Commodity futures markets: are they an effective price risk management tool for the European wheat supply chain ?

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"Between Crisis and Development: which Role for the Bio-Economy"

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Summary

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With respect to the effectiveness of hedging, the results indicate that this is still a viable alternative for commercial entities as spot and futures prices evolve closely. In other terms, particularly as short-term hedges, the basis has not been affected by the instability observed in commodity markets. The results imply that futures markets are not only still efficient tool in risk management but may also be a useful tool for food security purposes.

Keywords: Futures prices, commodity prices, volatility, wheat

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1. INTRODUCTION

The relatively recent instability of commodity prices has brought back the interest on futures markets and their use for hedging as a device to reduce vulnerability to risk. As pointed out by Lence (2009), vulnerability to risks is amongst the most important problems faced by commodity producers in developing and developed countries. Furthermore, this renewed interest has extended use of futures and options contracts to the area of food security, as they have been proposed as a way in which importing countries could manage price volatility (Sarris et al., 2011).

As it is well known futures markets perform several functions: they provide the instruments to transfer price risk, they facilitate price discovery and they are offering commodities as an asset class for financial investors, such as fund and money managers who had not previously been present in these markets.

Commercial participants use futures contracts to hedge their crops or inventories against the risk of fluctuating prices, e.g., processors of agricultural commodities, who need to obtain raw materials, would buy futures contracts to guard against future price rises. If prices rise (i.e., both cash and futures prices), then they use the increased value of the futures contract to offset the higher cost of the physical quantities they need to purchase. However, hedgers are not the only agents operating in futures markets, as one can also find non-commercial participants, who do not have any involvement in the physical commodity trade in contrast to commercial participants, such as farmers, traders and processors. These are called "speculators" and they buy and sell futures contracts in order to obtain a profit. It's a matter of fact the massive increase in trading in commodity derivatives over the past decade; commodity derivatives include futures and options traded on organized Exchanges as well as the forwards and the options traded over the counter. Trading in commodity derivatives also increased along with the rapid expansion of the presence of the commodity index traders (United Nations, 2011).

This paper focuses on the usefulness of futures prices for hedging against price risk, paying particular attention to the hedging performance in recent years. The work can be considered as an indirect test of whether the increasing presence of speculation in futures markets have made them divorced from the physical markets and therefore not useful for price hedging.

It is well known that despite the recommendation of analysts, only a minority of farmers do operate in futures markets and as pointed out in Blank et al. (1991, 1997), in many cases when they operate in futures market, they do it as speculators and not as hedgers. Nevertheless, the interest in analysing the aforementioned question is whether hedging in futures markets has become an even less attractive operation or it is still a valid mechanism to reduce the vulnerability to price risk.

The paper is structured as follows: first, we provide a brief overview of the discussion of how events in futures markets are affecting commodity price volatility. This is followed by the empirical part of the paper where the data and the methods are explained. The next section presents the results of the different tests and the last section offers some conclusions.

2. Hedging between Volatility and Speculation

Most of the studies on the behaviour of commodity prices in recent years assert that food price volatility has increased. Table 1 presents the volatility of the four spot price returns: variability increases over time in all the markets.

Table 1. Wheat spot price volatilities.

Cash market	1988 - 1997	1998 - 2005	2006 - 2012
Chicago	0.280	0.313	0.495
Rouen	n.a.	0.168	0.286
Bologna	n.a.	0.142	0.196
East Anglia	0.180	0.217	0.233

Notes: Standard deviations of logarithmic changes in daily nominal spot prices at an annual rate
Source: Own calculation based on data presented in section 3.1 .

It is conventional to measure volatility as the standard deviation of price returns i.e. first differences in logarithmic prices. Normally daily volatilities are quoted at an annual rate by multiplying by $\sqrt{250}$ where 250 approximates the trading days in the year.

A matter still under discussion is whether the volatility will remain high over the longer run. According to Gilbert and Morgan (2010) the volatility of major agricultural food commodities actually grew over the most recent years, but there have also been periods of high volatility in the past and the recent volatility levels could drop back to historical levels over the coming years.

The above point is related to the current discussion on the effects that the increasing speculation may have brought to commodity markets (see for instance, Bohl and Stephan (2012) for a recent literature review on the issue); particularly whether increasing speculation is the culprit behind the rise in commodity prices and in their apparent volatility. It should be noted that this is a recurrent topic in the futures market literature, namely the role of speculators on futures markets (e.g., providers of liquidity). In practice, a major difficulty is to define who the speculators are (Gray, 1967), and this affects any estimation of their effects on the markets.

A number of authors – e.g. Gheit (2008); Masters (2008); Masters and White (2008) - have commonly asserted that speculative buying by index funds in commodity futures and over–the–counter (OTC) derivatives markets created a ''bubble,'' with the result that commodity prices, and crude oil prices, in particular, far exceeded fundamental values at the peak (Irwin, et al., p. 377). Furthermore, according UNCTAD (2009):

"Financial investors in commodity futures exchanges have been treating commodities increasingly as an alternative asset class to optimize the risk-return profile of their portfolios. In doing so, they have paid little attention to fundamental supply and demand relationships in the markets for specific commodities. A particular concern with respect to this financialization of commodity trading is the growing influence of so called index traders, who tend to take only long positions that exert upward pressure on prices. The average size of their positions has become so large that they can significantly influence prices and create speculative bubbles, with extremely detrimental effects on normal trading activities and market efficiency. Under these conditions, hedging against commodity price risk becomes more complex, more expensive, and perhaps unaffordable for developing-country users. Moreover, the signals emanating from commodity exchanges are getting to be less reliable as a basis for investment decisions and for supply and demand management by producers and consumers." (UNCTAD, 2009, p. iv).

On the contrary Irwin et al. (2009a) considered that fundamentals offer the best explanation for the rise in commodity prices. Four of their points are worth noting: first, the arguments of bubble proponents are conceptually flawed and reflect misunderstanding of how commodity futures markets actually work, as they state that the money flows that go into futures and derivatives markets pressures the demand for physical commodities, when that money only operates in the futures market.[1] Second, a number of facts about the situation in commodity markets are inconsistent with the existence of a substantial bubble in commodity prices such as the fact that the available data do not indicate a change in the relative level of speculation to hedging. Third, the available statistical evidence does not indicate that positions for any group of investors in commodity futures markets, including long–only index funds, consistently lead futures price changes and fourth, there is a historical pattern of attacks upon speculation as scapegoat during periods of extreme market volatility.

It is clear that if futures markets trends follow factors that are not related to fundamentals, one should expect changes in futures prices and spot prices to become divorced or less correlated. The implication of the above disassociation between futures and the physical market would necessarily be a reduction in the effectiveness of hedging spot price risk using futures markets. As it is well known the correlation between both prices (futures and spot) is fundamental for the traditional minimum variance calculation of the optimal hedge ratio (Ederington, 1979; Sanders and Manfredo, 2004). Also, it is important to note that what is important when hedging is not the absolute movements of the futures and the cash/spot prices but the relationship between them, i.e., the basis.

Therefore, one could say that, if after computing the hedging ratio and the hedging effectiveness measures one finds that hedging in futures markets is still a useful tool for risk management, then it means that both markets are still related and the financialization of futures markets has not broken that link. This is the topic of the work of the next section.

3. EMPIRICAL WORK

3.1 Data

Due to their importance for food security, and in less degree for energy (i.e., biofuels), we decided to focus the empirical analysis on European wheat markets. In this respect, France, Italy and the United Kingdom are three of the major wheat-growing countries in Western Europe. Although in the last twenty years the harvested area has changed in different ways depending on the country; in all countries, yields have kept increasing. France and the UK show the highest yields exceeding the 7 tonnes per hectare.

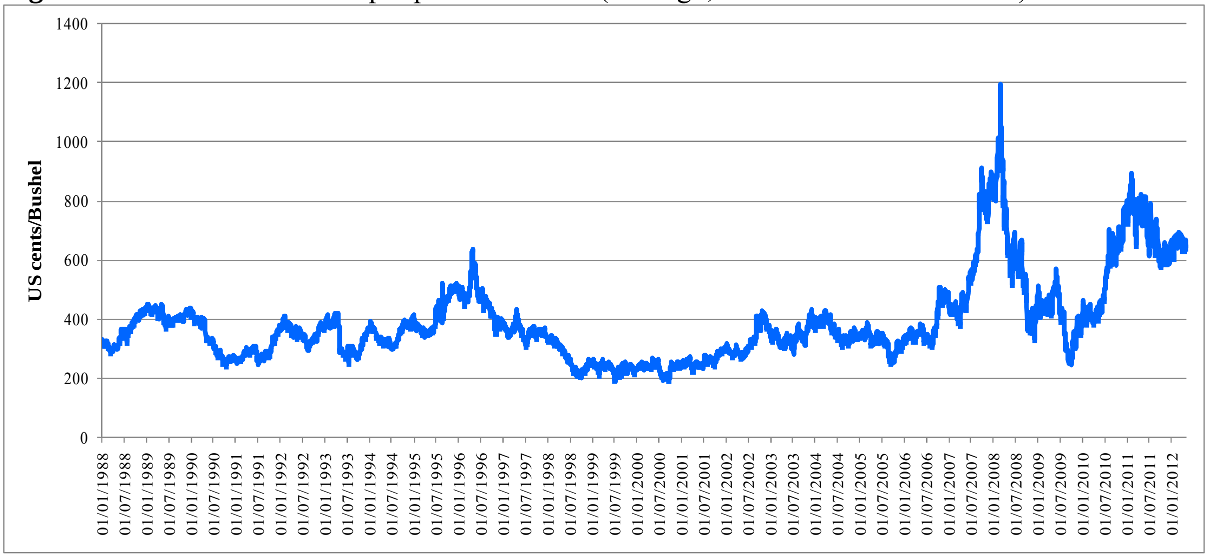
[1] Note that there are at least two ways in which futures markets can affect the physical markets: the first one is through arbitraging between the two markets. The second way is through the use that commercial entities make of futures prices for pricing their products (e.g., processors selling flour for future delivery). Clearly, the latter strategy makes sense only if the entities believe that the two markets are related. As regards the former reason, note that arbitrage will force both prices (futures and spot) to converge at the delivery time.

The price analysis was performed using data for feed wheat contracts from the London International Financial Futures and Options Exchange (NYSE LIFFE London abbreviated LIFFE) and for milling wheat contracts from the Marché à Terme International de France (NYSE LIFFE Paris abbreviated MATIF). In order to provide a comparison data from the Chicago Mercantile Exchange Group (abbreviated in CBOT) wheat contracts were also used. For LIFFE and CBOT contracts the data comprised the period 1988 until 2012, while for MATIF contracts the data were available only since 1998.

As hedging performance requires the contemporary evaluation of cash price changes, spot prices from East Anglia (UK), Rouen (France), Bologna (Italy) and Chicago (USA) were also collected.

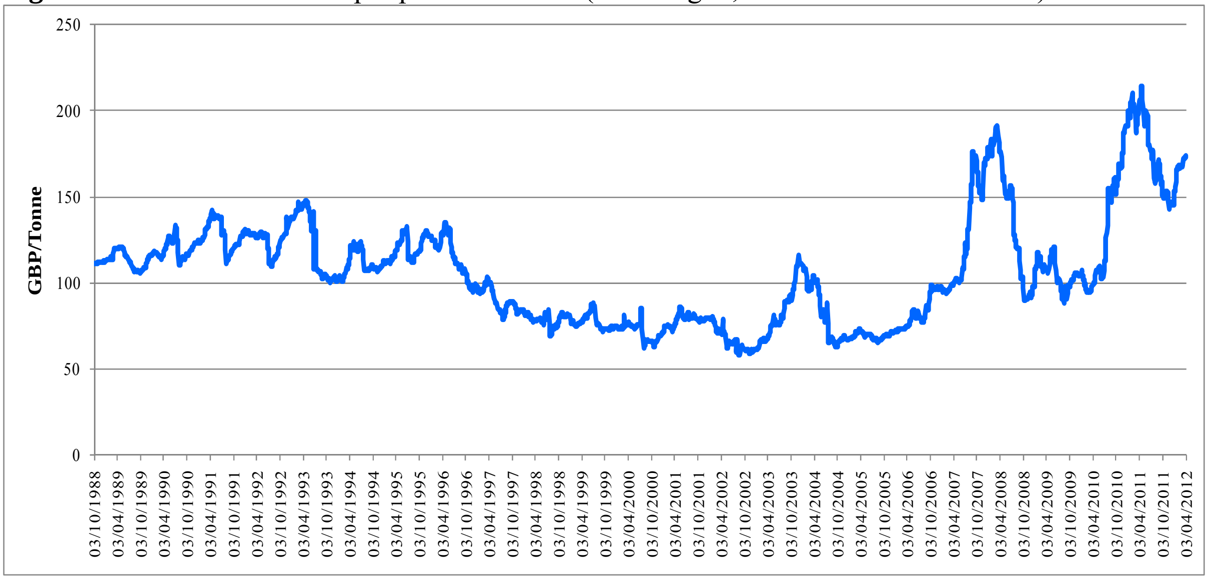
Figure 1, which presents the evolution of wheat spot prices in three EU countries during a 25 years interval and in Chicago, shows the increasing dispersion observed in commodity prices since 2007.

Figure 1a. Evolution of USA spot price for wheat (Chicago, SRW wheat – 1988-2012).



Source: CME-CBOT

Figure 1b. Evolution of UK spot price for wheat (East Anglia, Feed wheat – 1988-2012).



Source: AHDB

Wheat prices rose dramatically from late 2006 but collapsed in the second half of year 2009. Prices recovered in the second half of 2009 to levels close and, sometimes, higher than the preceding price spike. However, it seems that prices, still after the second spike, will attest to higher levels, without returning back to the levels that characterized the period up to 2006.

3.2 *Methodology*

The methodology of the paper is straightforward and based on Carter (1984) and Castelino (1989). It consisted of analysing two issues in the selected markets: first, we explored the efficiency of the future markets, and second, we addressed the effectiveness of hedging before and after 2006, i.e., two periods of very different volatility levels.

For the purpose several sub-analyses were performed such as: the correlation between spot prices and futures prices by contract, the analysis of the basis volatility, the estimation of the hedging ratios and the effectiveness of hedging.

Figure 1c. Evolution of France spot price for wheat (Rouen, Standard milling wheat – 1988-2012)

Source: La Depeche Agricole

Figure 1d. Evolution of Italy spot price for wheat (Bologna, Milling wheat # 3 – 1988-2012)

Source: AGER Borsa Merci di Bologna

3.3 *Efficiency analysis*

The continuous flow of information, public or not, force prices to fluctuate. A futures market is considered to be efficient when:

- It demonstrates that prices adjust to the information available (i.e., "price efficiency");
- It does not persistently favour one side of the market, no matter if they are "long" or "short" positions (i.e., "market bias").

As regards price efficiency, as the available information for this paper was limited only to historical prices, we tested only the notion of weak price efficiency (Fama 1970). Other notions of efficiency (i.e., semi-strong or strong) would have required availability of public information on the fundamentals (supply-demand sheets, ending stocks, stock to use ratio, and so on) or private information, respectively. From the price efficiency point of view, one would expect that the increasing role of hedge funds and commodity index traders (frequently referred to as "non-informed" traders) in futures markets would have reduced the price efficiency of the market.

The second efficiency test refers to the theory of "normal backwardation", which assumes that an inefficient market should give a structural advantage to the long positions taken by speculators with respect to the short positions taken by hedgers. According to Carter (1984) this characteristic, called thin market, is usual of markets that are less active and where futures contracts lack interest among speculators. In those conditions the hedgers, interested in transferring the risk to other agents, would accept market returns in the long-run favouring the buyers of the contracts.

The existence of the bias in favour of speculators was tested using the implication that a trade routine such as the long position taken by speculators in futures market should have earned them positive profits over time (in contrast, hedgers are supposed to be continuously net short and the losses they made are a "payment" for the price insurance they receive). In this paper, following Carter, we used the trading routines designed by Cootner (1960) and by Gray (1961).

The Gray's trading routine assumes that the speculator takes a net long position all the year round. If the annual harvest is immediately hedged, the price at harvest time must be low enough to induce speculators to invest on the long side of the hedge. Futures prices must rise continuously over the postharvest life of the contracts in order to insure profits for speculators as a whole. The hypothetical Gray's trading routine involves purchasing the futures contract closest to maturity buying it on the first trading day in the delivery month of the preceding futures contract. Then, every contract is sold on the first trading day of its own delivery month.

Gray's assumption is that hedgers' position is always net short, and then speculators, as a group, must be net long. Cootner, instead, noted that hedging was not always net short: when commitments to deliver at fixed prices are larger than commitments to buy, hedging may be net long. During the period of declining interest on short-hedging, prices must fall: under this condition a rational behaviour of speculators is to be long not for all the months but only for a part of the year, otherwise they were short.

It should be noted that in order to apply Cootner's routine to current data it was needed to explore the existence of seasonality and what the seasonality pattern was. This allowed us to adapt the trading routine to the actual price dynamics determining the months which are better for a long position and for a short one.

Cootner's empirical research on US wheat futures statistics found that, on the average, prices fell from May to October-November and rose steadily thereafter. "In short, as the crop came and the movement into commercial channels reached a peak, prices fell. As the crop was consumed, hedges were lifted and prices rose." (Cootner, 1960, p.401). Carter applied a Cootner-type trading routine assuming speculators were short, in the Winnipeg barley market, for October and November and in the CBOT corn market for September, October and November. The period hypothesised by Carter is shorter (two or three months) than the one used by Cootner.

As in Carter (1984) the forecasting ability of the futures markets was also studied[2]. As regards this test two aspects are of interest: first, whether futures prices are good predictors of spot prices at the delivery time. For this purpose, following Carter, the implied prediction of futures prices at planting time was compared with the spot prices at delivery time. This was done only for those contracts associated with the crops (i.e., the spot prices at delivery time were post-harvest prices) considering the average futures prices at the planting month and the average spot prices at the delivery month. The forecasting ability was measured by the coefficient of variation of the mean squared errors of the prediction divided by the average spot price at the delivery month.

[2] Stein (1981) suggested that the forecasting ability of the futures markets is a more useful test of market efficiency than the ones used by Fama (1970).

To allow for a comparison of the results for the studied markets (given the fact that the each of the studied markets are in different currencies), a coefficient of variation was used instead of just the mean square prediction error; i.e., the mean square prediction error was divided by the mean of the post-harvest spot price. The second aspect of interest is to observe the sign of the prediction error to verify whether there is an apparent bias (i.e., whether the errors are all positive or negative).

3.4 Hedging effectiveness analysis

While the economic theory behind hedging is still the minimum variance portfolio approach, the econometrics when estimating hedging ratios has evolved with the progress in time series econometrics; Lien and Tse (2002) provide an overview of relatively recent econometric methods to compute the hedging ratio.

According to Sanders and Manfredo (2004) minimum variance measures of hedging effectiveness have not changed dramatically since Ederington's (1979) initial use of the correlation coefficient to measure the relationship between changes in cash and futures prices. In fact, they point out that minimum variance hedging effectiveness is most commonly evaluated through an ordinary least squares (OLS) regression of the change in cash price as a linear function of the change in the futures price (Leuthold, Junkus and Cordier, 1989, p. 92), where the resulting R^2 is the measure of hedging effectiveness (Hull, 2008, p. 85).

Myers and Thompson (1989) found that the model with the prices in levels provided a poor estimation of the ratio (since the variables are normally non-stationary), the estimation of a model such as (1), i.e., in changes, provided reasonably accurate estimates (Myers and Thompson, p. 859).

The presence of unit root within the various price time serie has been tested and, in order to avoid the non-stationarity issue, the variables have been expressed in differencies. Once removed the possibility of a spurious regression and supported by the acquired stationarity of series, in this paper, we use the traditional model to compute the hedge ratio (Carter, 1984), where ΔP_{st} is the change in the spot price, ΔP_{ft} is the change in the futures price, β is the hedging ratio (α is the intercept of the regression and ε_t is the regression error) and the R^2 values give the proportionate reduction of price risk attainable.

$$(1) \qquad \Delta P_{st} = \alpha + \beta \Delta P_{ft} + \varepsilon_t$$

Furthermore we also introduced dummy variables for the years 2006 until 2012, to evaluate whether the hedging ratios and their effectiveness had been affected by the described events in futures markets. The model with dummies is given by (2):

$$(2) \qquad \Delta P_{st} = \alpha + \beta \Delta P_{ft} + \sum_{i=2006}^{2012} \gamma_i \cdot d_i \cdot \Delta P_{ft} + \varepsilon_t$$

Where d_i is the dummy variable that takes the value of 1 in year i and 0 otherwise, γ_i is the coefficient associated to the dummy, so the hedge ratio corresponding to year i is equal to $(\beta + \gamma_i)$.

It is important to note that the type of hedging varies depending on the type of the operator. All the operators working along the wheat supply chain have a potential interest for hedging, but for everyone hedging has its own meaning. Thus, in order to evaluate hedging effectiveness for farmers is needed to define planting interval and post-harvest period.

The season for growing wheat is a lengthy one, generally 10 to 11 months, beginning and ending in different periods according to the country and the type of wheat marketed (spring or winter). France, Italy and the United Kingdom differ in the cultivation calendar. In the UK the cultivation of winter wheat begins mid September to 3rd week October; in a normal season harvesting is in mid-August and is accomplished with the beginning of September. For spring wheat, instead, the drilling should be finished in March and harvesting is approximately two weeks later the winter wheat.

Anyway the spring sown wheat represents less than 5 per cent of the total wheat area and its contribution to total production is negligible3.

In France, and mostly in Italy, cultivation starts later than UK. It begins, for France and Italy, in October-mid November and finishes at the end of June (Italy) or July-early August (France). For the US the cropping calendar is approximately the same of Northern Europe: plantings in September and harvesting in July. Insofar, for Italy and the US, the post-harvest price should be taken during July; for UK and France during August is better.

According to the delivery months provided by the three Exchanges, the wheat futures price forecasts were taken from the same contracts listed in Table 2. It was assumed that the kind of hedging suitable for farmers was a long-term hedge "seasonally specified". For this, it was considered that the farmer opened the hedge in the month of the planting time which was assumed to be October for France Italy and UK, and earlier (September) for the US. Furthermore, it was also assumed that the farmer lifted the hedge after nine; ten or eleven months according to the country (see Table 2).

Table 2. Parameters adopted for wheat hedging evaluation in the different countries

Country	Exchange	Contract delivery month	Planting time (month of year t)	Post-harvest time (month of year t+1)
US	CBOT	September	September	July
Italy	MATIF	September / August (*)	October	July
France	MATIF	September / November (*)	October	August
UK	LIFFE	November	October	August

Notes: (*) The September contract is available on MATIF only until 2007.

Hedging is also used for merchants and for processors in the supply chain. The length of the hedge suitable for these categories is shorter than for farmers ("short-term hedge) and is not "seasonally specified". Merchants and processors usually hedge their physical (spot) positions all over the year holding position in the futures market for less than 10-11 month: the lengths assumed here are 30, 60 and 90 trading days. These intervals imply, approximately, one month and a half, three months and four months period respectively. It follows that the evaluation of the effectiveness for the hedges in question needs a separate computation comparing the dynamics of spot and futures prices for all the 30, 60 and 90 trading-day intervals available. Finally, as comparison with Carter (1984) hedges at very close range (7 trading days) that imply, approximately 10 calendar days were also calculated.

Every test, at the same time, provides results not only for short-hedging but also for a long-hedging procedure. The last type of hedge is common for processors; however, both types are used by merchants and traders depending on their counterpart in the transaction.

4. RESULTS AND DISCUSSION

4.1 *Results from the efficiency analysis*

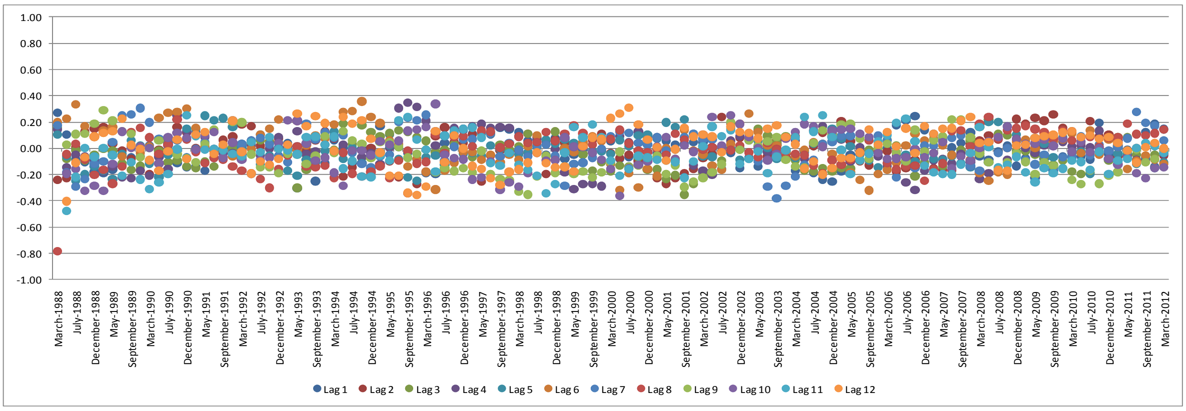
As mentioned the test for autocorrelation of the returns (first difference of logs) represents a weak-form test for efficiency. An efficient market would show low autocorrelation because expected changes in market returns should be equal to 0 if the sequence of prices follows a martingale model.[4] Figures 2 to 4 show that the autocorrelation coefficients for time lags between 1 and 12 (each with a different colour) are relatively low for all the contracts and markets. Actually, these results suggest that the expected values of the changes in market returns are relatively independent of all past

[3] Spring wheat remains of interest for farmers only because it can be sown after the turn of the year if weather dictates.

[4] A martingale is a stochastic process where knowledge of past events will never help to predict future values of the process. In particular, a martingale is a sequence of random variables for which, at a particular time in the realized sequence, the expectation of the next value in the sequence is equal to the present observed value, even given knowledge of all prior observed values at a current time.

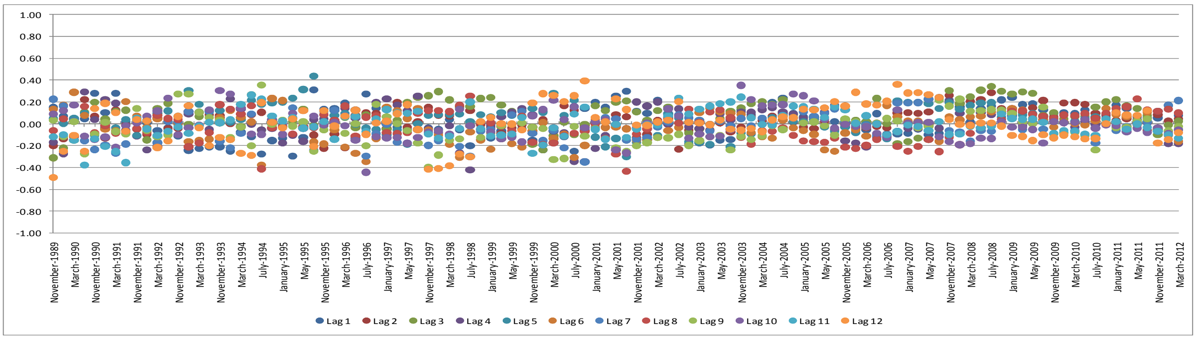
information. These results indicate that all the studied markets are price efficient, at least in Fama's weak sense. Furthermore, in comparative terms, the MATIF market seems to perform better (in terms of weak efficiency) than the other two markets as its autocorrelations are closer to zero.

Figure 2. Serial correlation coefficients for first differences between the natural logs of daily wheat futures at CBOT 1988-2012.



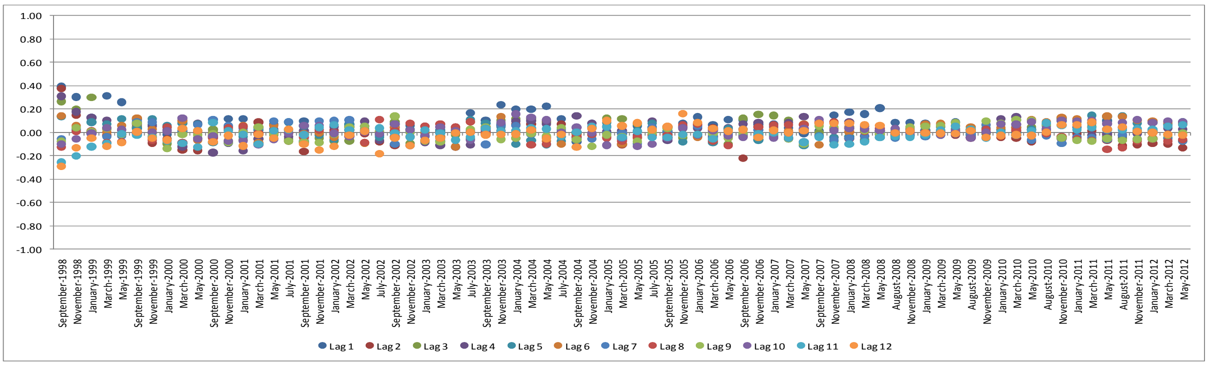
Source: Own calculation based on data presented in section 3.1.

Figure 3. Serial correlation coefficients for first differences between the natural logs of daily wheat futures at LIFFE 1988-2012.



Source: Own calculation based on data presented in section 3.1.

Figure 4. Serial correlation coefficients for first differences between the natural logs of daily wheat futures at MATIF 1998-2012.



Source: Own calculation based on data presented in section 3.1.

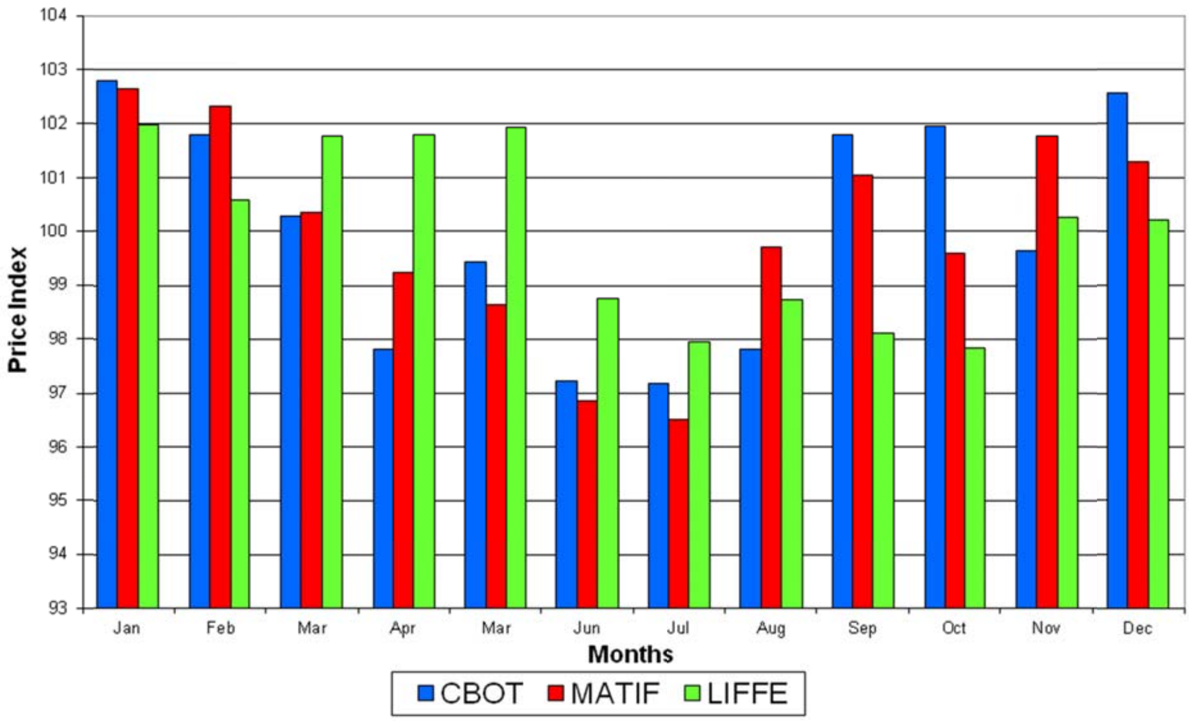
The second efficiency test, in addition to the estimate of the randomness of returns, is whether speculators perceive a premium applying Gray's and Cootner's routines described above. According to Carter (1984) "a thin grain futures market tends to favour buyers of contracts over sellers because in such a market there is often a good deal of short selling by hedgers which does not attract a sufficient amount of long buying by speculators" (p. 5). That is, a market made by buyers should ensure positive profits, over time, to long positions; in other terms, the premium for speculators becomes a long-run efficiency test because if the market ensures significant profits to speculators, this would become thin and in the long run inefficient.

The trading routine introduced by Gray (1961) represents a type of strategy that the speculator could implement. It is very simple and implies a long position all over the year. The trader acquires the contract at the beginning of the period and carries it through to March 2012. On the first day of the delivery month the trader switches forward to the next futures month. For instance, in the case of MATIF this means taking a position in the March contract in the preceding January 1 and shifting forward to the next May contract on the March 1.

In contrast with Gray's routine, Cootner (1960) recognized the fact that prices decline during a part of the year and grow in the remaining part. Thus, the speculator's strategy, in the Cootner view, should be adapted to the average behaviour of prices, in particular paying attention to the seasonality pattern. A rational behaviour by the investor must, therefore, prefer to be net long only when prices are rising, and net short when prices are declining. Due to this, to perform Cootner's routine it was necessary to estimate the seasonality pattern observed for CBOT, MATIF and LIFFE.

Figure 5 presents the seasonality analysis using nearby futures prices[5]. As regards the seasonality for CBOT data, on the average, prices fell from January to July and rose steadily thereafter. The seasonality in MATIF data is not quite different from the observed in CBOT and both show much clear patterns than the LIFFE. While seasonality in the East Anglia spot price (the "physical" market) is clear and well shaped, LIFFE nearby futures prices show a different pattern, without the expected growing and descending phases. Instead, it presents two steps, one between May and June (down) and other between October and November (up).

Figure 5. Average monthly price indexes of wheat futures.



Source: Own calculation based on data presented in section 3.1.

It is interesting to mention that the seasonality found for CBOT wheat contracts in Cootner's paper is different than the one found in the present analysis. Besides covering a different period (Cootner's data covered the period 1928 to 1954), he did not include all the year but only a selection of them that were deemed as stable -those years, which according to Telser (1958), the wholesale price index of the Bureau of Labor Statistics had changes of less than 5 per cent.

In addition, it should be noted that today's pressure on short hedging is probably not only represented by farmers (as in the period covered by Cootner's analysis) but also we have to add the

[5] Although the seasonality patterns using nearby futures prices and spot prices are similar, they are not the same. For instance, in the Chicago market, spot prices take the lowest value during July/August, while using nearby futures prices, the minimum falls approximately one month before (June or July). Because of this, we used futures prices for the calculation of seasonality indices as those are the prices that would matter for speculators.

influence of other supply chain stakeholders (as processors, merchants and traders) with their different needs.

Table 3 reports the average profits per trade that could be earned, before brokerage fees, following Gray's (i.e., named 'long only' in the Table) and Cootner's (i.e., named 'long and short in the Table') routines. Cootner's routine shows profits higher than Gray's routine for all the markets.

While in CBOT and in LIFFE markets the losses observed with Gray's turns into a gain with Cootner's; in the MATIF market both routines showed a profit, increasing slightly from €2.36 per trade (Gray) to €2.74 (Cootner). Nevertheless, in all the cases the average profits were not statistically different from zero (using a t student test) at 95 per cent significance; therefore, the conclusion from Table 3 is that the none of the routines in the three studied markets show a systematic bias in favour of speculators. It is important to note that prices at the beginning and ending dates show an upward trend that probably affects the profit level per trade.

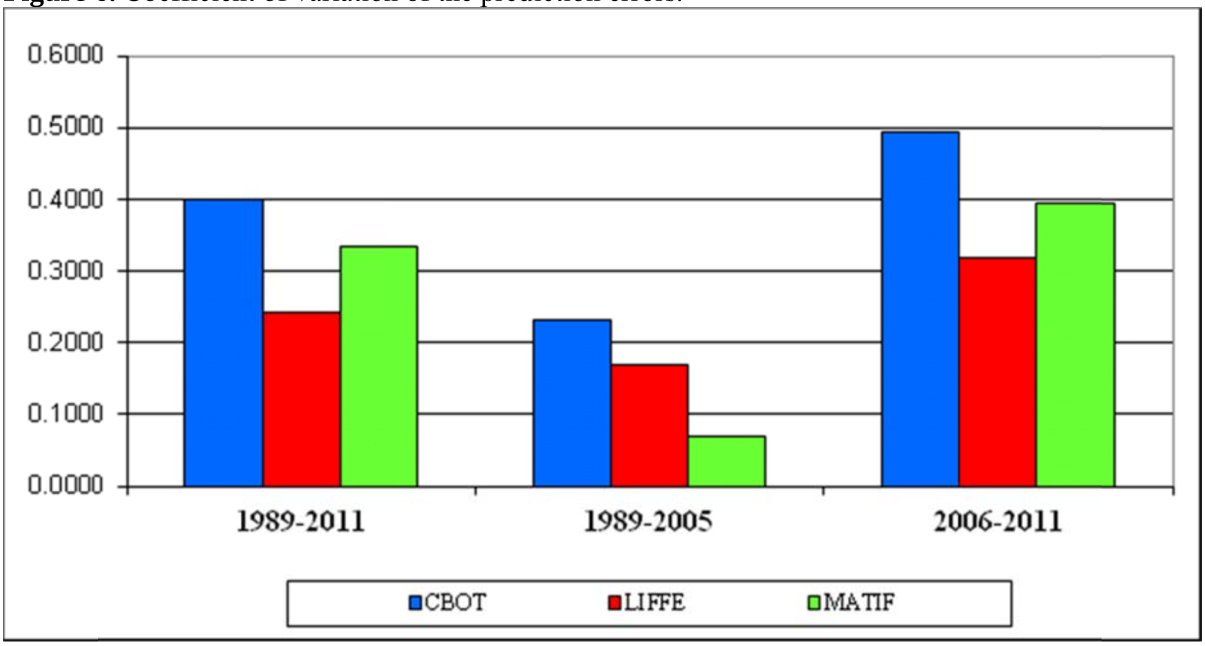
Table 3. Results of trading routines in wheat futures

Exchange	Speculative market position	Dates	Price at beginning and ending dates	Number of trades	Average Profit / Loss per trade	t-Ratio
LIFFE	Long only	1/11/89 -1/03/12	£/t. 110.5-164.8	112.00	£/t. -1.01	-0.06
LIFFE	Long and Short	1/11/94 – 1/11/11	£/t. 107.1-147.8	102.00	£/t. 0.39	0.03
MATIF	Long only	1/09/98 – 1/03/12	€/t. 118.9-214.5	73.00	€/t. 2.36	0.11
MATIF	Long and Short	2/11/98 – 1/11/12	€/t.124.3-187.8	78.00	€/t. 2.74	0.14
CBOT	Long only	1/03/88 – 1/03/12	$/bu. 3.2-6.6	120.00	$/bu. -0.06	-0.08
CBOT	Long and Short	1/03/88 – 1/12/11	$/bu. 3.2-6.0	143.00	$/bu. 0.06	0.10

Source: Own calculation based on data presented in section 3.1 .

With respect to the forecasting ability of the futures markets, Figure 6 shows that the prediction power in all the markets[6] is between 60 and 70 per cent when we consider the entire sample, but the prediction forecast worsens when the period 2006-11 is considered; however, it should be noted that this period is too small to be conclusive about.

Figure 6. Coefficient of variation of the prediction errors.



Note: Data for MATIF Exchange are available since year 1999 instead of 1989.
Source: Own calculation based on data presented in section 3.1.

6 The prediction test for the MATIF Exchange considered the cash prices referred to the Rouen market.

The data show that the sign of the prediction errors were both positive and negative without any clear bias.

4.2 Results from the hedging effectiveness analysis

Table 4 presents the variability of futures markets returns reporting the volatilities for the same three periods listed in Table 1, for all the futures contracts. As shown in Table variability increases over time in all the futures Exchanges.

Table 4. Volatilities of wheat futures markets daily returns.

Exchange	1988 - 1997	1998 - 2005	2006 - 2012
CBOT	0.18	0.20	0.31
MATIF	n.a.	0.10	0.21
LIFFE	0.08	0.12	0.18

Notes: Standard deviations of logarithmic changes in daily futures prices at an annual rate; average for all futures contracts with delivery month included in the calendar years.
Source: Own calculation based on data presented in section 3.1 .

It is commonly assumed that less active markets (thinner markets), such as the European ones, should exhibit more price volatility than more active markets such as CBOT wheat. Contrary to the expectations, variability was bigger in the CBOT than in the European markets.

As pointed out by United Nations (2011) since the beginning of the last decade, commodity derivative markets, including those for agricultural commodities, have experienced significant inflows of funds from non-traditional investors. Probably CBOT, as more important market at international level, attracts more liquidity and investors than the other markets. Presumably in CBOT the presence of non-traditional investors is greater than anywhere. The financial investors hold large futures positions including in basic agricultural future contracts such as wheat, maize and soybeans as well as in cocoa, coffee and sugar. Although speculators are needed to ensure market liquidity, too many speculative funds should produce in CBOT more frequent and erratic price changes than in the European exchanges.

In general terms, but not always, cash prices variability is lower than for futures contracts. Looking at Tables 1 and 4 it is worth noting that, during the period 1998-2005, the variability of spot prices exceeded that of futures contracts.

Risk transfer and price discovery are two of the major contributions of futures markets to the organization of economic activity (Garbade and Silber, 1983). While the former refers to hedgers using futures contracts to shift price risk to others, the latter denotes the use of futures prices for pricing commercial transactions on the cash market. The significance of both contributions depends upon a close relationship between the prices of futures contracts and cash commodities (op. cit., p. 289).

Variability of spot prices (Table 1) depends on price fluctuations in the market and measures the actual price risk that farmers, merchants and processor must face. Hedging cannot completely eliminate the effect of price risk on income, can only reduce it as long as, in the hedging interval, the variability of the basis (nearby futures price minus the cash price) is lower than the cash price variability. Thus, in addition to the efficiency of the wheat futures markets, we have to explore whether the basis has become more erratic in futures markets and less useful for hedging. The basis risk could be associated with investors' activity as excess of trade activity unrelated to fundamentals could distort the relationship between futures and spot markets and increase the basis risk.

The level of the basis risk (i.e., when futures and cash prices do not evolve in a similar way during the period before contract expiration) is linked to the correlation between spot and futures prices. At the starting of the series, MATIF, for both France and Italy, show low levels of correlation, which are then steadily increasing to similar results to those of a mature market such as the CBOT. The data also show that the degree of association fell during a relatively short interval at the beginning of 2000 to 2003; however, after 2004, and especially in the high volatility years, correlation became high in all the studied markets.

The traditional purpose of hedging is to minimize potential losses from an adverse change in spot prices. Thus, the hedging activity consists to exchange price risk (i.e., the risk the change in spot prices) by risk basis (i.e., risk derived from a change in the basis).

Tables 5 and 6 provide the results of the analysis of the hedging effectiveness of futures contracts for all the studied markets. It is important to note different operators along the supply chain, have their own particular type of hedge. Thus, farmers typically should go short on futures (i.e., sell futures contracts) near the planting season and continue that short position until harvesting months when hedges are lifted. This would allow them to hedge against changes in spot prices between the planting and harvesting time. The results for farmers are presented in Table 5.

Other operators of the supply chain, such as merchants or processors, do not need to hedge in a specific season of the year as in the case of farmers, but they do so throughout the year and for periods which are much shorter than the planting-harvesting season typical for farmers (i.e., the short-term hedges). The results for hedges for lengths of 7, 30, 60 and 90 days are presented in Table 6.

Tables show the results of OLS regressions in which the hedge ratios are set equal to the estimated β coefficients and the regression R^2 values provides the proportionate reduction of price risk attainable. For years of high volatility the stability of the estimated parameters has been investigated with the use of slope dummy explanatory variables.[7]

Table 5. Estimates of effectiveness of hedging wheat by farmers.

Cases	Coefficients		R^2	Slope dummies for years with high variability					Obs.
	α	β		β_2006-07	β_2007-08	β_2008-09	β_2009-10	β_2010-11	
CBOT - Chicago									
Farmer's hedging	10.25	0.39	0.14						448
	2.36	*8.55*							
With year dummies	11.94	0.86	0.67	0.19	-1.67	-0.42	2.15	-0.73	448
	3.92	*13.51*		*1.85*	*-18.29*	*-5.39*	*10.81*	*-3.93*	
Liffe - East Anglia									
Farmer's hedging	-5.79	1.01	0.73						330
	-7.58	*29.95*							
With year dummies	-6.12	1.12	0.87	-0.15	6.73	-1.62	0.39	-0.85	330
	-10.26	*23.41*		*-2.53*	*8.72*	*-8.79*	*5.30*	*-9.01*	
Matif - Rouen									
Farmer's hedging	-8.71	0.82	0.64						249
	-7.71	*21.10*							
With year dummies	-7.71	1.26	0.70	-0.47	2.93	-0.54		-1.41	249
	-6.73	*8.69*		*-3.13*	*4.65*	*-2.57*	*0.00*	*-3.35*	
Matif - Bologna									
Farmer's hedging	-10.61	0.78	0.40						286
	-9.67	*13.81*							
With year dummies	-11.26	0.78	0.46	-0.10	2.60	-0.05	0.78	0.27	286
	-8.77	*4.41*		*-0.51*	*2.82*	*-0.20*	*2.91*	*0.63*	

Results in Table 5 show that when the entire sample is used, the performance of the European Exchanges, in terms of the variance reduction that farmers could have attained through hedging, is better than in the Chicago market. Thus, a US farmer hedging 39 per cent of his wheat using the Chicago wheat futures would have reduced his price risk only by 14 per cent; whilst the reduction using the European Exchanges ranged from 40 per cent (for the case of spot prices from Bologna and the MATIF Futures Markets) to 73 per cent (for the East Anglia spot prices and the LIFFE Futures Markets).

It is important to note that the results using the entire sample mask dramatic changes in the hedging ratios since 2007 for all the cases. As shown in Table 5 the optimal ratios change

[7] It is should pointed out that the value of the hedge ratio can be above one (i.e., the proportion of the physical commodity hedged under futures contracts could be more than the actual physical in hand, this is due to the fact that the computation of the number of future contracts to buy or sell does come from the solution of a portfolio problem, where the operator decides the optimal demand for physical commodity and futures contracts).

significantly by the subsequent years from one year to another (e.g., case of LIFFE-East Anglia from 2007/08 to 2008/09).

Table 6. Estimates of effectiveness of short-term wheat hedging.

Cases	**Coefficients**		R^2	**Slope dummies for years with high variability**							**Obs.**
	α	β		β_2006	β_2007	β_2008	β_2009	β_2010	β_2011	β_2012	
CBOT - Chicago											
7 days hedge	0.06	0.86	0.72								6,297
	0.37	*128.01*									
With year dummies	0.10	0.84	0.73	-0.08	0.07	0.01	0.14	-0.08	0.09	0.06	6,297
	0.61	*63.47*		*-2.04*	*2.83*	*0.76*	*4.62*	*-3.44*	*3.70*	*0.91*	
30 days hedge	0.33	0.85	0.77								6,274
	1.11	*145.77*									
With year dummies	0.26	0.86	0.78	0.12	0.04	-0.03	0.21	-0.21	-0.02	0.11	6,274
	0.86	*72.05*		*3.37*	*2.04*	*-1.82*	*7.76*	*-9.73*	*-0.79*	*1.26*	
60 days hedge	0.44	0.92	0.80								6,244
	1.10	*158.84*									
With year dummies	0.22	0.92	0.81	0.17	0.04	-0.03	0.42	-0.16	-0.02	0.15	6,244
	0.56	*79.54*		*4.79*	*1.99*	*-1.84*	*14.41*	*-7.75*	*-0.79*	*1.18*	
90 days hedge	0.54	0.94	0.81								6,214
	1.13	*161.34*									
With year dummies	0.41	0.93	0.81	0.11	0.03	-0.04	0.18	-0.01	0.16	-0.36	6,214
	0.83	*80.89*		*3.00*	*1.68*	*-2.65*	*5.44*	*-0.68*	*6.32*	*-4.48*	
Liffe - East Anglia											
7 days hedge	0.03	0.55	0.32								6,101
	0.65	*53.07*									
With year dummies	0.00	0.35	0.34	0.22	0.33	0.39	0.27	0.33	0.24	0.57	6,101
	0.08	*21.45*		*2.69*	*10.49*	*11.09*	*6.23*	*10.23*	*7.79*	*5.45*	
30 days hedge	0.04	0.80	0.65								6,078
	0.56	*106.93*									
With year dummies	-0.07	0.60	0.68	0.30	0.32	0.38	0.29	0.31	0.17	0.45	6,078
	-0.99	*48.12*		*4.46*	*15.16*	*16.28*	*8.66*	*13.91*	*6.80*	*8.14*	
60 days hedge	0.00	0.89	0.78								6,048
	0.04	*145.41*									
With year dummies	-0.06	0.77	0.78	0.24	0.15	0.22	0.20	0.15	0.15	0.25	6,048
	-0.70	*70.11*		*4.56*	*8.43*	*12.34*	*6.31*	*8.15*	*7.32*	*3.79*	
90 days hedge	-0.05	0.95	0.86								6,018
	-0.54	*192.66*									
With year dummies	0.01	0.88	0.86	0.04	0.06	0.12	0.13	0.05	0.12	0.04	6,018
	0.08	*96.53*		*0.99*	*4.29*	*8.59*	*3.88*	*3.51*	*7.03*	*0.55*	
Matif - Rouen											
7 days hedge	0.04	0.72	0.48								3,670
	0.51	*58.40*									
With year dummies	0.03	0.54	0.50	0.22	0.35	0.32	0.21	0.15	0.01	-0.05	3,670
	0.36	*14.33*		*2.55*	*7.58*	*6.90*	*2.74*	*3.21*	*0.15*	*-0.53*	
30 days hedge	0.07	0.93	0.85								3,647
	0.68	*141.03*									
With year dummies	-0.09	0.82	0.85	0.16	0.21	0.12	0.10	0.08	-0.01	0.25	3,647
	-0.84	*39.42*		*3.42*	*8.60*	*5.03*	*2.37*	*3.26*	*-0.52*	*4.68*	
60 days hedge	0.12	0.95	0.91								3,617
	1.05	*191.33*									
With year dummies	-0.06	0.92	0.91	0.04	0.07	0.03	0.10	0.05	-0.05	0.10	3,617
	-0.51	*60.41*		*1.22*	*3.96*	*1.50*	*2.36*	*2.61*	*-2.43*	*2.48*	
90 days hedge	0.15	0.99	0.94								3,587
	1.28	*241.48*									
With year dummies	0.25	0.95	0.94	-0.01	0.04	0.07	0.22	0.06	-0.02	0.03	3,587
	1.98	*79.64*		*-0.29*	*2.74*	*4.65*	*6.47*	*3.87*	*-1.42*	*0.89*	
Matif - Bologna											
7 days hedge	0.09	0.35	0.18								3,670
	1.13	*28.85*									
With year dummies	0.11	0.34	0.19	0.07	0.02	-0.03	-0.04	-0.05	0.12	-0.07	3,670
	1.27	*8.92*		*0.78*	*0.33*	*-0.57*	*-0.52*	*-1.02*	*2.49*	*-0.67*	
30 days hedge	0.15	0.70	0.57								3,647
	0.94	*70.20*									
With year dummies	-0.07	0.71	0.59	0.19	0.02	-0.19	-0.09	0.04	0.15	-0.12	3,647
	-0.45	*22.51*		*2.72*	*0.50*	*-5.16*	*-1.44*	*1.10*	*3.81*	*-1.53*	
60 days hedge	0.04	0.81	0.71								3,617
	0.20	*93.43*									
With year dummies	-0.29	0.92	0.73	0.07	-0.03	-0.31	-0.37	-0.12	0.12	-0.30	3,617
	-1.45	*35.70*		*1.29*	*-0.86*	*-10.05*	*-5.17*	*-3.74*	*3.45*	*-4.69*	
90 days hedge	0.00	0.90	0.78								3,587
	0.01	*114.28*									
With year dummies	-0.13	1.00	0.80	-0.06	-0.06	-0.27	-0.10	-0.13	0.11	-0.40	3,587
	-0.54	*45.09*		*-1.26*	*-2.27*	*-9.85*	*-1.49*	*-4.78*	*3.53*	*-6.58*	

It is obvious from Table 5 that if farmers had computed their hedging ratios based only on historical price information the errors (and therefore losses from the hedging strategy) would have been significant. Probably the appropriate strategy for computing hedging ratios would have been that proposed by Myers and Thompson (1989) and incorporate additional relevant information (e.g., supply and demand information).

The hedging effectiveness of the short-term hedges (i.e., Table 6) are, in general, high and sometimes very high (with more than 75 per cent of price risk reduction in several cases). The short-term hedges improve their performance with the lengthening of the hedge duration. This behaviour is common to all markets.

In contrast with the results obtained for the farmers' hedging, the inclusion of the dummy variables to adjust the ratios do not improve much the coefficient of determination (despite the fact that in many cases they are statistically significant) of the short term hedging regressions, i.e., the changes in the hedging ratios add little to the reduction in the price risk. The value of the ratios obtained in Table 6 would indicate that for shorter periods than those used for the farmers' hedging, the futures and the physical markets would be still closely related and therefore useful for hedging price risk.

It should be noted that when the physical market is more distant from the futures centre, as in the Italian case (i.e., spot price in Bologna – and futures price in MATIF, which is based in France), the hedging effectiveness lowers. Thus, respect to Rouen prices, the basis absolute level between Bologna prices and MATIF prices is much higher due to greater transportation costs.

Finally, as regards the 7 days hedges, the studied markets show that CBOT Exchange performs substantively better than the European Exchanges. Probably this is related to an issue of market liquidity.

5. CONCLUSIONS

The primary aim of this paper has been to study two related topic: first, the efficiency of two European wheat futures markets, LIFFE and MATIF (and also CBOT for comparison purposes) and second, to assess the usefulness for hedging purposes, i.e., for different commercial entities to swap price risk for basis risk. The latter topic is particularly important because if due to the increasing use of futures contracts as part of financial portfolios, futures markets become divorced from spot markets, it would mean one risk management tool less for the commercial entities dealing with commodities (e.g., farmers, traders, processors).

In general, the results indicate that the increasing role of non-related-with-the physical investors, as hedge funds and commodity index traders, have not reduced the price efficiency and usefulness for hedging of the three selected Exchanges. The several weak-form tests such as serial autocorrelation analyses did not reject the hypothesis that all the studied wheat futures markets were efficient.

As regards whether holding a speculative position, structured in a rational way, would bring consistently profits, the result show that in the last 20 years these profits are not statistically different from zero. Based on this evidence the European Exchanges futures contracts perform as well as the US CBOT.

The analysis of the forecast performance of futures markets showed that the prediction capacity of in the three markets was modest with a coefficient of variation of the error that was between 25 to 40 per cent.

With respect to the effectiveness of hedging, the results indicate that this is still a viable alternative for commercial entities as spot and futures prices evolve closely. In other terms, particularly as short-term hedges, the basis has not been affected by the instability observed in commodity markets.

The results of the hedging effectiveness can provide an assurance (as an implicit test) that the increasing presence of financial speculation has not made futures markets divorce from the physical markets. It is only for lengthy period hedges (such as farmers' hedges) that appear to be some concerns of their effectiveness.

The above results imply that futures markets are not only still efficient tool in risk management but may also be a useful tool for food security purposes; however, it is important to stress that the analysis carried out in this paper is only valid for the regions where the Exchanges are located and the use of these Exchanges or other for food security would require to compute the basis using appropriate spot prices and the most adequate futures contracts.

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