



Derivative markets serve a risk-shifting function, and can be used to lock-in prices instead of relying on uncertain price developments. Being a vehicle for risk transfer among hedgers and speculators, futures markets also play a role in price discovery, as well as in price information. The risk transfer function allows to match risk exposure of the cash market price with its opposite in the same market or at the future market as a profit opportunity.

Following the expectations theory hypothesis, the current future price is a consensus forecast of the value of the spot price in the future. So, future prices give necessary indications to producers and consumers about the likely future ready price and demand and supply conditions of the commodity traded.

Commodity derivatives have a crucial role to play in the price risk management process in any economy, especially in agriculture dominated countries and even more in less developed agricultural commodity exports dependent countries. Agricultural prices depend on specific circumstances and many commodity exchanges fail to provide an efficient hedge against the risk emerging from volatile prices of many products in which they carry out futures trading. Some recent studies with new insights have shown that complex structures of financial time series may reveal its fundamentals (Mantegna and Stanley 1999; Gabaix et al. 2003).

The fundamental hypothesis explored here is that there are underlying non linear mechanisms of the market, which provide it with some structure. These structures in market behavior might be revealed with the use of tools from econophysics, by studying the series of commodity derivatives either in price and/or volume transacted.

## Data and methods

We worked with the volume and close price of the first nearby contract of the agricultural commodities futures traded daily in the New York Board of Trade, NYBOT<sup>1</sup> (cocoa, coffee, cotton, frozen concentrated orange juice and sugar).

We used the nearby future contracts as these are the contracts closest to expiration and represent the benchmark for the spot (or cash) market, and the first nearby contract is the closest one to expire and theoretically with the smallest basis (difference between the price of a future contract and the underlying commodity's spot price). It's important to remark that there is a substantial variation across futures markets in the pattern of open interest with respect to contract maturity: in currency and financial indexes most of open interest is highly concentrated in the first two nearby contracts (80%), in metals and agricultural, open interest tends to be less concentrated and in energy markets is evenly distributed among nearby and distant futures (Hong 2001).

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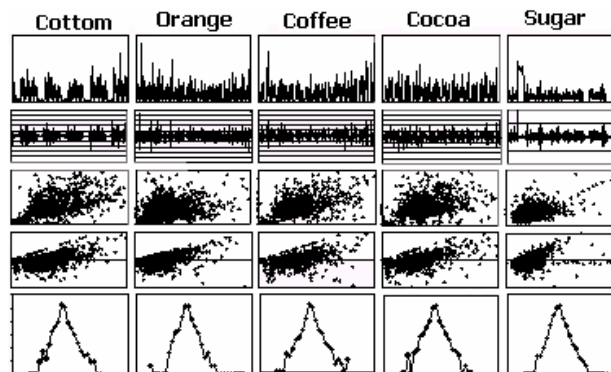
<sup>1</sup> [www.nybot.com/library/cocoa.xls](http://www.nybot.com/library/cocoa.xls), [www.nybot.com/library/coffee.xls](http://www.nybot.com/library/coffee.xls), [www.nybot.com/library/cotton.xls](http://www.nybot.com/library/cotton.xls), [www.nybot.com/library/fcoj.xls](http://www.nybot.com/library/fcoj.xls), [www.nybot.com/library/sugar11.xls](http://www.nybot.com/library/sugar11.xls).

The data series used were from June 01, 1999 to May 28, 2004 in a daily basis, exhibiting series of 1243 records. Time series were analyzed using program facilities of *Excel*®, *Minitab*®, and the analysis software *Chaos Data Analyzer* (Sprott and Rowlands 2003).

## Main results

### Statistical Analysis

Data series of the different commodities have their particularities and similarities. The commodity series do not follow a typical Gaussian distribution, but show a asymmetric distribution or a multimodal one with specific frequency concentrations and leptokurtic distributions. As data series were neither random nor stationary, there was evidence of an underlying model. Volume series showed an apparent cyclical behavior.

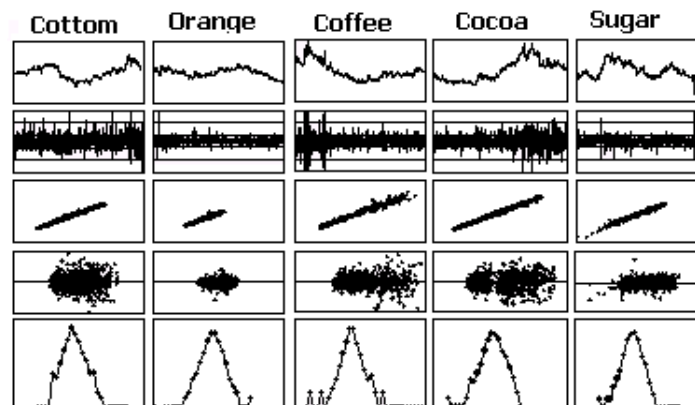


**Fig. 1.** Dynamics of VOLUME traded. First row: Time path (x: time; y: R/S: 0-10 times the average value). Second row: Difference, time vs. change at  $t+1(-10,10 \text{ sd})$ . Third row: Return map  $v(t)$  vs  $v(t+1)$  (4-4). Forth row: Phase space (-5:5). Fifth row: Histogram, log of observations vs sd (-8:9).

### Bivariate outcome and Portraits

Price and volume showed weak linear correlations, nevertheless, it is important to clarify that they seemed to have some kind of relationship as the data was not distributed randomly in the phase space, suggesting some non linear association or presence of attractors and clusters. The presence of attractors was most relevant for cacao. On the other hand, cotton showed an apparent cyclical behavior with change of levels in the time path. The difference plot and the phase-space plots

showed that Orange juice had much less variance than the rest, and that the patterns of the two commodities causing addiction (cocoa and coffee) were more similar among them than the rest. Variance in volume series was about two times that of price series. Each commodity showed a unique characteristic temporal pattern in the variance of volumes traded. This particularity was not evident in price fluctuations.



**Fig. 2.** Dynamics of PRICE. First row: Time path (x: time; y: R/S: 0-10 times the average value), Second row: Difference, time vs. change at t+1(-5,5 sd). Third row: Return map  $p(t)$  vs  $p(t+1)$  (0.2-2). Forth row: Phase space (-5:5). Fifth row: Histogram, log of observations vs sd (-8:8).

### Hurst exponent

The Hurst exponents of both volume and price series showed they were not independent, and carry memory. The fat tails of the distributions shown in the histograms confirm this. Their value –minor than 0.5- showed antipersistence, indicating that past trends tends to reverse in the future.

Commodities	Hurst exponent		Lyapunov exponent	
	Volume	Price	Volume	Price
Cocoa	0.168	0.265	0.541 (0.086)	0.214 (0.046)
Orange juice	0.079	0.079	0.653 (0.056)	0.215 (0.052)
Coffee	0.182	0.183	0.504 (0.090)	0.197 (0.047)
Sugar	0.275	0.291	0.548 (0.090)	0.246 (0.043)
Cotton	0.178	0.178	0.551 (0.073)	0.311 (0.045)

## Conclusions

Our results show that the dynamics of prices and volume traded in the future commodity markets differ, and that each commodity market shows particular dynamics in the trade of futures. The dynamics of these markets seem to depend on both, the structure of the market itself and economic factors affecting demand. These results call for caution when insights from one market are extrapolated to another. That is, the use of leading indicators to understand a sector of the economy might be misleading.

Price and volume of the futures of the commodities traded at the NYBOT, show a deterministic non-linear path with the presence of strange attractors. The underlying mechanisms producing those particular behaviors may be revealed by a deeper understanding of the trade system of each market and the economic variables affecting the demand of each commodity.

The clear antipersistence (Hurst exponent  $<0.5$ ) of the time series studied contrast with the persistence found in stock markets (Peters 1996). This antipersistence seems to be a common character of commodities (Levy-Carciente et al. 2004). A more detailed analysis of specific commodity markets should reveal more about the economics underlying these dynamics.

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