, referred to as “implied volatility”, is inferred from option prices traded at the Chicago Board of Trade.

The interest of this measure is twofold. Firstly, it is « forward looking », informing on the anticipation of future extreme moves by market participants rather than on the amplitude of past moves. This is a market price, instantaneously reacting to new information, contrary to historical volatility. Secondly, it includes information on the extreme moves anticipated by market participants.

This indicator, available since 2011 only, has been predictive of the 2012 price rise as well as the falls of the summers 2013 and 2014 (with an advance varying between one to several months). The direction of the anticipated extreme move may be identified by examining the sign of the correlation between the implied volatility and the prices: a positive (resp. negative) correlation points to the identification of an upside (resp. downside) extreme move potential.

2.3 Short-term extreme moves

Financial assets’ extreme price fluctuations on horizons of several months are often preceded by price turbulence on much shorter time frames (e.g. 1 to 20 trading days). Detecting short-term extreme moves has a great importance for several reasons. First, extreme moves may reveal fundamental information on the state of supply and demand that are already partially priced in the market signal yet only available to the most informed traders. These situations may lead to an amplification of the detected extreme move once this information becomes public. Second, if the detected extreme moves are not driven by any piece of fundamental information, they signal in any case large investment inflows (or outflows) from speculators, which could give rise to self-feeding price rises or falls. Indeed, speculators tend to behave as trend followers in aggregate (i.e. they buy when prices have risen in the recent past and sell in the opposite situation).

We defined “extreme moves” as variations in excess of three standard deviations over their specific horizons. The number of short-term extreme moves (of horizons ranging from 1 to 100 days) over a past rolling window proved predictive of the five

aforementioned extreme price moves. For example, regarding the 2007 price rise (which stretches from end of May 2007 to end of February 2008), a signal of upward instability is detected a first time in the middle of the year 2006 and a second time end of September 2007.

2.4 Valuation spread across different grain markets

Important valuation spreads across different grain markets signal tensions on certain markets that participants find it difficult to arbitrage away (large transportation costs between different locations, difficulty of substitution across different grains, etc.). These tensions may be resolved at the occasion of subsequent large price moves (either through an alleviation of the tension on the stressed market or through a contagion of the stress to another market).

As a matter of fact, the five aforementioned extreme price variations have all been preceded by important valuation spreads between grains and/or locations. For instance, corn was overvalued with respect to soybeans and wheat before the 2007 price rise (which was driven by wheat). The 2007 price rise (driven by the US wheat) was also preceded by a marked overvaluation of the French wheat with respect to the US wheat. The advance of the signal to the subsequent extreme price variation may vary between one to several months.

It should be noted that wheat is often a driver of extreme price falls and rises. This was the case for all five above mentioned extreme moves except the 2012-2014 fall (driven by corn).

3. Stock-to-use and trading volumes based signals

3.1 Stock-to-use

The information regarding end of campaign stock projections is the key fundamental variable driving grain prices. Recent literature shows that this information is immediately priced in by market participants.

The monthly United States Department of Agriculture (USDA) report represents a reference regarding supply and demand information in the food markets. Around the 12 of each month, the USDA releases, for each grain, the anticipations regarding annual production, demand and end-of-campaign stocks, both at the US and world levels. These data make it possible to monitor on a monthly basis the perception of market participants regarding the state of supply and demand in the medium term. The stock-to-use indicator is here defined as the ratio of the USDA estimate of the end-of-campaign stock to the estimate of the annual "total use" (including exports as the data are at the level of the United States rather than the world).

The 2010 and 2012 price rises occurred within a context of elevated stocks (relative to long term temporal averages). Only the 2007 price rise was preceded by low stocks. As for the 2008 and 2012-2014 falls, they paradoxically intervened within a context of relatively low stocks with respect to the long term average. The breaking points observed in the negative linear relationship between prices and stock-to-use have been predictive or contemporaneous of extreme price moves. For example, the first breaking point was detected in 2006, around one year before the beginning of the 2007 price rise. Also, the authors show that the price sensitivity to stock levels has significantly increased since 2007.

3.2 Trading volumes

Speculation on financial markets (investment flows, volumes, etc.) can be informative of future price moves. Previous research has highlighted a positive association between volumes and prices on stock prices. The authors here demonstrate that trading volumes prove more efficient than the stock of positions held by speculative or index traders to predict extreme price moves.

There exists a strong long-term positive relation of trading volumes to prices. Large deviations to this long-term relation may signal a divergence of opinions among traders, resulting in an attempt by "insiders" to trade at the expense of less informed traders. As a matter of fact, the 2007, 2010 and 2012 extreme price rises have all been preceded by trading volumes in excess of at least one standard deviation to the ones predicted by the long term positive linear relationship between volumes and prices (with an advance of

one to six months). In the three cases, this pattern has been characterized by a marked rise in volumes combined with a moderate fall in prices and open positions.

Conclusion

The last ten years have been the stage of particularly brutal extreme moves on agricultural markets. The research presented here led to **a method of identification of extreme moves** in a price series, which resulted in the detection of **five extreme moves in the Agricultural GSCI since 1990**, all located in the most recent decade. This work also led to the **design of early warning signals of future extreme price moves**. The authors indeed identified **six signals** that have been predictive (6 to 12 months ahead) or contemporaneous of the five extreme price and falls detected on agricultural prices since 1990. These indicators can thus be useful for governments and international bodies to anticipate potential agricultural market turmoil.

From the methodological standpoint, two caveats of the present analysis should be mentioned. First, the above mentioned variables give rise to "false signals". **Observing a conjunction of signals could reduce the probability of wrongly predicting an imminent extreme price move**. Second, the analysis carried out here is "in-sample": the predictive power of the six signals is only examined over the time period used for the design and calibration of the indicators. An "out-of-sample" analysis, examining the predictive power of these six signals on post-2014 extreme prices, is necessary to assess their reliability.

Another important question raised by the results of this study relates to the so-called "market efficiency". Indeed, the two extreme price falls of 2008 and 2012-2014 have respectively followed the extreme price rises of 2007 and 2010-2012. They could therefore be interpreted as corrections of previous "overshooting" behaviour.

Lastly, another important question raised by this study concerns the **suitable use that should be made of these early warning signals**. A first approach could consist in

trying **to prevent or smooth a potential future extreme move** with the help of a "regulation fund", which would intervene in the physical or paper markets in a counter-cyclical way (buyer when prices undershoot and seller when prices overshoot).
This approach could become more justified if the predictive power of the signals proves valid out-of-sample and if more sequences of extreme rises followed by extreme falls are observed in the prices.
A second less interventionist approach would simply consist in **warning physical operators and governments on the possibility of imminent extreme price moves** in order to help them mitigate their effects with appropriate hedging policies. However, the impact of this second approach could well be pro-cyclical on the prices.