Spot and Futures Prices of Agricultural Commodities: Fundamentals and Speculation

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Abstract

This paper investigates the long-run relationship between spot and futures prices for corn and soybeans, for the period January 2004 -September 2010. We apply cointegration methodology in the presence of potentially unknown structural breaks in the commodities prices and we then study the causality relationships between spot and futures prices within each specific sub-period identified, with the aim to analyze where changes in spot and futures price originate and how they spread. Empirical estimates highlight the following evidence: i) breaks relate to events that have significantly affected the supply and demand of corn and soybeans for food and energy purposes; ii) sub-periods consequently identified express different dynamics in the causal relationship between spot and futures prices and support the idea that many factors contributed to the 2007-2008 food price increase.

Keywords: *commodity, futures markets, price discovery, cointegration, structural breaks*
JEL classification: **C32, G13, G14, Q11**

1 Introduction

Over the last few years commodity prices have undergone strong fluctuations as a consequence of economic, political and financial issues that have reshaped the global economic equilibrium.

Most of the anomalies recorded during this period were attributed to the growing role played by financial instruments, specifically derivatives. In fact, although it is well known that derivatives provide economic benefits, such as information dissemination, price discovery and efficient allocation of resources (Chan 1992, Schwarz, Szakmary 1994), the tightened cross-market linkages that result from derivatives trading also fuel a common public and regulatory perception that derivatives generate or exacerbate volatility in the underlying asset markets, since they represent not only an important tool for managing risk exposure, but also an opportunity for trading and speculation. In particular, the low cost of futures trading may induce excessive speculation which, in turn, may cause commodity prices to vary excessively, with destabilizing effects in the markets.

In this regard, the study of the dynamics of futures and spot prices for agricultural commodities assumes particular importance, especially within the framework of the

recent global food balances crisis, where concerns have been raised about the possible role of futures and speculation in increasing the price of some agricultural commodities.
Some interesting studies have already analyzed the spot-futures relationship with the aim to shed light on the price discovery process. However, very few of them have focused on the time dynamic of the relationship and on causality linkages.
We intend to fill this gap by applying cointegration methodology in the presence of potentially unknown structural breaks in the prices of corn and soybean, using a recent methodology proposed by Keiryval and Perron (2009). We then study the causality relationships between spot and futures prices within each specific sub-period identified, using the procedure developed in Toda and Yamamoto (1995), in order to analyze where changes in spot and futures price originate and how they spread.
We focus on corn and soybeans, two of the most significant food commodities traded in global financial markets, and we use weekly data of spot and future prices from January 2004 to September 2010.
This work offers two new insights. Firstly, from a methodological point of view, while previous studies analyzed the long-run equilibrium relationship between spot and futures prices using conventional cointegration analysis, we use a refined methodology to analyze the existence of a potential structural break in the cointegration vector in order to gather the time dynamic of the relationship, which is important in a period of high price movements. To the authors' knowledge this procedure has never been applied to investigate the long-term dynamics between spot and futures prices in the corn and soybean markets. Secondly, we specifically focus on the price discovery role of spot and future markets during the recent food price crises with the aim to contribute to the debate on the role of financial markets speculation in food price increases. The topic is important as it has significant impacts on the financial and commodity industries, and society as a whole as well as having major policy implications.
The paper is organized as follows: Section 2 describes the theoretical framework. Section 3 presents the dataset used for the purpose of the study and a brief analysis of spot and futures price trend. Section 4 proposes the econometric methodology and section 5 develops the empirical results. Section 6 includes the discussion and final remarks.

2 Theoretical framework

Theoretically, the relationship between spot and futures prices can be derived from the spot-future parity, which implies that spot and futures prices should move together across time to avoid constant arbitrage opportunities based on the spot-futures relationship (Hull, 1997). Intuitively, since spot and futures prices for any commodity are driven by the same underlying information, they should be closely related; the exact nature of this relationship depends on many factors, among which seasonal effects, the nature of the commodity (storable or non-storable) and market expectations.

The theoretical equilibrium relationship between spot and future prices is a long-run, rather than a short-run, connection, and can be tested by examining whether spot and futures prices are cointegrated. There already exists a vast literature that highlights the long-run equilibrium relationship between commodities spot and futures prices (among others, Martin and Garcia 1981, Hokkio and Rush 1989, Wahab and Lashgari 1993, Giot 2003, Garcia and Leuthold 2004, Hernandez and Torero 2010), but only a few studies examine the time dynamic of such a relationship, i.e. the existence of a potential structural break in the cointegration vector (Dawson et al.. 2010; Maslyuk and Smyth 2009).

Such a methodological refinement is important. In conventional cointegration analysis, cointegration vectors are assumed to be time invariant; however, in the long-run, the relationship between the series may change due to a break, and the time-invariant formulation of the cointegrating vector will no longer be appropriate (Hansen 1992). Since commodities have experienced in recent years sizeable and long-lasting price changes (see Figure 1 in Section 3), it is likely that this methodology is able to capture more accurately the relationship between spot and futures prices, and, specifically, to properly analyze their causal relationship.

The study of the causal relationship between spot and futures prices is functional to the analysis of the “price discovery” role of spot and futures markets, defined as the lead-lag relationship and information flows between spot and futures markets (Schroeder and Goodwin 1991, Yang et al.. 2001, Brooks et al.. 2001). Accordingly, a market that reflecting new information more rapidly is said to have a price discovery function.

The issue of price discovery is significant in the light of the debate about the relation between the diffusion of financial instruments and the increase in food commodities prices. In fact, although it is common knowledge that derivatives provide economic benefits, such as information dissemination, price discovery and efficient allocation of resources, there is a widespread public and regulatory perception that such financial instruments generate or exacerbate excessive speculation which, in turn, forces prices away from their fundamental value, with destabilizing effects on real markets (Gerety, Mulherin 1991, Fleming, Ostdiek 1999).

However, it is important to correctly understand the meaning of the causal relationship between spot and futures prices, since, sometimes, the notion of price discovery is improperly used to evaluate hypothesis about the role of speculation in commodities price increase and decrease: when changes in prices appear first in the futures market, speculation may be an important determinant, vice-versa if changes in prices appear first in the spot market, they are caused by changes in market fundamentals that affect the supply/demand balance for the commodity (Kaufmann and Ullman 2009).

This way of interpreting the causal relationship between spot and futures prices is conceptually misleading, since price discovery does not necessarily reflect the existence of speculation, but the way prices echo new or unexpected information and spread this information through markets. See Irwin et al.. (2009) for a comprehensive explanation about the misunderstanding of the role of speculation in commodities price boom.

Empirical findings generally support the price discovery role of futures markets, i.e. spot prices are usually discovered in the future markets. Indeed, spot and futures prices on the same commodity have the same fundamentals and change if new information emerges that causes market participants to revise their estimates of physical supply and/or demand. Since contracts sold on futures markets generally do not require the delivery of the commodity but can be implemented immediately with little up-front cash, futures markets generally react more quickly than spot markets (Silvapulle and Moosa

1999). In particular, Garbade and Silber (1983) analyze the price discovery for four storable commodities including corn and soybean and conclude that futures markets generally dominate spot markets in registering and transmitting information. Crain and Lee (1996) also find that changes in wheat futures prices lead changes in spot prices, confirming that futures markets dominate spot markets in the price discovery process. In more recent years, Yang et al.. (2001) confirmed that futures markets play the dominant role in the price discovery process for storable commodities. Similarly, Henandez and Torero (2010), who analyzed spot and futures prices for wheat, corn and soybeans, find evidence that future prices Granger-cause spot prices more often than the reverse - particularly for corn and wheat. They also find that the causal relationship is remarkably stronger than in the past and adduce this result to the increasing importance of electronic trading of futures contracts, which results in more transparent and widely accessible prices. Other studies, however, have undermined these results and find that spot prices lead futures prices (Quan 1992, Kuiper et al.. 2002, Mohan and Love 2004)

The present analysis intends to extend these previous studies by examining and interpreting, across the recent food crises, the causal relationships in spot and futures markets within the sub-periods identified by structural breaks.

3 Data issues

In our analysis we focalized the attention in weekly spot and futures prices. The specific spot prices considered are corn U.S. No.2 yellow FOB U.S. Gulf and soybeans No.1 FOB U.S. Gulf. These quotations are the leading benchmark price for international trade and are considered as reported by the USDA on Friday of each week. Future prices are collected from DataStream and are from CBOT. Provided that futures prices with different maturities are traded every day, the data were compiled using prices from the nearby contract, but contracts are rolled over to the next contract on the first business day of the contract month; this is the standard procedure in the literature since the nearby futures contract is highly liquid and the most active (see Crain and Lee, 1996; Yang et al.. 2001; Hernandez and Torero 2010). The sample period comes from January 2004 to September 2010. All prices are in U.S. dollars per metric ton (US$/MT). Futures prices are denoted in U.S. cents per bushel, which were subsequently converted into US$/MT for comparison purposes with spot prices.

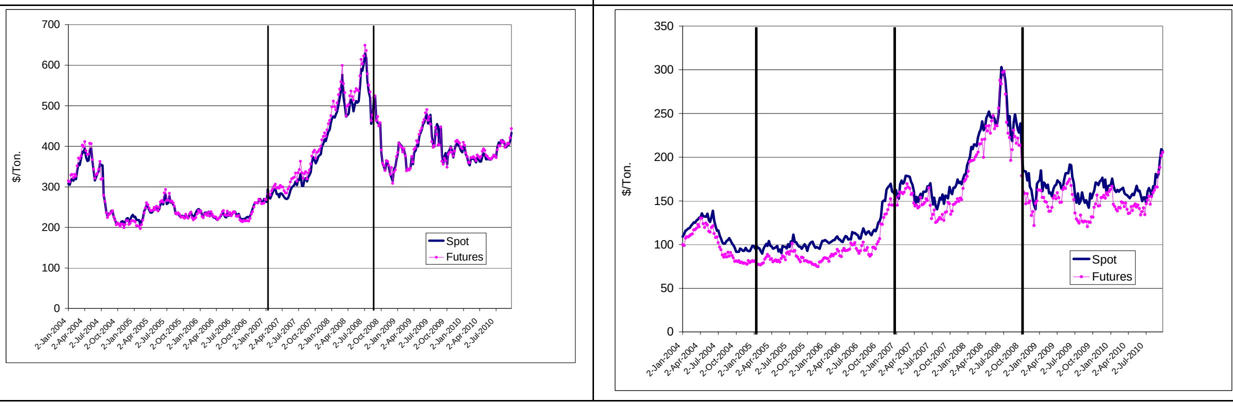
As we are interested in longer-term price movements, we use weekly values instead of daily observations (Kaufmann, Ullman 2009). This change reduces the likelihood of finding a causal relationship (Schwarz and Szakmary, 1994). Additionally, there is no evidence that the use of weekly data affects our results and conclusions, since they are substantially unaffected when we repeat the analysis using daily data.

Price evolutions of the over the period considered are showed in figure 1 and the summary statistics for a seven-year period are presented in tab. 1. The main evidence is that these prices reached unprecedented heights during mid-2008 and then subsequently declined with remarkable speed.

Several factors influenced the price dynamics during the period considered, among them we recall the strong increase commodities demand from China and India, the adverse weather conditions, the biofuels rush, the uncontrolled oil price growth and the global financial crisis. With regard to soybean from the end of 2006, harvested areas recorded a strong fall as farmers shifted land to corn, which offered attractive returns and prices that started continuous and uninterrupted growth. The supply scarcity in the following months pushed the price up very high levels within a year but prices dropped suddenly the following year. This decline was triggered by the prospect of improved crop output, combined with weak demand for oilseed products. In the case of soybean, the downturn in energy prices also contributed to the fall in prices. With regard to corn, prices increased first during the beginning of 2007, then slipped slightly to be followed by a new, very strong increase. At the turn of 2007, corn prices went through a moment of particular impetus induced by the ethanol boom which absorbed increasing amounts of production (about one-fifth of the previous harvest production was used for the distillation of biofuel). This situation was intensified by the dry climate that reduced yields. However, in the following period, high maize prices gave way to a substantial increase in plantings and this, together, with favorable weather conditions, boosted world output with an ensuing slight fall in prices.

As regards volatility, coefficients of variation indicate that corn and soybean spot prices were quite similar over the period whereas the corn futures price appeared to vary more than soybean futures price.

Soybean | Corn



Source: USDA and CBOT

Note: Black vertical lines denote structural breaks detected in par. 5

Figure 1. Trend of spot and futures price of Soybean and Corn

Table 1. Summary statistical information

	Soybean		Corn	
	Spot	***Futures***	***Spot***	***Futures***
Mean ($/Ton)	334.2	338.9	149.0	134.0
Standard Deviation ($/Ton)	95.9	101.2	44.6	45.5
Coefficient of variation (%)	28.7%	29.9%	29.9%	34.0%
Range ($/Ton)	425	453	214	224
Min. ($/Ton)	204	197	90	75
Max. ($/Ton)	629	649	303	298

Source: our elaboration of USDA and CBOT data

4 Econometric methodology

In our study, we analyze the long-run relationship between spot and future prices of corn and soybean during a period when evident breaks occurred, as fig. 1 highlights. Considering that, traditionally, spot and the relative nearby future contracts are cointegrated and considering moreover the significant changing dynamics recorded by the series during the period considered, in this study we search for a cointegration relationship that accounts also for structural breaks. Subsequently, for the sub period detected from the procedure utilized, we investigate the price discovery process using the Granger causality approach.

Specifically, to address the research question of this paper, the approach starts by investigating the order of integration of the variables. With this objective in mind, considering that testing for unit root of a series in presence of structural break using a traditional augmented Dickey-Fuller (1979) technique provides biased results (Perron, 1989), the order of integration of the variables is tested using also an alternative methodology. The first test used is the GLS augmented Dickey-Fuller (ADF-GLS) test of Elliot *et al.*. (1996) and the second is the Zivot and Andrews (1992). The ADF-GLS has a unit root under the null hypothesis and does not assume the presences of structural breaks. On the other hand, the Zivot and Andrews (1992) test is a sequential test that allows the existence of one endogenous break, where the null hypothesis is that the series is integrated without exogenous structural break.

Once the series are found to be of the same order of integration, we test for cointegrating relationship allowing the presences of multiple structural breaks. The literature presents several different approaches for the analysis of structural breaks. These differ on the estimation and inference about break dates, the inclusion of tests for structural changes, tests for unit root in presence of structural changes in the trend function, as well as tests for cointegration allowing for structural changes (see Perron 2005 for a exhaustive review). One of the most important issues concerns the possibility to manage multiple structural breaks when series are related to each other. Bai and Perron (1998) first dealt with these issues proposing a methodology limited to I(0) series. However, to fit within the purpose of this paper, focused on the analysis of the changing dynamics between spot and future price of corn and soybean during the recently financial crisis, Kejriwal and Perron's (2009) approach was utilized to estimate, test and compute multiple endogenous breaks dates in conintegrated regressor.

From the econometric point of view, the Kejriwal and Perron (2009) model is an extension of the Bai and Perron (1998) procedure to a more general model allowing for the possibility of both $I(0)$ and $I(1)$ variables in the regression.

The Kejriwal and Perron (2009) model is based on the following linear regression with *m* breaks and *(m+1)* regimes:

$$y_t = c_j + z'_{ft}\theta_f + z'_{bt}\theta_{bj} + x'_{ft}\beta_f + x'_{bt}\beta_{bj} + u_t \quad t = T_{j-1}+1,\dots,T_j \tag{1}$$

where y_t is the $I(1)$ dependent variable at time *t*, z_{ft} ($q_f \times 1$) and z_{bt} ($q_b \times 1$) are vectors of unit root variables, while x_{ft} ($p_f \times 1$) and x_{bt} ($p_b \times 1$) are vectors of stationary variables. The symbols ϑ_f, ϑ_{bj}, β_f and β_{bj} (j = 1, ..., m+1) are coefficients of these vectors, while u_t is the stochastic disturbance at time *t*. The subscripts *f* and *b* respectively represent the regressor that are fixed or change across the regimes. Conventionally, T_0=0 and T_{m+1}=T.
The purpose of the Kejriwal and Perron (2009) model is to estimate the unknown break points (T_1,...,T_m) together with the regression coefficients allowing for both a partial or a pure structural change model. In the partial structural change model, only a subset of coefficient changes across the *j* regimes; when $p_f = q_f = 0$, the model is referred to a pure structural change model, where all coefficients in the equation change across regimes. Using the algorithm of Bai and Perron (2003), which was based on the principle of dynamic programming, for each *m*-partition T_1 to T_m (denoted by $\{T_j\}$), Kejriwal and Perron (2009) obtain the least-squares estimates of β and ϑ by minimising the function:

$$SSR_t(T_1,\dots,T_m) = \sum_{j=1}^{m+1}\sum_{t=T_{j-1}+1}^{T_j}\left[y_t - c_j - z'_{ft}\theta_f - x'_{ft}\beta_f - z'_{bt}\theta_{bj} - x'_{bt}\beta_{bj}\right]^2 \tag{2}$$

Let $\hat{\beta}(\{T_j\})$ and $\hat{\theta}(\{T_j\})$ indicate the resulting estimates. Substituting these in the objective function, the resulting sum of squared residual will be $S_t(T_1,\dots,T_m)$, and the estimated break points are obtained as $\left(\hat{T}_1,\dots,\hat{T}_m\right) = \arg\min_{\hat{T}_1,\dots,\hat{T}_m} S_T(T_1,\dots,T_m)$. The minimization is taken over all (T_1,...,T_m) partitions such that $T_i,\dots,T_{i-1} \geq \varepsilon T$ for some $\varepsilon > 0$. The regression coefficient estimates are: those associated with the *m*-partition $\left\{\hat{T}_j\right\}$:

$\hat{\beta} = \hat{\beta}\left(\left\{\hat{T}_j\right\}\right)$ and $\hat{\theta} = \hat{\theta}\left(\left\{\hat{T}_j\right\}\right)$ respectively. As in Bai and Perron's (1998, 2003), the

Kejriwal and Perron (2009) procedure detects multiple structural breaks at unknown dates, identifying each break point date precisely. The procedure starts with the use of a Sup F_T (k) type test based on the null hypothesis of no structural breaks (*m*=0), against an alternative of *m=k* breaks. In a second step, the null hypothesis of no structural breaks is tested against the alternative of an unknown number of breaks given some upper bound *M* for the number of breaks in a *double maximum test* (*UD max*). Finally, based on a series of Wald-type test, the sequential test supF_T(l + 1|l) compares the null hypothesis of l breaks *versus* the alternative of (l + 1) breaks. Asymptotic critical values for these tests can be found in Kejriwal and Perron (2009).

For both commodities considered and for each of the sub-periods detected by the breaks in the spot and futures prices relationship we then investigate the Granger causality. Considering that when the series are integrated (Toda and Yamamoto (1995) have shown that the conventional Granger non-causality test is not valid as the test does not have a standard distribution), we apply the Toda and Yamamoto (1995) procedure following the Rambaldi and Doran (1996) approach. It is firstly necessary to select the maximum order of integration (d_{max}) of the variable considered (in our case, it is one), next it is necessary to determine the optimal lag (k) of the VAR model using information criteria, the preferred lag value being selected on the basis of AIC, HQIC and SBIC statistics. Then a VAR($k+d_{max}$) has to be estimated in a Seemingly Unrelated Regression (SUR) framework, lastly the hypothesis is tested using a Wald statistic test (MWALD) which has an asymptotic chi-square distribution. In our case, considering the relationship between spot (S) and futures (F) prices the VAR assumes the following specification:

$$S_t = \gamma_0 + \sum_{i=1}^{k} \gamma_{1i} S_{t-1} + \sum_{j=k+1}^{k+d_{\max}} \gamma_{2j} S_{t-j} + \sum_{i=1}^{k} \delta_{1i} F_{t-1} + \sum_{j=k+1}^{k+d_{\max}} \delta_{2j} F_{t-j} + \varepsilon_{1t} \qquad (3)$$

$$F_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} F_{t-1} + \sum_{j=k+1}^{k+d_{\max}} \alpha_{2j} F_{t-j} + \sum_{i=1}^{k} \beta_{1i} S_{t-1} + \sum_{j=k+1}^{k+d_{\max}} \beta_{2j} S_{t-j} + \varepsilon_{2t} \qquad (4)$$

The null hypothesis that spot price does not Granger cause futures price is formulated as $\beta_{11}=\beta_{12}=\ldots=\beta_{1k}=0$, while when futures does not Granger cause spot prices the null is: $\delta_{11}=\delta_{12}=\ldots=\delta_{1k}=0$.

5 Empirical results

The degree of integration of the variables was tested using the ADF-GLS test and the Zivot and Andrews (1992) test (ZA) that permits the presence of structural changes.
Table 2 shows the results of the tests using different alternatives: with level shift, with trend and with level and time trend shift. The tests indicate that all series are I(1) in all the cases considered and are stationary in the first differences. In particular the ZA test highlights the presence of unit root when breaks are considered.
Provided that series are integrated of order one we can analyze the cointegration between them. To investigate the presence of multiple breaks and estimate the data of the breaks in a cointegrating framework we then adopt the Kejriwal and Perron (2009) procedure. In tables 3 and 4 we report the specification of the model utilized and the results of these estimates where we can conclude that two breaks occur for soybean and three for corn. In particular, as regards corn, the first break is detected at the beginning of 2005. This break should be linked to the 2005 Energy Policy Act, a bill passed by the United States Congress on July 29, 2005 changed US energy policy by providing tax incentives and loan guarantees for energy production of various types and fixing a biofuel obligatory mandate for ethanol use with a first step of 15 billions of litres for

2006. Since corn is the raw material to produce ethanol, it is likely that the biofuel policy heavily influenced new pressures on the demand side of corn.

Table 2. Results of the Unit root tests

	ADF-GLS		ZA		
	Trend	Level Trend	Level	Trend	Level Trend
Spot-Soy	-1.175	-1.546	-3.416	-2.545	-3.254
Futures-Soy	-1.190	-1.473	-3.424	-2.692	-3.347
Spot-Corn	-0.629	-1.851	-3.701	-2.838	-3.361
Futures -Corn	-0.646	-1.672	-3.705	-2.852	-3.633
Critical Value					
1%	*-2.572*	*-3.475*	*-5.43*	*-4.93*	*-5.57*
5%	*-1.942*	*-2.900*	*-4.80*	*-4.42*	*-5.08*
10%	*-1.616*	*-2.588*			

Two remarkable breaks are then detected, both for corn and soybean, during the recent economic and financial crisis. Specifically, for corn the first of these two breaks is detected in December 2006, during the first rise of prices due to the strong demand for feed use, in particular from developing countries like China, and for ethanol production. For soybean, the first break is detected a few months later, at the beginning of 2007. This break can be attributed to several factors, among which the constant rise in the demand of soybean during a period where some external factors, such as weather, weakened the total production, leading to a gradual tightening in global stocks. Furthermore, steadily growing biodiesel requirements led to increased demand for vegetable oil, notably soybean in the U.S., rapeseed in Europe.

Table 3. Kejriwal and Perron (2009) tests of multiple structural breaks - So*y*

		Specifications			
z_t={futures-soy}	q=1	M=5	ε=0.15	h=52	x_t={0} p=0
		Tests			
SupF_T(1)	SupF_T(2)	SupF_T(3)	SupF_T(4)	SupF_T(5)	*UD max*
61.942**	171.546**	132.028**	102.839**	80.405**	171.546**
SupF_T(2|1)	SupF_T(3|2)	SupF_T(4|3)			
233.088**	7.510	3.706			
		Dates and confidences interval with four breaks			
$\hat{T}_1$	$\hat{T}_2$				
02/02/07	**08/15/08**				
(01/26/07 - 02/23/07)	(08/01/08 - 08/29/08)				

Notes: The sup$F_T(k)$ tests and the standard errors use the following specifications: no serial correlation in the errors, different variances of errors and different distribution for the data across segments. The confidence intervals are reported in parenthesis.
** denote significance at the 1% level. Critical values are obtained from table 1 and 3 of Kejriwal and Perron (2009).

Finally, the last break is detected, for corn and soybean, in Autumn 2008. This break coincides with the bursting of the commodities price bubble. In this period, international prices of all coarse grains declined sharply due to favorable global crop prospects and ample supplies in world markets. The downturn was further aggravated by the market expectation that a global economic slowdown could lower demand for coarse grains and that the steep drop in crude oil prices could also depress demand (for corn in particular) from the ethanol sector. Not to be overlooked, moreover, was the simultaneous collapse of the U.S. financial system, which then extended to the rest of the world economy, and the concurrent lack of liquidity and trading volume that limited the ability of the futures market to transmit price information to spot markets effectively.

Table 4. Kejriwal and Perron (2009) tests of multiple structural breaks - Corn

		Specifications			
z_t={futures-corn}	q=1	M=5	ε=0.15	h=52	x_t={0} p=0
		Tests			
SupF_T(1)	SupF_T(2)	SupF_T(3)	SupF_T(4)	SupF_T(5)	*UD max*
136.431**	91.600**	74.978**	58.661**	47.018**	136.431**
SupF_T(2|1)	SupF_T(3|2)	SupF_T(4|3)			
34.828**	22.656**	8.834			
		Dates and confidences interval with four breaks			
$\hat{T}_1$	$\hat{T}_2$	$\hat{T}_3$	Invertire date per inglese		
01/14/05	**12/15/06**	**10/10/08**			
(11/12/04 - 03/04/05)	(12/01/06 - 01/12/07)	(05/16/08 - 01/16/09)			

Notes: The supF_T(k) tests and the standard errors use the following specifications: no serial correlation in the errors, different variances of errors and different distribution for the data across segments. The confidence intervals are reported in parenthesis.
** denote significance at the 1% level. Critical values are obtained from table 1 and 3 of Kejriwal and Perron (2009).

These breaks define sub-periods where different directions of causality in spot and futures prices could be present and where, alternately, prevails the role of market fundamentals or financial issues, therefore the analysis focuses on the study of Granger causality following Toda Yamamoto's approach. It has to be noted that Granger causality requires careful interpretation. Hamilton (1994) suggests it is better to describe "Granger causality" tests between X and Y as tests of whether X helps forecast Y rather than whether X causes Y, i.e., causality has to be interpreted as a forecast and not a causality. For this reason, as outlined in section 2, the relationship between spot and futures prices we detect cannot be interpreted as a mere relation of cause and effect (speculation *vs*. fundamentals or vice-versa), but the ability of a price to anticipate (forecast) the pattern of the other.

As reported in table 5, empirical results highlight different outcomes for the two commodities examined. For what concerns corn prices, in the first and in the last sub-period detected by breaks, futures prices lead spot prices, highlighting the forecasting role of the futures market, in line with prevalent findings in previous empirical studies (Garbade and Silber 1983, Crain and Lee 1996, Henandez and Torero 2010). Conversely, in the second and in the third sub-period, during the peak of the commodity price crisis, empirical data highlight that there are bidirectional information flows between spot and futures markets. In line with Irwin *et al*.. (2009), it can be argued that demand and supply pressures over physical commodities are as important as trading on the futures market to increase the price discovery role of spot markets.

For soybeans, the detected breaks distinguish different dynamics in different periods. In particular, before the first break there is no clear evidence of a causality relation, that is, even though variables are related in a long-run way, the price discovery function is unclear. Instead, during the second sub-period, when we recorded the highest and sharpest soybean price increase, there is evidence of a Granger causality effect from spot to futures prices, but futures prices do not contain any information about spot prices. This finding emphasizes the different role of price discovery drivers for this commodity, more related to fundamental patterns rather than financial trading on futures markets. This is in line with the fact that the soybean futures market is less liquid than the corn futures market; the last is deeper and thicker and one of the reasons may also lie in the explosion of interest in ethanol, which has stimulated the awareness of traders in this market. Finally, similar to corn in the third sub-period there is evidence of bidirectional information flows between the two markets.

Table 5. Toda-Yamamoto test of Granger Causality

	k	*d*	χ^2	p-*value*	Causality direction
Soy					
1st sub period					
Futures	1	1	2.31	0.1286	F ---X→ S
Spot	1	1	0.62	0.4319	S ---X→ F
2nd sub period					
Futures	1	1	0.95	0.3297	F ---X→ S
Spot	1	1	9.18	0.0024	S -----→ F
3rd sub period					
Futures	1	1	4.24	0.0396	F -----→ S
Spot	1	1	0.02	0.8835	S -----→ F
Corn					
1st sub period					
Futures	2	1	23.69	0.0000	F -----→ S
Spot	2	1	3.07	0.2157	S ---X→ F
2nd sub period					
Futures	2	1	67.39	0.0000	F -----→ S
Spot	2	1	7.84	0.0199	S -----→ F
3rd sub period					
Futures	2	1	71.64	0.0000	F -----→ S
Spot	2	1	6.93	0.0313	S -----→ F
4th sub period					
Futures	2	1	122.84	0.0000	F -----→ S
Spot	2	1	0.47	0.7898	S ---X→ F

Notes: See table A and B, respectively for soy and corn, for definition of the sub period detected by the breaks. In the last column F and S indicate Futures and Spot prices while the symbol -----→ and ---X→ respectively indicate *Granger cause* and *does not Granger cause*.
Since the different IC utilized to detected the optimal lag length provide different results for the corn series, spanning from 2 to 3 lags, we also test for k=3, without detecting any relevant differences in respect to 2 lags.

6 Conclusion

The futures prices of corn and soybean; we then utilize a specific approach (Toda and Yamamoto, 1995) to investigate their causal linkages. Results show that breaks were detected at specific stages in the agricultural commodity markets and relate to events that have significantly affected the supply and demand of corn and soybeans for food and energy purposes.
The sub-periods consequently identified express different dynamics in the causal relationship between spot and futures prices. In line with the main findings that emerge in the literature investigating the spot-futures price relationship in commodity markets, futures prices play a major role in price discovery, that is in registering and transmitting information from the related real market; due to the greater transparency and, often, greahe exceptional price rises recorded in the last few years has destabilized the world economic scenario and has lowered the level of world agricultural stocks to levels unseen

for 25 years. Among the main causes we can find firstly, the strong increase in the demand for commodities from China and India, countries with increasingly higher standards of living and the surge in energy demands that this entails. The rush to biofuels, initially considered as the main cause of this inflationary pressure, is another major factor: increasingly significant quantities of agricultural products are, in fact, being diverted away from their traditional food markets. The uncontrolled increase in the oil price, has had repercussions throughout the economy and has had in particular a crucial impact on the fertilizer market and transport. Last but not least, financial speculation, which caused considerable price volatility and prevented the planning of supply in many countries, contributed to creating a situation of marked instability.
Over the period January 2004 – September 2010 we apply an econometric methodology (Kejriwal and Perron, 2009) allowing us to test for multiple structural changes in the cointegrated system between spot anter liquidity of commodity futures over physical commodities, futures markets react more quickly to new or unexpected information than the underlying spot market. However, in times of crisis and in particular in phases of strong price increase, the cash market also becomes an important actor in the price discovery process. Specifically, as regards soybean, our findings emphasize that price discovery is more related to fundamental patterns rather than financial trading on futures markets, in line with the fact that the soybean futures market is less deeper and thicker than the corn futures market.
Overall, changes in supply and demand fundamentals are important in explaining the recent drastic increase in food prices, although it is likely that other reasons, such as rising expectations, speculation and hysteria also played a role in the increasing level and volatility of food prices (IFPRI, 2009).
Within the contest of the price relationship between the two commodities considered, the study offers new insights into how corn and soy markets relate at an industry level. The findings may also be important for producers, in order to better manage price risk, and for traders, in order to exploit speculative and/or arbitrage opportunities.

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