Impact of the phenomenon of financialization on Maize prices' volatility (VAR modelling)

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Abstract:

This working paper aims to describe the relationship between the phenomenon of financialization and the volatility of commodities prices, especially maize prices in the last decade. In fact, agricultural markets affected by the financialization process, have been characterized by a big uncertainty, as a result, commercials have been very risk averse.

Many researchers have been investigating the relationship between financial speculation activity and commodity prices volatility since 2007/8 crisis. However, our study is particular when it analyzes this impact by introducing the behavior of commercials. Thus, we have tried to identify this effect through risk aversion of commercials based on VNM expected utility theory and VAR modelling, referring to a research methodology based on a descriptive and critical approach of world cereal markets (spot and future market), and empirical research method using quantitative independent variables that lead to analytical results.

Findings reveal that variables used in the econometric model are borderline I(1). Otherwise, the variable *Spl* (spread) does not affect the commercials behavior. In cereal market, Commercials are very risk averse and sensitive to prices evolution. The long/short financial speculators' position variation have an important impact on the behavior of commercials, which engage them in herd behavior, hence the soaring or the sharp drop of cereal prices.

Key words: financialization, uncertainty, risk aversion, maize prices' volatility, VAR modelling.

JEL Classification Codes: C55, D9, G41, Q02.

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1. INTRODUCTION

Prices volatility is a new phenomenon recently emerged in agricultural markets, particularly grains market, they reached an exceptional peak in the year 2008, and then they declined sharply, but started rising again in 2010. In fact (Gozgor & Marco Lau, 2016), in the last couple of years, the global economy faced the challenge of increased contagion across financial markets with increasing political and financial market uncertainties.

It's well known that the mid-2000s marked the start of a trend of steeply rising commodity prices, accompanied by increasing volatility. This period was characterized principally by an increased demand, in particular, in emerging economies (China, India, Brazil…etc), and the use of cereals in the production of biofuels, at the same time, supply was declined sensibly as a result of the adverse effects of climate change and a decline in the productivity of agricultural lands.

Volatility cannot be explained only by factors cited above, another major factor is the phenomenon of financialization and financial speculation, volumes of financial investments in commodity derivatives markets has increased significantly since 2004. (Han, Zhou, & Yin, 2015) The global financial crisis is the most influential exogenous shock on energy–agricultural price links.

In fact, commercials have been uncertain, in this situation, they find in future markets the mean to hedge their positions against uncertainty that lead to sharply prices changes. From the other side, investors have been engaging in commodities markets for diversification, because not only they offer good hedging properties against inflation, but also, it becomes evident that commodity futures contracts exhibited the same average returns as investments in equities, while over the business cycle their returns were negatively correlated with those on equities and bonds.

All these changes in the ten recent years led to the increasing role of the financial motives, financial markets and financial actors in the operation of commodity markets, hence the increased financialization of agricultural

commodity markets. That is why we need to explain the relationship that may already exists between the financialization process and the commodity prices volatility.

Many researchers investigate the relationship between speculation activity and commodity prices volatility, while some researchers support this linkage, others do not support it for different reasons. The purpose of this paper is to identify the impact of financial speculation on commodity prices volatility through the behavior of commercials (producers) against risks.

2. Advantage and inconvenient of financial Speculation:

Financialization is the phenomenon which characterized the agricultural future markets since 2000, from 2003 to 2008 funds allocated to commodity index replication trading strategies have grown from 15 billion dollars to 320 billion dollars, at the same time, the prices for the 25 commodities that make up these indices have risen by an average of 200%.

In fact, speculation has been raised excessively in commodity future markets, and its impact has been hotly discussed by researchers in recent years, most of them think that the volatility which characterized commodities future markets is a consequence of excessive speculation;

Hedge fund manager M.W. Masters is the most ardent supporter of the speculation impact on commodity prices volatility; he argues that unprecedented buying pressure from index investors created a massive bubble in commodity futures prices, and this bubble was transmitted to spot prices (Aulerich, Irwin, & Garcia, 2013), so price spikes were driven in large part by a new type of speculators in commodity futures markets. It means that changes in futures prices lead changes in spot prices more often than the reverse, as noted by M.Hernandez and M.Torero.

Ke Tang and Wei Xiong, in their work file titled “index investment and the financialization of commodities,” found that commodities in the S&P GSCI and DJ-UBSCI had significantly greater volatility increases than did off-index commodities in 2008. So commodities price changes do not reflect only fundamentals changes, they argue that concurrent with the

rapid growth of index investment in commodity markets, prices of non-energy commodities have become increasingly inter-correlated, and also correlated with Oil prices. This situation is a result of the speculation process started in 2000, it reflects the financialization of the commodity markets and helps to explain the large increase in the price volatility of non-energy commodities around 2008. Hence, the price of an individual commodity is no longer determined solely by its supply and demand. Instead, prices are also determined by the aggregate risk appetite for financial assets, and the investment behavior of diversified commodity index investors.

J.Cordier and A.Gohin (2012) in their analysis have been looking for an impact of speculation on cereals prices by analyzing the relationship, first, between assets under management of the commodity funds and the agricultural futures prices; second; they searched a sequential relationship between these variables through the commitment of commodity funds on related futures markets.

They concluded that significant causality exists between assets under management variability of commodity funds and prices variability, but mainly from commodity index funds. However, no significant causality was detected of commodity funds commitments on futures markets, they argue that this absence of causality is due to the ability of commodity funds to hedge their prices risk on the OTC market as a complement to the futures markets.

On June 24, 2009, a report about excessive speculation in the wheat market was presented in the US Senate by C.Levin and T.Coburn; this report unveiled some key data that confirms the impact of speculation on commodities prices volatility, particularly, in the wheat market:

"*The amount of speculation in the wheat market due to sales of commodity index instruments has, correspondingly, grown significantly over the past five years. CFTC data indicates that purchases by index traders in the largest wheat futures market, the Chicago Mercantile Exchange, grew sevenfold from about 30,000 daily outstanding contracts in*

early 2004, to a peak of about 220,000 contracts in mid-2008, before dropping off at year's end to about 150,000 contracts. The data shows that, during the period from 2006 through 2008, index traders held between 35 and 50% of the outstanding wheat contracts (open long interest) on the Chicago exchange and between 20 and 30% of the outstanding wheat contracts on the smaller Kansas City Board of Trade. » (Levin & Coburn, 2009)

Having realized this, the US Senate voted in 2010 the Dodd-Frank Act in order to limit speculation in commodity markets, this law has faced some critics believing that the act will ultimately hurt economic growth, like limitation of the bond market-making role that banks have traditionally undertaken, this situation, in turn, can lead to lessen market liquidity.

Researchers like S.Irwin, S. Sanders, Gilbert, Stoll and Wally, Hamilton and Wu, consider that speculation activity is source of liquidity in agricultural commodity market, and, based on normal backwardation theory, they think also that it is a condition *sine qua non* to reach equilibrium between spot and future prices in these markets, thus, they do not support the Master's hypothesis. Gilbert has used time-series test, such Granger causality test to analyze the impact of speculation on cereal prices; findings report that there is no significant time-series relationship between weekly financial index trading and returns in wheat, corn, and soybeans markets.

As notified by the FAO in the treaty of Rome (23 Juin 2010), Large commodity funds now hold about 25-35 percent of all agriculture futures contracts and, with other investors, have become an important source of liquidity to the market Futures contracts involving the formal obligation to sell or buy a given amount of a commodity at a specified time and price. They thus provide farmers and traders with an important defense or "hedge" against price risks.

However, it is very important to note that only two percent of futures contracts end in the delivery of the physical commodity as they are traded, generally, before their expiration date. As a result, such contracts, or obligations, are drawing growing numbers of financial speculators and

investors, especially as they can provide attractive returns when equities and bonds may become unappealing (FAO, 2018).

Irwin and Sanders think that bubble argument does not withstand close scrutiny, and excessive speculation is not an argument for the volatility of agricultural commodities prices volatility for four reasons: (Irwin & Sanders, 2009)

1) The arguments of bubble proponents are conceptually flowed and reflect fundamentals and basic misunderstandings of how commodity markets actually work;
2) Some facts about the current situation in commodity markets are inconsistent with the existence of a substantial bubble in commodity prices;
3) Available statistical evidence does not indicate that positions for any group in commodity futures markets, including long-only index funds, consistently lead futures price changes;
4) There is historical pattern of attacks upon speculation during periods of extreme market volatility.

All arguments against speculation impact does not support the Master's hypothesis, but it's very important to note that all empirical studies have faced data limitations;

- Some researchers (Sanders and Irwin, Brunetti, Morris) note that speculation has grown most rapidly before the year 2006, whereas data on speculation positions are not available before 2006;
- The aggregation of public data on index positions across all futures contract maturity months may obstruct linkage between changes in prices and index positions by contract maturity month;
- The impact should be more evident in a shorter time. Nonetheless, the CFTC provides only weekly data about financial index positions in agricultural futures markets, and for this reason, the impact of changes in index positions will be less clear, hence reducing the power of time series methods to detect its impact.

It is well known that the role of information flows is crucial for prices formation[1]. However, market participants make trading decisions based on factors that are totally unrelated to the perspective commodity, such as portfolio considerations, or they may be following a trend, ignoring changes in fundamentals. Thus, the trading decision process is characterized by considerable uncertainty, particularly in agricultural markets, most of the traders follow other participants in trading decisions, which leads to creating the so-called "intentional herding," and this behavior is accused of creating a speculative bubble that cannot be justified by changes in fundamentals.

3 . Uncertainty of agricultural future markets:

Market participants continuously update their expectations about prices evolution from the inflowing public and private information. As a result, prices move upward or downward when new information is publicly available or when private information leads to transactions that affect prices. It means that market participants evaluate their assets based on fundamentals, that is what we call an act fully rationally, but when they ignore their own information and variations in fundamentals to follow other market participant's decision, market efficiency will not be reliable, and prices evolution cannot be explained solely by fundamentals variation.

In fact, traders can engage in herd behavior in some circumstances, particularly when the market is characterized by a big uncertainty, this behavior consists to mimic the action of a dominate group of investors, it can be qualified as an irrational behavior as it may also be fully rational.

For example, an investor who is ready to invest in the securities of an issuer, ignoring other market participant's decision, but he changes opinion when he realizes that other investors have decided to abandon.

Some recent models consider that the herd behavior is a deviation of rationality, this behavior is known as a "noise trading," it means that traders decisions are affected by a pseudo-signals, some market participants take a sell or buy decision only to assign supply and demand, which lead to affect prices.

Herd behavior can be rational, in this context spurious herding must be distinguished from the intentional herding, as it described by Bikhchandani and Sharma, this behavior consists to take the same decision unintentionally when traders face the same circumstances independently from the other market participants decision. This behavior does not contradict the *EMH*, for example, banking panics.

Unlike the previous, intentional herding may be described by following other market participant's decision because of a psychological impact, and they behave so for four motives: (markets, 2011)

- Imitation that arises when traders and their employers doubt their own abilities to take a right decision;
- When agents invest on behalf of others, herding can be a result of a compensation incentive; Thus, they align their positions with benchmark portfolios;
- Conformity-based herding relates to an alleged intrinsic performance of individuals for conformity;
- Imitation based on believing that market participants can glean information by observing the behavior of other agents.

In spite of this distinction between various herding types, if all these acts lead to affect price movements, early moves will benefit the most. Imitation by followers will gradually become less profitable the larger it is delayed, and the greater becomes the probability that newly arriving public information will alter the informational cascade, thus, motivation to engage in herding behavior decline progressively until it ended, and the extent to which herding affects prices depend on the degree of uncertainty. Within that period, it will be difficult to distinguish the well informed from the uninformed agents, called the followers. In this situation, market participants may believe mistakenly that most agents possess accurate information, hence the dramatic effects on prices that can lead to bubbles and excessive volatility because of the ensuing confusion, which allows the uninformative herd behavior to affect drastically prices.

This analysis shows that market participants can react for some reasons, whether they are rational or irrational their behavior can instantaneously push prices to deviate from fundamentals for a long period creating a big uncertainty. Therefore the decision process became more complicated for a risk-averse agents, in particular, producers and customers, this effect was more obvious in cereal market in 2007 until 2012.

It has become very difficult to predict and analyze agent's behavior, empirical work files realized cannot sufficiently provide evidence about this phenomenon, and some findings are in favor others against of the presence of this herd behavior and its impact on prices. It is for this reason that we conclude that prices movements depend in general on fundamentals changes, and financial investor's game in the market (spoofing [2], layering[3]…etc).

According to normal backwardation theory[4], the difference between the forward prices and the expectation of spot prices can be justified by a speculator remuneration called risk premium, this remuneration can change proportionately to the degree of risk aversion that can be different from an agent to another. In this situation, it can be more evident, under uncertainty, ensuing by a herd behavior, that we can expect an indirect but significant impact of speculation on prices through excessive risk aversion of producers and customers.

Decision under risk and uncertainty:

Act in a situation where the information is available and symmetrically distributed is not a problem for the various market participants, because the ensuing price would be right, it is considered as an equilibrium price. However, if the market is characterized by great volatility (described by variability and uncertainty), the ensuing price may not reflect supply and demand tendency, and the future price cannot be explained based on a future spot price expectation. Therefore, market cannot regulate itself.

The economic theory developed in XIX century was static. It assumed that information is perfectly and symmetrically distributed, and this was not

the case for the cereal market in the last decade, risk and uncertainty were a principal characteristic of the market that results from the various wrong market signals due to strong speculation and blind herd behavior. Consequently, decision-making would be complicated in such circumstances.

It was only in the early 1950s that uncertainty took in account in the general equilibrium theory, in this way, K.Arrow, H.Debreu, J.V.neumann, O.Morgenstern, Savage, and others, proposed a new model of the general equilibrium theory under uncertainty, this model represents the crucible of modern economic theory. In this context, producers, customers, and financial investors know approximately possible results.

Utility and Moral expectation theory:

It all started with the St.Petersburg paradox[5], a question brought forward for the first time by N.Bernoulli in 1917, this dilemma was resolved later by D.Bernoulli in his publication titled *"The new theory of risk and game"*, then, later in the 1950s, this new theory was developed by Von Neumann and Morgenstern to create the game theory.

The utility theory postulates that people behave as if they make a decision by assigning imaginary utility values to the original monetary values, and knowing that any agent reaches a saturation point for utility. There is a decline in the marginal utility that person derives from consuming each additional unit of any product, and the saturation level may differ from agent to another. Thus, someone may be interested in a prize of 100 MU, but the same prize cannot be interesting for another agent, and there is no gambler who can continue to play until *E(x)* tend towards $+\infty$.

D.Bernoulli argues that any slow increase of wealth (Δw), the increasing in utility (Δu) is given by:

$$\Delta u \approx \frac{1}{w}\Delta w \Rightarrow \frac{du}{dw} = \frac{1}{w} \Rightarrow u = \ln w$$

For Bernoulli this hypothesis is valid for a most of agents, hence in St Petersburg game, the mathematical expectation is becoming a moral expectation, and this does not tend to infinity, but to a finite number:

$$EU(w) = E(\ln w) = 1/2 \ln 2 + 1/4 \ln 4 .....1/2^n \ln 2^n + 1/2^{n+1} \ln 2^{n+1} = \sum_1^{\infty} 1/2^{n+1} \ln 2^{n+1} = 1.38$$

This means that, when *n* (number of flips) tend towards infinity, the moral expectation may tend to a finite number. Thus, there is no gambler who can continue to risk until infinity. This idea was carried forward later in 1944 by E.Borel, J.V.Neumann and O.Morgenstern, concretized in a theory of games and economic behavior, based principally on realistic hypothesis, particularly uncertainty, asymmetrical information and the probability of results.

Expected utility theory (VNM):

According to VNM analysis, if economic agents evaluate results based on their utility, not by a monetary unit, the situation of uncertainty can be described as follows:

Let *E* be the finite set of possible events, and *P* a set of the probability distribution on this set *E*, $e_1, e_2 .....e_n$ as possible events, and $r_1, r_2 .....r_n$ considered as the results assigned to each event, $p_1, p_2 .....p_n / \sum p_i = 1$ considered as probabilities associated to each event which lead to a result *r*.

The set of combinations $[(r_1, p_1),(r_2, p_2).....(r_n, p_n)]$ describes an uncertain position where plenty of events are possible. However, if we refer to Bernoulli's analysis, we may introduce the utility criteria, and this situation should be described as:

$$[(u(r_1), p_1),(u(r_2), p_2).....(u(r_n), p_n)]$$

Considering possible outcomes as a wealth *(w)* of an economic agent, we obtain the following formula:

$$[(u(w_1), p_1),(u(w_2), p_2).....(u(w_n), p_n)]$$

VNM argue that, economic agents choose, in an uncertain situation, based on an expected utility carried from every situation as follows:

$$U[(w_1, p_1),(w_2, p_2),.....(w_n, p_n)] \neq \sum_{i=1}^{i=n} p_i w_i = \sum_{i=1}^{i=n} p_i u(w_i) = EU(w)$$

This equation represents the formula that describes the expected utility of an economic agent. Thus, individual faces a preference of decision-making in an uncertain situation will always prefer actions that maximize expected utility by comparing $U[(w_1, p_1),(w_2, p_2),.....(w_n, p_n)]$ to $EU(w)$, in other words, individuals make decision by comparing mathematical expectation of possible outcomes utility, and the utility of every possible outcome: *UE(W)~EU(W).*

Therefore, three types of economic agents can be distinguished:

- Individual who prefers *E(wf)* to $(\tilde{w}_f)$ / $(\tilde{w}_f)$ mean the final wealth.

  $\Rightarrow UE(\tilde{w}_f) \rangle EU(w_f)$

This behavior is considered as a risk aversion. Hence the individual utility function can be represented by a logarithmic function ($U(w) = \ln w$), for example.

- Individual who prefers $(\tilde{w}_f)$ to *E(wf)*

  $\Rightarrow UE(\tilde{w}_f) \langle EU(w_f)$

  This behavior is considered as a risk- seeking. Hence the individual utility function must be represented by a positive exponential function $U(w) = e^w$, for example.

- The third type of behavior is the indifference, or risk neutral, $UE(\tilde{w}_f) = EU(w_f)$, which can be represented by a linear function ($U(w) = aw + b$), for example.

Indeed, D. Bernoulli has explained one type of behavior; it is a risk aversion behavior, represented by the logarithmic function.

We will go further to consolidate our ideas and hypothesis, it consists to describe a commercial (producer) behavior in cereal market; this commercial (producer) is supposed risk averse under uncertainty in relationship simultaneously to a fundamentals changes and to the wrong market signals as a result of a great speculation, as it described above.

Based on VNM deduction, the utility function that describes the commercial behavior is taken as *lnw*, this function can be introduced in our econometric model to seek the impact of speculation on cereal prices through commercials (producers) behavior.

4. Application for maize prices volatility by VAR modelling:

VAR modelling was introduced for the first time by Sims in 1980 to mitigate the failures and deficiencies of macro-econometric models, because of their incapacity to forecast economic crisis in 1973, 1979. In the same context, Granger developed a new concept of causal link well known by Granger causality. This consist plainly in demonstration if the variable X cause (in the sense of Granger) a variable Y through random shocks, looking first the extent to which past values of the variable Y explain the actual value of the variable Y, and see afterwards the improvement of the estimation due to the lags' values of the variable X taken into account.

It consists, in our case, to analyze the indirect impact of the variation of speculators position (swap dealers, Money managers, and other reportables) on the behavior of commercials, but not a direct impact on cereal prices, using VAR model. Commercials are supposed, in this study, risk-averse as long as they use hedging instruments, and they engage in herd behavior.

Data description:

CFTC is an institution whose mission is to regulate, control and collect information, it aims to protect market users and their funds, consumers, and the public from fraud, therefore, it provides information in periodic reports about the commitment of traders, and these reports are available in both a short and long format. The supplemental reports show aggregate futures and options positions of noncommercials, commercials and index traders in 12 selected agricultural commodities.

Statistical data used in this study is gathered from the Cbot market. Concerning traders position; the data is collected from weekly reports of the

CFTC, monthly maize and corn prices are available in UNCTAD and FAO web site, and prices are expressed in dollars per ton.

A chosen time series are used from June 2006 until December 2015, the study period contains 115 observations. Using this data, we proceed to estimate the time series data using the ninth version of Eviews software.

Model specification:

In this study, it is a question of regressing historical price values on actual prices, and on the other variables that may have a significant impact on future prices evolution, the other variables taken in account in our model are: the speculation position variation (long and short position) and the spread as follows:

$$f(t) = \alpha_0 + \alpha_1(f(t-1)) + \alpha_2\Delta(lal)_t + \alpha_3\Delta(sal)_t + \alpha_4\Delta(spl)_t + \mu_t$$

$f(t)$) : As utility function of a professional at the time *t* , such as *f(t) = U(x)*, *x* represents the wealth of the commercial and the price of a ton of maize.

(lal_{t1}): As a speculator long position variation (swap dealers, money managers, and other reportables) for the period t.

$(sal)_{t_1}$: As a speculator short position variation (swap dealers, money managers, and other reportables) for the period t.

$(spl)_{t_1}$: As a spread (swap dealers, money managers, other reportables) for the period t.

Considering a risquophobe commercial (as was our hypothesis), his utility function can be as, U(x) = ln x.

Let $f(t) = \ln x \Rightarrow \Delta f(t) = \frac{d \ln x}{dx} = \frac{1}{x}$, such as, x represents the wealth of the commercial and it is considered as the price of a ton of maize.

Before estimating the model, all variables should submit the various stationary tests, and detect if any seasonal effect exists.

Stationary tests:

A time series stationary means that its variance and expectation are independent of time variation. Otherwise, we consider the time series as

non-stationary. Thus, we cannot estimate an econometric model that its variables are not stationary, because the impact of explanatory variables on explained variables would be confused by the time variation.

A common test used is the ADF test (Augmented Dicky fuller test), based on three types of models:

- The first one does not contains any constant or time drift, this model is written:

$$\Delta X_t = \phi X_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

- The second is a model with constant and time drift, this model is written:

$$\Delta X_t = \mu_1 + \phi X_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

- The third model contain a constant, but not a time drift, it is written :

$$\Delta X_t = \mu_1 + \beta t + \phi X_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

According to ADF test, if *H0* is selected in any model of three models, we qualify the process as non-stationary, in this situation; the estimated value of *t* of student associated to ϕ parameter exceeds the critical tabulated value of Mackinnon (ADF *tab*):
It means that:

$$H0 : \phi = 0$$

$$H1 : \phi < 0$$

We accept *H0,* and we reject *H1* if ADF *cal* > ADF*tab*. Otherwise, we accept *H1* and we reject *H0.*

Application for Maize prices case:

First, we start with stationary testing of our designed model for maize prices series as follows:

Table 1. testing the designed model for maize prices series

	Variable	Coefficient	Std Error	Tstat	Proba	Critical value (at 5%)	Tcal
Modèle 1	Ux(-1)	0.000286	0.001239	0.230807	0.8179	- 1.943688	0.230807
Modèle 2	Ux(-1) C Trend	-0.050400 0.279767 -0.000158	0.025376 0.131708 0.000213	-1.986138 2.124147 -0.739303	0.0495 0.0359 0.4613	-3.450073	-1.98613
Modèle 3	Ux(-1) C	-0.056507 0.303076	0.023944 0.127615	-2.359923 2.374923	0.0200 0.0193	-2.887190	-2.359923

Source: Authors' estimations

Based on this table realized from results obtained from Eviews9 software, we have noticed that ADF*cal* > ADF*tab* for each model, therefore we accept *HO* and we reject *H1*, it means that the first, second and the third model have at least a unit root, so, we judge the series *Ux* as non-stationary, it is a kind of DS (differency stationary).

Similarly, as for the first variable, we proceed for the other variables, and we conclude that the same results and analysis are obtained. This means that all time series are not stationary for all variables at a critical level of 5%.

As the variables are not stationary at a critical level of 5%, we proceed with another alternative approach to make them stationary; this approach consists in testing the stationary of the first difference of the model.
The obtained results are presented in the following table:

Table 2. testing the stationary of the first difference of the model

1st difference	ADF*tab (α = 5%)*	ADF*cal*
dLux	-1.943688	-8.253380
dLal	-1.943688	-7.327658
dSal	-1.943688	-10.59026
dSpl	-1.944006	-2.715256
dpx	-1.943714	-8.212370

Source: Authors' estimations

This table indicates that ADF*cal* < ADF*tab* for all variables, so, we reject *H0* and we accept *H1.* Therefore, we consider that the variables of our model are stationary for the first difference at a 5% level of freedom, and all variables are borderline *I(1).*

We test the stationary of residuals in the following step to see whether they are stationary or not, if they are stationary we confirm that independent variables have a significant impact on the variable *U(x)* in the long run.

Based on the table (1) (see appendix 4), and Dicky-fuller test, we conclude that residuals are stationary, we can then estimate our model in the following step:

Estimation of the model:

We proceed in what follows to the estimation of our model using Eviews 9 software in order to describe the relationship between risquophobe behavior of commercials (professionals) and the past values of maize prices and speculators positions in the long run.

The obtained results show that the variable spread all *(spl)* and the constant (*c*) have a probability which is superior to the degree of freedom (α>5%) (see the table (2) in the appendix 4), we will then select the variables of the model by eliminating variables with a probability superior to *α*, after that we should proceed to the reestimating of our model (see the table 3 in the appendix4).

Statistical interpretation of the obtained results:

The obtained results indicate that $R^2 = 0.950125$, this means that variables *lal, sal, lpx*, explain the variable *U(x)* variation for 95.01%.

The variables discussed seem all significant as long as the probability is less than α for all variables.

Residuals must not be auto-correlated. Thus, we should first test the auto-correlation of residuals as follows:

H0 : Residuals are not auto-correlated

H1 : Residuals are auto-correlated.

We cannot reject the null hypothesis if Chi-square probability is superior to α.

Based on Eviews9 software we test the auto-correlation of residuals, and then we obtain the table 4 (see the appendix 4):

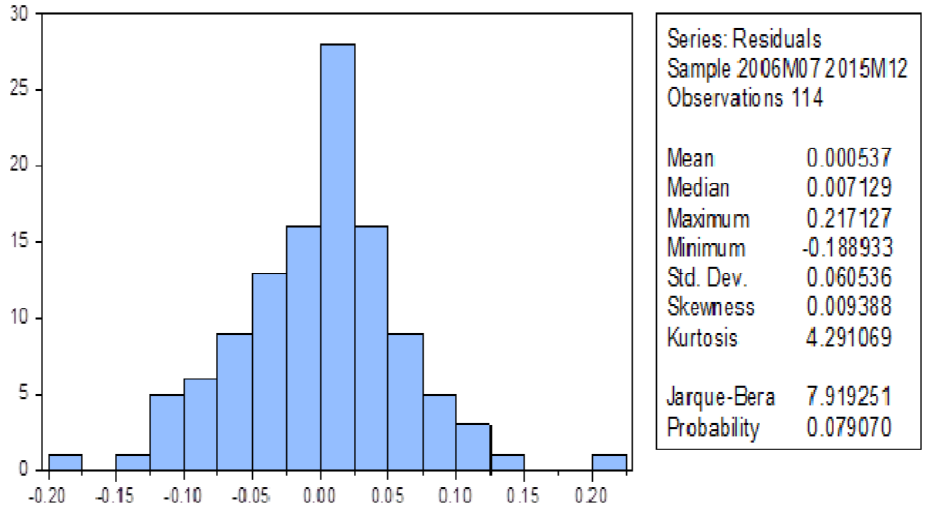
It can be noted that Prob. Chi-Square(2) of $R^2 = 41.40\% > \alpha$, so we accept the null hypothesis, and we reject the alternative hypothesis, it means that residuals are not auto-correlated (see the graphic in appendix n°3)

- The other test that we must check is a possible existing of the Heteroskedasticity in residuals series. We can also use Eviews9 software to check this test, so, we obtain the table 5 (see the appendix 4).

From this table we not that the observed $R^2 = 5.77\% > \alpha$, so we cannot reject the null hypothesis, this means that there is no Heteroskedasticity in residuals series.

- The third test that we must check too, is the normal distribution of residuals, for that purpose we can use a Jarque-Bera statistics test as follows:

Fig.1. Jarque-Bera statistics test



Source: Authors' estimations

We confirm that the probability is superior to α, so we accept the null hypothesis and we reject the alternative hypothesis, it means that residuals are normally distributed.

Economic interpretation of the obtained results:

The obtained results confirm our theory about the significant impact of speculative positions on maize prices volatility through commercials (professionals) behavior. Hence, our econometric model can be written as:

$$L(Ux)m = 0.976851Lpx + 2.58\ Lal - 2.30Sal$$

Knowing that all variables are borderline I(1), this means that all independent variables (past values of prices, speculator long and short positions) have a significant impact on commercials risk aversion with a single period lag (one month).

Passed values of maize prices are integrated into our econometric model with a positive sign, and a coefficient = 0.97, it indicates that the fact that commercials are very sensitive to prices evolution, and that is how it

should have been, their decision to buy or to sell depend on the future price development, based on passed development process.

Speculative long positions are integrated with a positive sign and a coefficient = 2.58, it indicates that the long position of speculators has an important effect on utility function of commercials, thus a positive effect on their risk aversion. Therefore, any long position variation of speculators in future market can create a herd behavior wave, which stimulates the emergence of a new speculative buying wave in the commodities market, conducting to a massive increase of prices, because the market will transmit a spurious positive signal of buying.

Speculative short positions have a lower impact (coefficient = 2.3), but they are integrated with a negative sign. Consequently, the impact will be negative on commercials behavior, it means that the fact that speculators get rid of their buying positions, commercials risk aversion increases, which will affect negatively the utility function, conducting to a reticence vis a vis to buying decisions, which stimulate a sharp drop of maize prices.

5. CONCLUSION:

The obtained results indicate that commercials facing financialization of commodities markets have become uncertain, because of strong speculation, as a result they often engage in herd behavior, on that point, the use of hedging techniques is a valuable argument of commercials risk aversion.

Several research studies indicate that there is no impact of speculation on prices volatility, particularly in cereal markets, however, the use of future market instruments justify the uncertainty and the risk aversion of commercials, resulting from a big wave of speculation accompanied with a herd behavior, which can stimulate, for its part, the soaring or the sharp drop of prices.

We have tried to analyze the commercials behavior in cereal market based on a VNM expected utility theory, and we concluded that the impact of speculator position variation is evident in the long run for the maize

prices, the fact that the commercials behavior is affected , 96% of professionals behavior changes are explained by the variation of speculators positions. As a result, our theory based on the possible effect of commercials risk aversion, which is subject to the speculation impact on prices volatility, is well verified through this econometric modelling. This gives rise to justify the use of new policies to limit financial speculation impact without reducing physical market liquidity, and as proposed by Von Braun and Torero, a virtual reserve can minimize speculative attacks and avoid excessive spikes of prices in physical markets.

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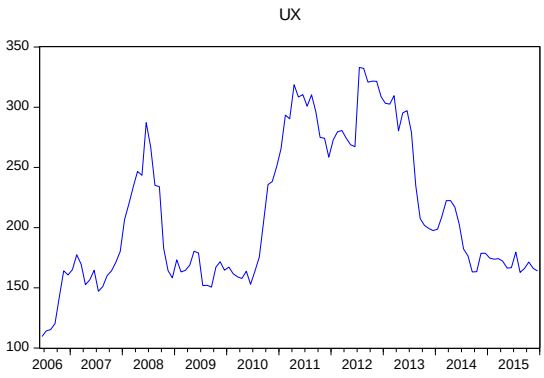
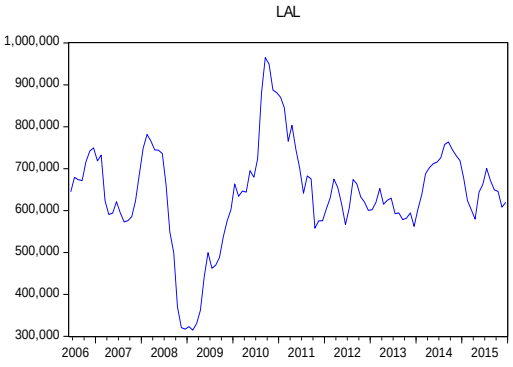
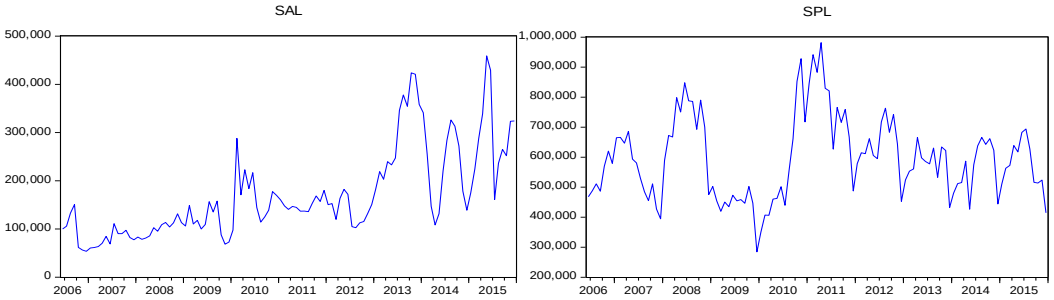
7. **Appendices:**

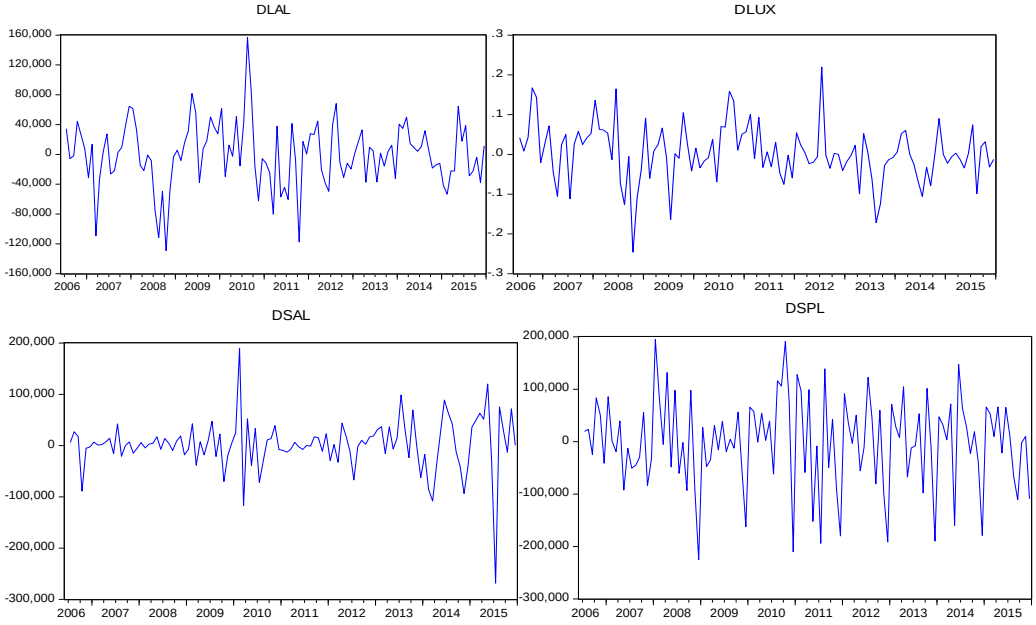
Appendix n° 1: Evolution of discussed variables (2006-2015)



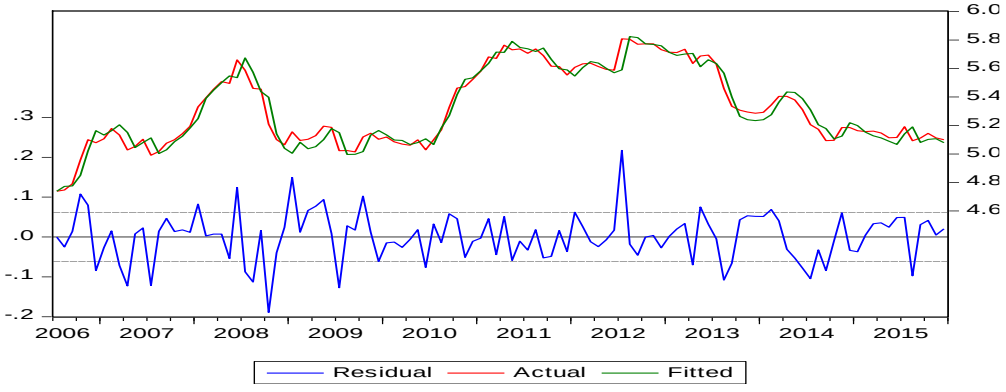




Appendix n° 2 : Stationary tests



Appendix n° 3 : Residuals auto-correlation test



Appendix n° 4 :

Table 3.

Null Hypothesis: D(RESID) has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.84693	0.0000
Test critical values:	1% level	-2.586550	
	5% level	-1.943824	
	10% level	-1.614767	

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

Table 4.

Dependent Variable: LUX
Method: Least Squares
Date: 09/15/17 Time: 21:05
Sample (adjusted): 2006M07 2015M12
Included observations: 114 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LAL	2.47E-07	5.26E-08	4.702160	0.0000
SAL	-2.34E-07	6.19E-08	-3.781725	0.0003
SPL	-7.24E-09	5.59E-08	-0.129545	0.8972
PX	0.941710	0.024931	37.77248	0.0000
C	0.199342	0.123474	1.614441	0.1093

R-squared	0.951654	Mean dependent var	5.321551
Adjusted R-squared	0.949880	S.D. dependent var	0.271075
S.E. of regression	0.060687	Akaike info criterion	-2.723306
Sum squared resid	0.401437	Schwarz criterion	-2.603297
Log likelihood	160.2284	Hannan-Quinn criter.	-2.674601
F-statistic	536.3940	Durbin-Watson stat	1.775798
Prob(F-statistic)	0.000000		

Source: Authors' estimations

Table 5.

Dependent Variable: LUX
Method: Least Squares
Date: 09/15/17 Time: 21:12
Sample (adjusted): 2006M07 2015M12

Included observations: 114 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SAL	-2.30E-07	6.19E-08	-3.714431	0.0003
LAL	2.58E-07	4.68E-08	5.512945	0.0000
PX	0.976851	0.006096	160.2576	0.0000

R-squared	0.950125	Mean dependent var	5.321551
Adjusted R-squared	0.949226	S.D. dependent var	0.271075
S.E. of regression	0.061081	Akaike info criterion	-2.727259
Sum squared resid	0.414132	Schwarz criterion	-2.655254
Log likelihood	158.4538	Hannan-Quinn criter.	-2.698036
Durbin-Watson stat	1.788331		

Source: Authors' estimations

Table 6.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.860892	Prob. F(2,109)	0.4256
Obs*R-squared	1.763842	Prob. Chi-Square(2)	0.4140

Source: Authors' estimations

Table 7.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.579782	Prob. F(3,110)	0.0572
Obs*R-squared	7.493548	Prob. Chi-Square(3)	0.0577
Scaled explained SS	11.69090	Prob. Chi-Square(3)	0.0085

Source: Authors' estimations

8. Citations:

[1] The EMH (*efficient market hypothesis)* postulates that all publically available information is immediately reflected in prices, even private information available only to individual market participants is reflected in the price through the effects of the transactions of the persons in possession of the information, for this reason, commodity price developments would reflect nothing but information on fundamentals.

[2] An illegal practice, it is also a form of market manipulation in which investors use visible non-bona fide orders to deceive other traders as to the true levels of supply and demand.

[3] Layering is a form or variant of spoofing where the trader places several orders a few ticks apart to give the appearance of buying or selling, which cause the midpoint of the spread to move away from those orders, and the same trader executes a trade on the opposite side of the market.

[4] Developed by J.M Keynes, based on this theory, a market is said to be in contango when future prices lie above spot prices, and it said in backwardation when the future prices are below the expected future spot prices. This theory is used to explain the relationship between the future prices and the expected value of the spot prices of the commodity at some future date. Normal backwardation suggests that the future prices will be bid down to a level below the expected spot price, and will rise over the life of the contract until the maturity date. On the maturity date, future prices are equal to spot price.

[5] St Petersburg game is played by flipping a fair coin until it comes up tails, and the prize is determined based on the total number of flips, *n*, which equal to 2^n monetary units. For example, if the coin comes up tails the first pitched, the prize would be $2^1\,MU^*$, if it comes up tails the second time, the prize would be $2^2 = 4MU$, and if it comes up tails the *n* time, the prize would be $2^n\,MU$. Knowing that probability of a consequence of *n* flips is: $\frac{1}{2^n}$, the expected value of the game(E(x)) is the sum of the expected payoffs of all the consequences;

$$E(x) = \left(\frac{1}{2}\right)2^1 + \left(\frac{1}{2}\right)^2 2^2 + \dots\dots\dots\left(\frac{1}{2}\right)^n 2^n + \left(\frac{1}{2}\right)^{n+1} 2^{n+1}$$

$$= 1+1+1+1\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots N= +\infty$$

If it refers to mathematical analysis, taking into account mathematical expectation as it is justified by Pascal and Fermat, this game may not contain any contradictions. However, the expected value of the game is an infinite number of dollars, which lead us to believe that the game organizer cannot reward the winner if E(x) tend towards $+\infty$, he should have established a higher price for the lottery. And from the other side, the rational gambler would not accept to pay even 100 MU, for example, to enter such a game knowing that the prize could be only 2 MU. Then something has gone wrong with this way of thinking about the game, which has become, following this logic, not playable. This paradox has questioned the concept of mathematical expectation.

D. Bernoulli claimed that two analysis criteria ignored in the previous analysis:

- Behavior and individual characteristics.
- The evaluation method of the results, which calculated, based not on monetary units, but on utility-based units.