A Direct Test on Speculative Bubbles in Agricultural Commodity Prices

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***Abstract* - The sharp increase in agricultural commodity prices in 2008 and 2011 has triggered an intensive debate on the causes of these price booms. It has been claimed that speculative bubbles were partly responsible for the price surge. Our paper contributes to this discussion by implementing a novel test procedure for speculative bubbles which has been suggested in the stock market literature. We use a regime switching regression model to test the hypothesis that agricultural prices are driven by periodically collapsing bubbles. The analysis is conducted for wheat, corn, soybeans, sugar, rough rice, and cotton. Our results show that the data do not support this particular hypothesis for speculative bubbles, except for soybeans.**

Introduction

The sharp increase in agricultural commodity prices in 2008 and in 2011 has triggered an intensive debate on the causes for these price booms. There is a consensus among agricultural economists that several factors contributed to the price increase, among them are crop failures and an increased demand for biofuels. The most controversial discussion, however, is about the impact of financial investors and speculative activities on prices of agricultural commodities. The fact that the price peak in 2008 occurred subsequent to an increase of the trading volume of commodity futures held by index funds led to the conjecture that a speculation drives agricultural prices. A focal point of the discussion is whether or not speculative bubbles exist in agricultural prices, i.e. prices deviate from their fundamental values. The empirical evidence on this issue is ambiguous. Our paper contributes to this discussion by implementing a novel test procedure for speculative bubbles which has been suggested in the stock market literature.

Statistical Bubble Test

The answer to the question of whether or not a bubble is present heavily depends on the definition of an asset's fundamental values. The common present value model defines them by the discounted stream of expected future cash flows that will accrue to the owner of the asset. The price of an asset P_t can deviate from its market fundamental value P_t^* due to a bubble component B_t:

$$P_t = P_t^* + B_t \quad (1).$$

Direct bubble tests investigate, whether the characteristics of the data are consistent with a specific bubble process B_t, that is explicitly modelled. Motivated by the empirical observation that price bubbles periodically collapse, Blanchard (1979) introduce a stochastic model in which the price bubble moves randomly between a collapsing and a surviving state. Van Norden and Schaller (1993) relax the Blanchard model in their regime switching model by three assumptions. First, the probability of a bubble being in the surviving state in the next period depends on the bubble size in the current period. Second, the bubble size in the current period is assumed to be a function of the size of previous bubbles. Third, negative bubbles are not ruled out. The application of the van Norden and Schaller model to agricultural commodities requires defining the counterpart of the dividend of a stock. Here, we follow Pindyck (1993) who suggest to derive the fundamental value of a commodity as the present value of expected net convenience yields y_t. The latter is conceptually similar to the dividend accrued from holding a stock.

The present value model implies a co-integration relationship between spot prices and convenience yields, i.e., their relation can be expressed as

$$P_t = c + \beta \cdot y_t + \varepsilon_t \quad (2),$$

where c and β are parameters to be estimated. c reflects a constant part of the fundamental price that does not vary with the net convenience yield. In the case of no bubbles, the error term ε_t is a stationary process. The basic idea is to consider the deterministic part of (2) as a fundamental value, whereas the residual captures the bubble component. In other words, we model the fundamental price as a multiple of the current net convenience yield plus a constant. Subtracting P_t^* from P_t yields the absolute bubble measure B_t. The relative bubble term $b_t = B_t/P_t$ and the daily gross returns $R_{t+1} \equiv \frac{P_{t+1}+y_{t+1}}{P_t} - 1$ are used as inputs for the regime switching model:

$$\begin{aligned} R_{\mathcal{S},t+1} &= \beta_{\mathcal{S}0} + \beta_{\mathcal{S}1} \cdot b_t + \varepsilon_{\mathcal{S},t+1} \\ R_{\mathcal{C},t+1} &= \beta_{\mathcal{C}0} + \beta_{\mathcal{C}1} \cdot b_t + \varepsilon_{\mathcal{C},t+1} \\ P(\mathcal{S}) = q_{t+1} &= \Phi\left(\beta_{q0} + \beta_{q1} \cdot |b_t|\right), \end{aligned} \quad (3)$$

One can derive some testable implications of the model (c.f. van Norden and Shaller, 1993): first, $\beta_{\mathcal{C}1}$ should be negative ($\beta_{\mathcal{C}1} < 0$) and second, $\beta_{\mathcal{S}1}$ should be positive ($\beta_{\mathcal{S}1} > 0$), or more generally, $\beta_{\mathcal{S}1} > \beta_{\mathcal{C}1}$. The sign restrictions state that the expected returns in a surviving (or collapsing) regime vary positively (or negatively) with the size of the bubble. Thus, the

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larger the relative size of the bubbles is, the larger the difference between returns in these two regimes should be. A third testable restriction refers to the probability of being in the surviving state: β_{q1} measures the sensitivity of the probability with respect to the bubbles size; β_{q1} must be negative, i.e., the probability of a bubble being in the surviving state decreases if the absolute size of the bubble increases.

Data and Empirical Results

The empirical analysis is conducted for six agricultural commodities. Net convenience yield is a latent variable and cannot be observed directly. However, for commodities traded on a futures market, y_t can be inferred from futures quotations with different maturities if a no-arbitrage condition is imposed. Table 1 contains mean values, depicting the first and second nearby futures contract prices, inferred spot prices and estimated net convenience yields.

Table 1. Descriptive statistics of agricultural commodities.

Commodity	Jan 89 to Dec 11	1st nearby	2nd nearby	Spot price	CY
Wheat*	cents/bu.	409.3	417.1	406.2	-0.047
Corn*	cents/bu.	297.2	302.9	294.2	-0.039
Soy**b**eans*	cents/bu.	713.8	714.8	713.7	0.114
Rough **R**ice*	cents/cwt	8.9	9.0	8.9	-0.001
Sugar**	cents/lb.	11.5	11.4	11.6	0.003
Ctton**	cents/lb.	67.3	67.6	67.1	0.004

*CBOT, **ICE, Data: Bloomberg, CY: Net convenience yield

Figure 1 shows the fundamental price P_t^* and the absolute bubble measure B_t for the case of wheat. Apparently, the size bubble term, i.e., the fraction of the wheat price that cannot be explained by the convenience yield, increased in 2007/08 as well as in 2011. This finding, however, cannot be interpreted as evidence for the presence of periodically collapsing bubbles in the sense of Blanchard (1979).

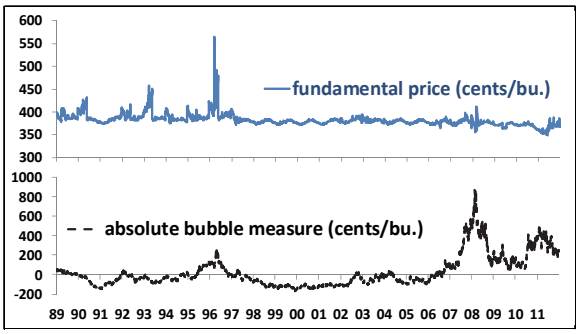

Figure 1. Fundamental price, bubble measure (wheat).

Table 2 reveals that for five commodities (wheat, corn, rice, sugar, and cotton) at least some of the coefficients (β_{q1}, β_{s1} and β_{c1}) do not satisfy the restrictions implied by the model of periodically collapsing bubbles. In fact, only for soybeans all estimated parameters are in line with the model predictions. More precisely, β_{q1} is negative and highly significant for all six commodities, which means that the probability of being in state $\mathcal{S}$ decreases as the (relative) bubble size increases, which is required by the theoretical model. In contrast, the estimated slope coefficients for the returns in the two regimes, β_{s1} and β_{c1}, either show a wrong sign (for wheat and sugar) or the estimates are not significantly different from zero (for corn, cotton, and rice).

Table 2. Selected model parameter estimates.

Coeff.	W	C	Sb	RR	S	Ct
β_{q1}	**-1.66**	**-2.16**	**-0.58**	**-0.73**	**-1.32**	**-3.99**
β_{s1}	-8E-04	0	**2E-03**	0	-7E-04	0
β_{c1}	-0.003	-0.002	*-0.007*	-0.001	-0.001	-0.001
$\beta_{s0} \neq \beta_{c0}$	2.91*	0.60	3.70*	0.94	0.70	0.02
$\beta_{s1} > \beta_{c1}$	0.11	1.53	***6.33***	0.23	0.04	0.65

β_{q1}: The probability of being in the surviving state in the next period should be smaller the larger the bubble is
β_{s1}: Returns in the surviving regime should vary positively with the size of the bubble
β_{c1}: Returns in the collapsing regime should vary negatively with the size of the bubble

Significance: bold=1%, italic=5%, *=10%

A negative coefficient for β_{s1} for wheat and sugar implies, that the return in the surviving state decreases with the bubble size, which is not plausible. Even the weaker requirement that $\beta_{s1} > \beta_{c1}$ is statistically insignificant according to a likelihood ratio test which is displayed in the lower part of Table 2. This finding holds for all commodities except for soybeans, where the difference is significant.

Conclusions

We have investigated the presence of speculative bubbles in commodity futures prices and have found mixed outcomes. Our results show that there is little evidence for the particular bubble process under consideration. The rejection of the periodically-collapsing-bubbles-hypothesis might be explained by the fact that markets for agricultural commodities never experienced a price crash comparable to past market crashes, e.g., the dot-com bubble in 2000 or the recent subprime mortgage bubble. Nevertheless, other bubble processes – such as deterministic bubbles, near random walk bubbles and other forms of market inefficiencies like fads – might nonetheless exist. Our results do not provide an ultimate answer to the question of whether or not bubbles are present and definite answers to this question should be treated with caution. Against this background, we recommend that far reaching suggestions on the regulation of speculative activities in agricultural commodity markets, which have been made in the aftermath of the price booms, should be carefully reconsidered.

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