

NCCC-134

APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

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Suggested citation format:

Power, G. J., and J. R. C. Robinson. 2009. "Cotton Futures Dynamics: Structural Change, Index Traders and the Returns to Storage." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [<http://www.farmdoc.uiuc.edu/nccc134>].

Cotton Futures Dynamics: Structural Change, Index Traders and the Returns to Storage

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*Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis,
Forecasting and Market Risk Management
St. Louis, Missouri, April 20-21, 2009*

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Abstract

The commodity bull cycle of 2006-2008 and subsequent dramatic price decline have been a source of hardship for traditional commodity market participants such as producers and merchant/shippers. The usefulness of futures markets has been called into question, especially given that some market movements did not appear to be justified by economic fundamentals. An emerging research literature examines the possible influence of futures traders, and particularly the non-traditional Index Traders, on the well-functioning of futures markets and underlying commodity markets. Cotton is a relatively under-studied commodity that is of particular importance for producers in the South and Southwest. To this end, this paper asks the following questions: (1) What role have (primarily long-only) Index Traders played, if we simultaneously account for important ongoing changes in cotton economic fundamentals? (2) Have seasonal and long-run patterns of convenience yield and price volatility changed during or since the commodity bull cycle? (3) How well do the data support a theory of storage model using the concept of convenience yield, and has the relationship changed with the commodity bull cycle? The results presented in this paper suggest that traditional, well-established economic relationships for cotton futures markets clearly have been disrupted during the period 2006-2009. However, we find no direct evidence to support the claim that Index Traders are responsible for changes in prices or volatility.

Keywords: Cotton, futures markets, theory of storage, convenience yield, Index Traders

Introduction

On March 5th 2008, the synthetic options-based cotton futures price reached four times the daily limit-up, leading to sudden and substantial margin calls for traditional, commercial traders shorting futures to hedge their long asset positions (Davis, 2008). Aside from a few exceptions, commodity prices have been exceptionally high and volatile during most of 2006-2008 (Schnepf, 2008), which traditional market participants have attributed to typically long-only Index Traders. For example, as illustrated in figures 1-4, the trade volume of cotton futures has tripled in the last three years alone (ICE), while Index Trader positions (combined net long) have steadily increased from 2004 to 2008 from about 10,000 to 120,000 contracts, representing since mid-2005 about 40% of open interest (Fenton, 2008).

[Figures 1-4 about here]

Cotton futures are of particular interest. In addition to the strange price spike of March 5th 2008, market behavior has been very unusual during 2008. For instance, certificated cotton stocks nearly tripled in 2008 from about 5,000 contracts to 14,000 contracts (see figure 5). Also, some work sponsored by the ICE and conducted by Informa has noted evidence of increased volatility and price influence on the cotton futures market. More generally, cotton has received relatively less attention than other agricultural commodities, such as corn, soybeans and wheat grown in the Midwest, as studied e.g. by Irwin, Garcia, Good and Kunda (2008). The cotton industry has greatly changed over the last fifteen years, as explained in more detail below, which suggests

that it is essential to adequately capture variation in different economic fundamentals that might affect cotton prices and volatility.

Only a limited amount of research has been directed to the question of a possible relationship between speculative funds and agricultural commodities. So far, this literature has no evidence that index funds are responsible for the sharp price increases in commodity futures markets (see e.g., Sanders, Irwin and Merrin, 2009). However, to the point of this paper, price changes need not be the only measure of market disruptions. We therefore examine models in which the dependent variables are price changes, excess volatility (defined later), and convenience yield, the latter to examine possible disruptions in relationships predicted by the theory of storage.

[Figure 5 about here]

This paper aims to answer the following questions:

- What role have long-only Index Traders played once the significant changes in cotton economic fundamentals have been accounted for?
- How have convenience yield and the volatility of cotton varied over time and seasonally?
- How well does the data support a theory of storage model? Has the relationship recently changed?

To answer these questions, two models are estimated. First, we recover stochastic convenience yield and seasonal volatility time series, following Smith's (2005) Kalman filter-based approach (also Roberts & Fackler, 1999; Sorensen, 2002). This uses all available cotton futures price observations, avoids a contract "splicing" bias and includes GARCH effects. Second, we use the estimates of convenience yield and volatility to test the theory of storage (e.g. Carter and Revoredo-Giha, 2007; Miranda and Rui, 1996; Telser, 1958; Zulauf, Zhou and Roberts, 2006) as well as Index Trader influence in a model that accounts for index trader impact as well as important dynamic changes in cotton fundamentals. The latter include (see also figures 6-9):

- Increases in market concentration as a few large companies, active in futures hedging, buy from US producers and sell to Asian textile manufacturing facilities;
- Increases in US cotton exports from about one-third of production to more than three-quarters to the Far East alone;
- China leaving the fixed Yuan-USD rate in July 2005 for a "semi-floating" (trading band) rate;
- Increased demand for corn to produce ethanol reducing available acreage and leading to a forecast of cotton plantings nearly 50% lower than two years ago (USDA-ERS)
- Stocks and the stocks-to-use ratio approximately doubling since 2004-2005 (USDA-ERS).

[Figures 6-9 about here]

Data have been collected for these fundamental variables as well as cotton futures settlement prices, trade volume, open interest, and positions from the Commitment of Traders reports including, since 1/2006, Index Traders.

Cotton is a relatively under-studied commodity in the futures literature. This paper aims to provide insights into the role of changing cotton market fundamentals (i.e., structural change) as well as the influence of Index Traders on the full term structure of futures prices and also on measures of convenience yield and volatility in a model of the returns to storage in the tradition of Working.

Background

U.S. cotton production has a long history in the southern and southwestern U.S, with considerable fixed investment in mechanized harvesting, gin plants, and warehouses (e.g., Robinson et al., 2009). However, the cotton industry has seen some major changes over the last fifteen years. These include significant advances in productive technology in cotton growing, the introduction of planting flexibility into USDA farm programs, and a dramatic transition from a mainly domestic textile market for raw cotton fiber to primarily an export market (Meyer, MacDonald, and Foreman 2007). For example, in the early 1990s only one third of U.S. cotton was exported. Today the U.S. textile industry has contracted, and at least 75% is exported to more modern textile producers in the Far East (National Cotton Council). One implication of the shift to an export market is that the U.S. cotton industry is likely more influenced by global fundamentals.

Several other structural developments in the U.S. cotton market involve the influence and interactions of major market participants. The U.S. cotton market is dominated by several major multinational merchandising companies who buy from U.S. growers and cooperative marketing pools and sell to textile manufacturers. At the former New York Board of Trade (now Intercontinental Exchange Futures, hereafter ICE), the hedging activities of these merchants may have a significant influence of futures prices, but this has not been studied.

The last decade has also seen the rise of speculative investment funds as participants in the ICE. In particular, the net long position of the index fund sector has grown substantially since 2001 in many commodity futures markets (Jakab 2006) including cotton (Robinson, 2009). The level volume of contracts bought and sold by speculators has increased dramatically, leading to record levels of open interest (i.e., the number of contracts held at one time). Several studies have shown that speculators were influential as shown in the relationship of the net position to prices. For example, Reddy (1999) investigated the effects of speculative positions on nearby cotton futures price based upon the test for the existence of causal relationship between net positions of speculators and futures price. Reddy also showed that ICE prices have had less of an influence on the A-Index, reflecting the globalization of the cotton market.

Of particular recent interest has been the relationship between the fund sector and commodity markets. The years 2007-2009 saw dramatic price increases in many commodities, cotton included, followed by sharply lower prices in concert with global recession. Commodity fund investment and deleveraging were identified in the media and by many analysts as causes or contributors to this price behavior. The U.S. cotton futures market saw a notable upward price spike in March 2008 which brought industry, media, and government attention to the influence of speculation in this market (Davis, 2008).

Model, variables and data

To answer the questions asked in this paper, a two-step econometric approach is adopted. First, we estimate a full-information model of the term structure of futures prices using the Kalman filter. This makes it possible to use all available futures price data, instead of only the first two or three nearby contracts. Previous research has found that so-called multi-factor models, using one or more latent state variables and expressed in state-space form, provide superior results in terms of in-sample fit and out-of-sample forecasting accuracy (Bernard et al., 2008; Schwartz, 1997; Smith, 2005).

In this literature, it has been found that the use of three state variables is generally optimal (e.g., Cortazar and Naranjo, 2006). Therefore, we use the following three-state variable model: let S be the spot price of the commodity, e.g., cotton, let y be the demeaned convenience yield, and let v be the long-term spot price return. These are the model's three state variables. Time series $\{S_t, y_t, v_t\}$ of these unobserved variables are estimated from the data. The spot price S follows geometric Brownian motion with drift equal to the instantaneous expected spot price return $(v - y)$. Assume that y is mean-reverting (to a long-run value of zero) with a speed coefficient k , while v is mean-reverting (to a long-run value of \bar{v}) with a speed coefficient a . Using these state variables allows us to capture price variations due to both short-run effects, through convenience yield (e.g., due to fluctuating inventories), and long-run effects, through the long-term spot price return (e.g., due to slowly-evolving changes in fundamentals). Price dynamics can then be described by the following model (e.g., Cortazar and Schwartz, 2003):

$$\begin{aligned} dS &= (v - y)Sdt + \sigma_1 Sdz_1 \\ dy &= -kydt + \sigma_2 dz_2 \\ dv &= a(\bar{v} - v)dt + \sigma_3 dz_3 \end{aligned}$$

where $dz_i dz_j = \rho_{ij} dt$ for all $i \neq j$, $\rho_{ii} = 1$, and all dz_i are increments of a Wiener-Ito process under the real-world probability measure \mathbf{P} . Following convention, the model is rewritten such that all dz_i^* are increments of a Wiener-Ito process under the risk-neutral probability measure \mathbf{Q} , where risk premia associated with each of the three risk factors or state variables are defined as λ_i :

$$\begin{aligned} dS &= (v - y - \lambda_1)Sdt + \sigma_1 Sdz_1^* \\ dy &= (-ky - \lambda_2)dt + \sigma_2 dz_2^* \\ dv &= a((\bar{v} - v) - \lambda_3)dt + \sigma_3 dz_3^* \end{aligned}$$

where $dz_i^* dz_j^* = \rho_{ij} dt$ for all $i \neq j$ and $\rho_{ii} = 1$. The standard approach to recover a closed-form solution is to formulate a Feynman-Kac partial differential equation, which is then solved subject to the terminal boundary condition $F(S, y, v, T)_{T=0} = S$ such that:

$$\ln F(S, y, v, T) = \ln S + B(T), \text{ where:}$$

$$B(T) = \left[\begin{array}{l} -y \frac{1 - \exp(-kT)}{k} + v \frac{1 - \exp(-aT)}{a} - \lambda_1 T + \frac{\lambda_2 - \sigma_1 \sigma_2 \rho_{12}}{k^2} (kT + \exp(-kT) - 1) \\ + \frac{\sigma_2^2}{4k^3} (-\exp(-2kT) + 4\exp(-kT) + 2kT - 3) + \frac{a\bar{v} - \lambda_3 + \sigma_1 \sigma_3 \rho_{13}}{a^2} (aT + \exp(-aT) - 1) \\ - \frac{\sigma_3^2}{4a^3} (\exp(-2aT) - 4\exp(-aT) - 2aT + 3) - \frac{\sigma_2 \sigma_3 \rho_{23}}{k^2 a^2 (k+a)} [k^2 \exp(-aT) + ka \exp(-aT) \\ + ka^2 T + ka \exp(-kT) + a^2 \exp(-kT) - ka \exp(-(k+a)T) - k^2 - ka - a^2 + k^2 aT] \end{array} \right]$$

The equation implies that the forward curve, e.g., whether futures markets are normal or inverted, depends on only one variable, time-to-maturity T , which enters nonlinearly. From this equation, then, the volatility of futures prices is predicted by the model to be:

$$\begin{aligned} \sigma_F^2(T) = & \sigma_1^2 + \sigma_2^2 \frac{(1 - \exp(-kT))^2}{k^2} + \sigma_3^2 \frac{(1 - \exp(-aT))^2}{a^2} - 2\sigma_1 \sigma_2 \rho_{12} \frac{(1 - \exp(-kT))}{k} \\ & + 2\sigma_1 \sigma_3 \rho_{13} \frac{(1 - \exp(-aT))}{a} - 2\sigma_2 \sigma_3 \rho_{23} \frac{(1 - \exp(-aT))(1 - \exp(-kT))}{ak} \end{aligned}$$

with limiting cases that are constants:

$$\begin{aligned} \lim_{T \rightarrow 0} \sigma_F^2(T) &= \sigma_1^2 \\ \lim_{T \rightarrow \infty} \sigma_F^2(T) &= \sigma_1^2 + \frac{\sigma_2^2}{k^2} + \frac{\sigma_3^2}{a^2} - \frac{2\sigma_1 \sigma_2 \rho_{12}}{k} + \frac{2\sigma_1 \sigma_3 \rho_{13}}{a} - \frac{2\sigma_2 \sigma_3 \rho_{23}}{ak} \end{aligned}$$

These constant limiting cases together imply that volatility is decreasing in time-to-maturity, which is consistent with Samuelson's maturity hypothesis.

Estimation of this model, using all available futures price data, produces two outcomes: estimated time series observations of state variables $\{S_t, y_t, v_t\}$ and solutions to the model parameters $\{k, a, \bar{v}, \lambda_1, \lambda_2, \lambda_3, \sigma_1, \sigma_2, \sigma_3, \rho_{12}, \rho_{13}, \rho_{23}\}$. We can compute a time series of model-predicted nearby futures contract volatility using the above equations. To study the determinants of excess volatility, a definition of excess volatility is needed: let it be the difference between volatility estimated from a GARCH model and volatility predicted from the term structure model for the nearby futures contract, i.e., $\tilde{h}_t = h_t - \sigma_t^2$.

Consider the time series of convenience yield y_t and excess volatility \tilde{h}_t . Our objective is to investigate the influence of fundamental economic variables and futures speculative activity on the supply of storage relationship, volatility, and price changes. The second step involves regressions that use as dependent variables futures price log-differences, $r_t = \Delta \ln F_{t+1}$, convenience yield y_t , and excess volatility \tilde{h}_t and as independent variables a set of economic fundamentals as well as measures of futures speculative activity:

$$\begin{aligned}
r_t &= s_1(t) + \beta_0 + \beta_1 t + \beta_2 \text{InvStockUse} + \beta_3 \text{Exports} + \beta_4 \text{Yield} + \beta_5 \text{Plant} + \beta_6 \text{CommLong} \\
&\quad + \beta_7 \text{CommShort} + \beta_8 \text{FutVolume} + \beta_9 \text{CommNet} + \varepsilon_t \\
y_t &= s_2(t) + \delta_0 + \delta_1 t + \delta_2 \text{InvStockUse} + \delta_3 \text{Exports} + \delta_4 \text{Yield} + \delta_5 \text{Plant} + \delta_6 \text{CommLong} \\
&\quad + \delta_7 \text{CommShort} + \delta_8 \text{FutVolume} + \delta_9 \text{CommNet} + \rho_2 y_{t-1} + \xi_t \\
\tilde{h}_t &= s_3(t) + \gamma_0 + \gamma_1 t + \gamma_2 \text{InvStockUse} + \gamma_3 \text{Exports} + \gamma_4 \text{Yield} + \gamma_5 \text{Plant} + \gamma_6 \text{CommLong} \\
&\quad + \gamma_7 \text{CommShort} + \gamma_8 \text{FutVolume} + \gamma_9 \text{CommNet} + \rho_3 \tilde{h}_{t-1} + \zeta_t
\end{aligned}$$

where: $s(t)$ is a sinusoidal function (defined below) that captures seasonality

t is a time trend

InvStockUse is the inverse of the commodity inventory stocks-to-use ratio

Exports is US net exports

Yield is the harvest yield

Plant is the annual plantings acreage

CommLong is the number of net long futures traders registered as Commercial

CommShort is the number of net short futures traders registered as Commercial

FutVolume is the total futures volume of trade (all contracts)

CommNet is the net position of all Commercial

$\{\varepsilon_t, \xi_t, \zeta_t\} \sim N(0, \Sigma)$ are error terms and Σ need not be a diagonal matrix

The list of included variables requires a few explanations. Based on plots of the autocorrelation functions, a lag is included for convenience yield and for excess volatility, but not for price changes. Seasonality is captured using a sinusoidal function which is identical each year:

$$s_i(t) = \gamma_{11}^i \cos(2\pi t) + \gamma_{12}^i \sin(2\pi t) + \gamma_{21}^i \cos(4\pi t) + \gamma_{22}^i \sin(4\pi t), \text{ for } i=\{1,2,3\}$$

Therefore, the coefficients and the overall shape of seasonality should be different for price changes, volatility and convenience yield. The inverse of the stocks-to-use ratio is used because previous research has found that the relationship between volatility and stocks or between convenience yield and stocks is nonlinear and better captured if the inverse of the variable is used. Plantings is included to control for the acreage crowding-out effect of ethanol and biofuels on cotton, while yield is included to account for the trend in cotton harvest yield independently of production. The number of net long futures traders, *CommLong*, is a proxy for market concentration among long-net-position futures traders, e.g., mills. Likewise, *CommShort* is a proxy for market concentration among short-net-position futures traders, e.g., merchants. We do not include Non-Commercial Net Positions as a separate regressor because this might create

multicollinearity with Commercial Net Positions. We include Commercial Net Positions rather than Non-Commercial because the latter category included Index Traders before 2006, but we have a separate regressor for Index Trader positions beginning in 2006.

Note that for the present analysis we are agnostic about identification, therefore the estimated coefficients should not be interpreted as causal effects but simply as changes if all else is held constant.

The above model is estimated using data for the period 1/1990 to 12/2005 inclusive. The results are interpreted as baseline relationships, as they represent a period during which futures markets were relatively stable and Index Trader participation was only beginning to show.

To answer the research questions, we compare the results with a second set of results obtained from regressions of the price changes, excess volatility, and convenience yield using data from the period 1/2006 to 4/2009 inclusive. The choice of 1/2006 as a break point between samples is motivated by the availability of the CFTC's Commitment of Traders report data beginning with 1/2006. Specifically, the variable used is *Index Trader Net Positions*. Also included in the specification for this second sample are *Certificated Stocks*, which increased dramatically during 2008, and *Yuan-USD Exchange Rate* which was fixed until July 2005 but has since been floating (within a fixed band).

Description of the Data

Descriptive statistics for the data are presented in table 1. Daily futures settlement prices and futures trade volume for cotton no.2 traded at the NYCE (now the ICE) were collected from the Commodity Research Bureau for the period 1/1990 to 4/2009. The number of active futures traders registered as Commercial and as Non-Commercial, the net long futures positions of Commercials and Non-Commercials, and the net long futures positions of Index Traders were all collected from the CFTC's weekly Commitment of Trader reports. The net long futures positions exclude option positions.

[Table 1 about here]

Daily cotton certificated stocks data were obtained from a database compiled at Texas A&M University (Gleaton, 2009) from data provided by the ICE. Similarly, an annual series of US plantings acreage, as well as monthly data on U.S. net exports, US ending stocks, US total use, and US stocks-to-use ratio were obtained from the same Texas A&M database using data compiled by USDA. The latter included revised USDA estimates of ending stocks when the marketing year ends, i.e., end of July. Note the discrete shift in stock numbers from July to August.

The daily Yuan-US dollar exchange rate data were collected from the Federal Reserve Bank of St. Louis database (FRED).

One difficulty associated with the data is that the variables are observed at different frequencies. Futures prices, for example, are daily while the stocks-to-use ratio has a monthly frequency of observation. Moreover, one variable, plantings, is annual. To estimate the first model, which requires only futures price data, the original daily frequency of observations is used. The data

can be described as an unbalanced panel with a length $T=4872$. Each day, about half a dozen futures contract maturities are traded. As contracts expire, the set of maturities that is traded changes, with older maturities expiring while newer maturities are introduced.

However, to estimate the second set of equations, we are limited by the highest frequency available for the greatest set of variables, which is in this case monthly, or $T=222$. The sample is divided into two subsamples: the first, 11/1990 to 12/2005 or $T=182$ is defined as pre-Index Trader while the second, 1/2006 to 4/2009 or $T=40$, is defined as post-Index Trader. Data for some variables are not originally in a monthly frequency and must be adjusted. For plantings data, which are annual, each year's observation is repeated for each month in that year. For futures price data, the challenge is to find a representative observation out of 21 business daily settlement prices. For the present analysis we use the monthly average, although our robustness checks suggest that the results are not significantly affected if we use instead the monthly median or the price on the 11th business day of the month.

Description and interpretation of the results

The present paper's research questions are:

1. What role have (primarily long-only) Index Traders played, once important changes in cotton economic fundamentals have been accounted for?
2. Have seasonal and long-run patterns of convenience yield and price volatility changed during/since the commodity bull cycle?
3. How well do the data support a theory of storage model? Has the relationship recently changed?

To answer these questions, we examine changes in the relationship between each of the three metrics of market behavior considered here (price changes, excess volatility, and convenience yield) and the fundamental economic and speculative trading variables. The results are presented in tables 2 and 3.

[Table 2 about here]

Changes in the relationship between price changes and economic and trader variables

The results of the second-stage regression of futures price changes over economic and trader variables suggest that Index Traders have not had any effect on price changes. While there exists a positive relationship, it is not significant. The observed correlation between Index Trader net positions and cotton futures prices would therefore appear to be accounted for by other variables. In the period 1990-2005, only one explanatory variable is significant: the net long positions of Commercial traders, which are negatively associated with price changes. In the period 2006-2009, the only significant explanatory variable is the Yuan-to-U.S. Dollar exchange rate: the U.S. dollar's appreciation is associated with positive price changes.

[Table 3 about here]

Changes in the relationship between convenience yield and economic and trader variables

In the first subsample, 1990-2005, convenience yield is found to be generally positive, seasonal, and serially correlated. The existence of a positive convenience yield has been used as an explanation for apparently negative returns to storage. Here convenience yield is found to be negatively affected by the number of net long Commercial (i.e., convenience yield increases with mills market concentration, other things equal), and is inversely related to the stocks-to-use ratio (although the coefficient is not statistically significant). If we define the *inverse stocks-to-use ratio* variable simply as scarcity, then a positive coefficient implies that convenience yield increases with scarcity, as predicted by theory. None of the other variables is significant.

In the second subsample, 2006-2009, convenience yield is found to be trendless but seasonal, and positively associated both with Commercial net positions and with futures trading volume. Although there is a negative association with Index Trader net positions, it is not significant. Note that the *inverse stocks-to-use ratio* variable coefficient is negative, which is opposite what economic theory predicts. Indeed, if we define *inverse stocks-to-use ratio* simply as scarcity, then convenience yield should increase with scarcity.

To illustrate the magnitude of the relationship, consider that holding all else constant, an increase of 50,000 contracts in Index Trader positions would decrease convenience yield by 5.6 percentage points, a substantial effect. Such a change in Index Trader positions is not an unreasonable scenario, as these increased from 51,058 net long contracts to 100,462 over the period 1/3/2006 to 5/22/2007.

Changes in the relationship between excess volatility and economic and trader variables

Excess volatility, defined as realized (GARCH) volatility minus model-predicted volatility, is positively autocorrelated, has a weak positive time trend, is seasonal, increases with the number of Commercial longs and Commercial shorts (therefore decreases with market concentration), decreases with Commercial net futures positions, decreases with futures trade volume, and as expected has a strong, inverse relationship with the stocks-to-use ratio.

In the second subsample, 2006-2009, excess volatility appears to be trendless and more weakly seasonal. The only other significant variable is the number of Commercial longs, for which the coefficient is positive, consistent with the 1990-2006 sub-sample. The sign is now reversed for the net futures position of Commercial, although the coefficient is not significant. The inverse relationship with the stocks-to-use ratio is maintained but the coefficient is not different from zero. The Index Trader net positions variable has a negative sign, but it is also not different from zero.

Conclusion

Faced with exceptionally high price volatility and massive futures positions driven by non-traditional Index Traders, traditional cotton market actors have suspected that futures prices in 2008 were driven not by economic fundamentals but rather by speculation. The purpose of this paper has been to investigate the possible effect of Index Traders on several measures of futures market behavior, in a model that also accounts for changes in economic fundamentals and other measures of futures trading activity.

In answer to the paper's three main questions, we may offer the following conclusions:

1. We find no substantive evidence that Index Traders have had a direct effect on prices, price volatility or convenience yield. Therefore, the apparent link between Index Trader positions and prices or volatility would appear to be coincidental and explained by other ongoing changes in cotton markets.
2. The explanatory power of various fundamental and futures market variables for convenience yield and price volatility is weaker for the period 2006-2009.
3. The theory of storage is empirically supported for the period 1990-2005, but not for the period 2006-2009. Likewise, the well-established inverse relationship between price volatility and inventories is clearly supported for 1990-2005 but not for 2006-2009.

In conclusion, the evidence suggests that traditional economic relationships in commodity futures markets were disrupted during 2006-2009, but it is not clear how speculation, and in particular Index Trader futures positions, might be responsible.

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Figure 1: Cotton futures price, 10/2007 to 10/2008

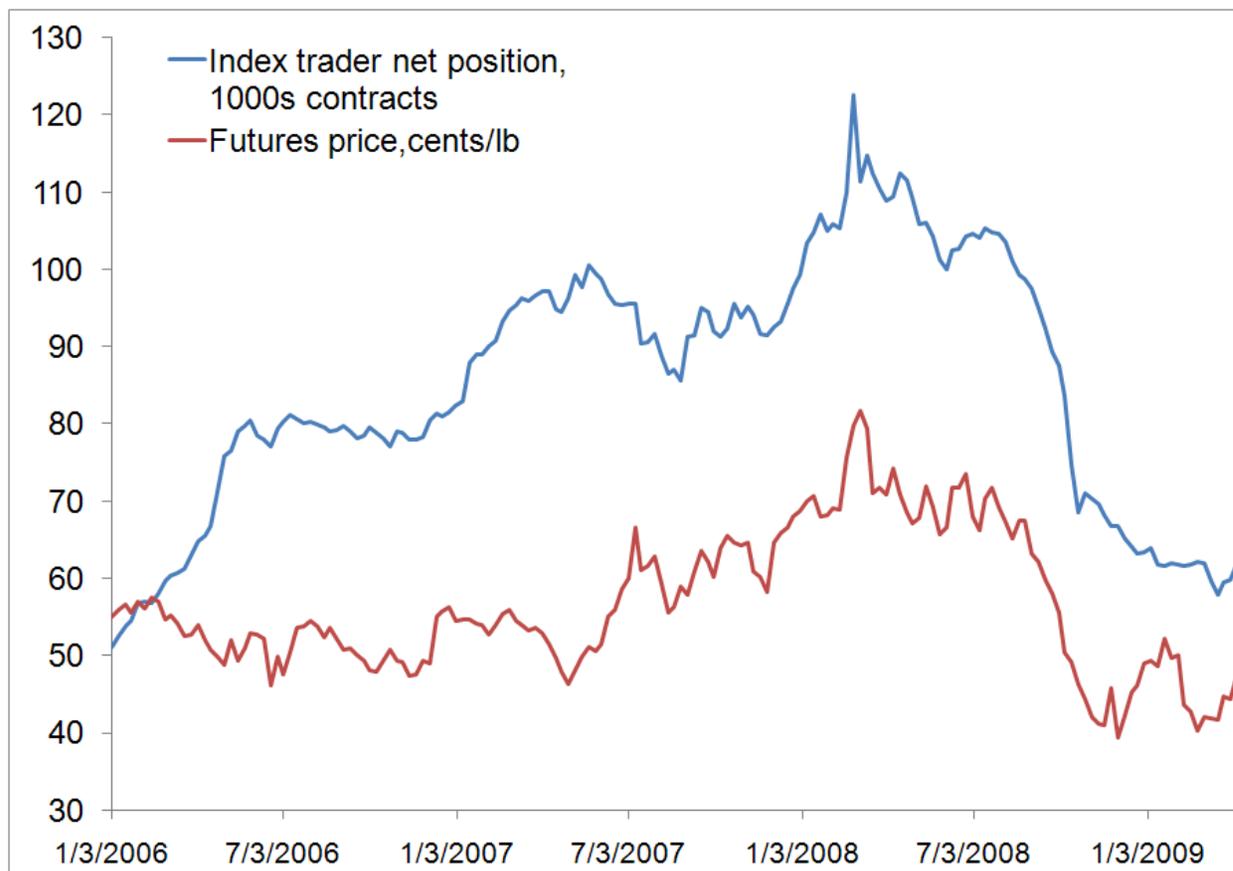


Figure 2: Cotton futures price and Index Trader net positions in cotton futures, 1/2006 to 3/2009

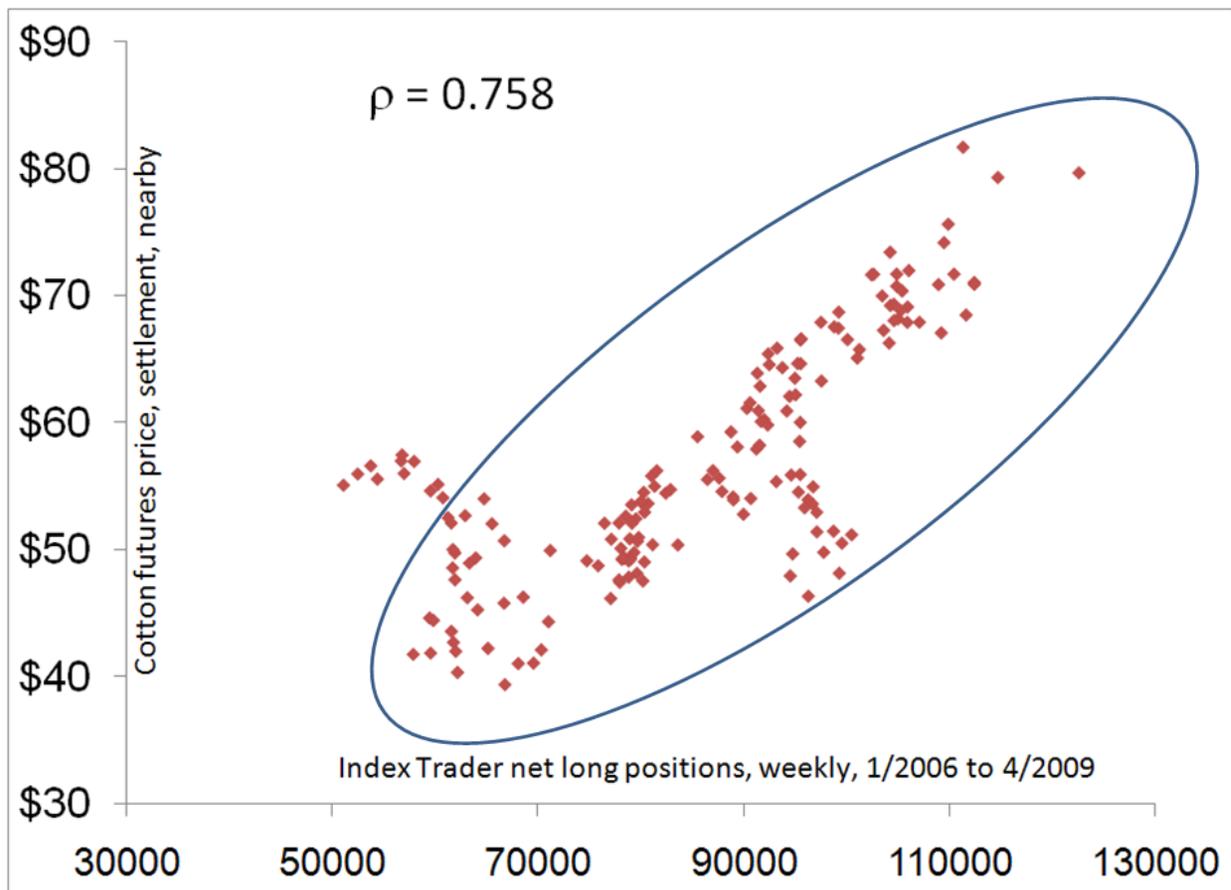


Figure 3: Correlation between cotton futures prices and Index Trader net positions (contracts)

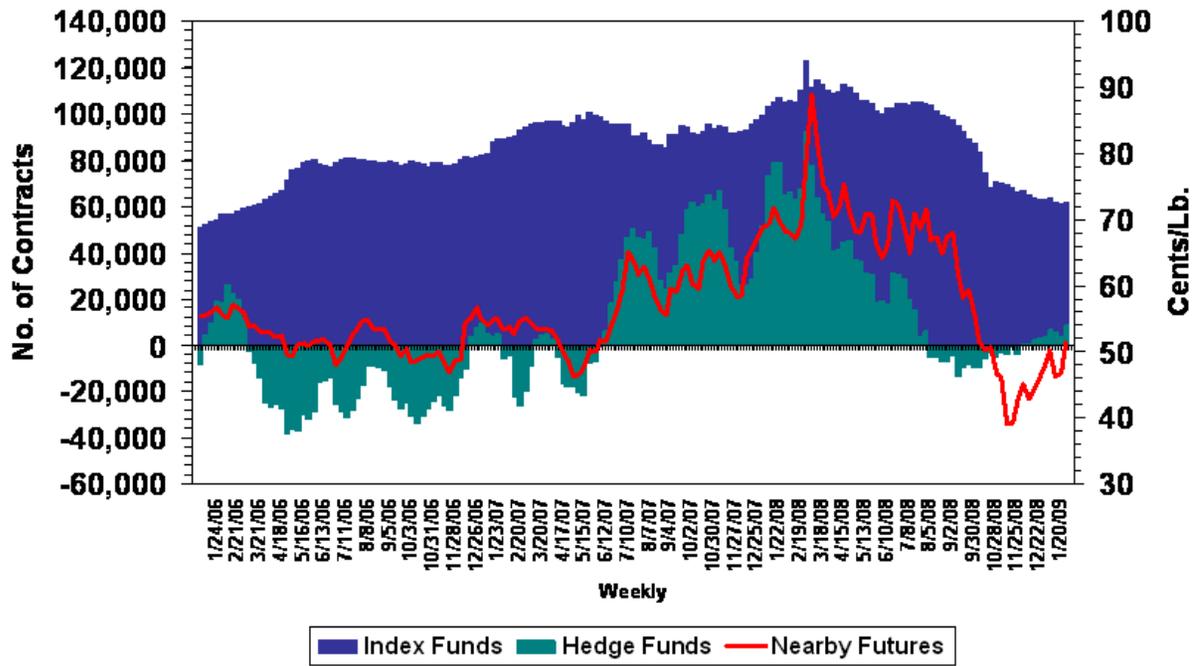


Figure 4: Net positions of Index Funds and Hedge Funds vs. nearby futures prices

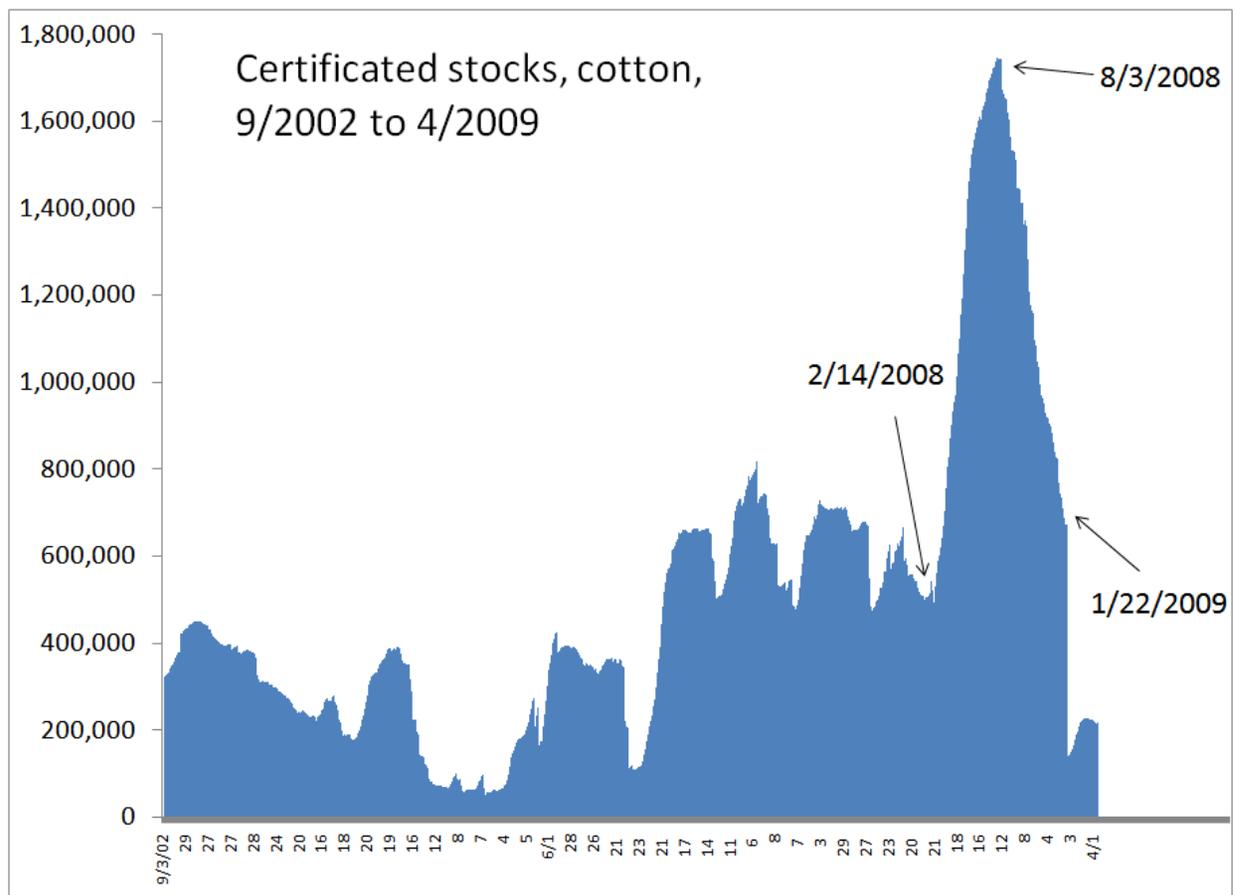


Figure 5: Certificated stocks, cotton, 9/2002 to 3/2009

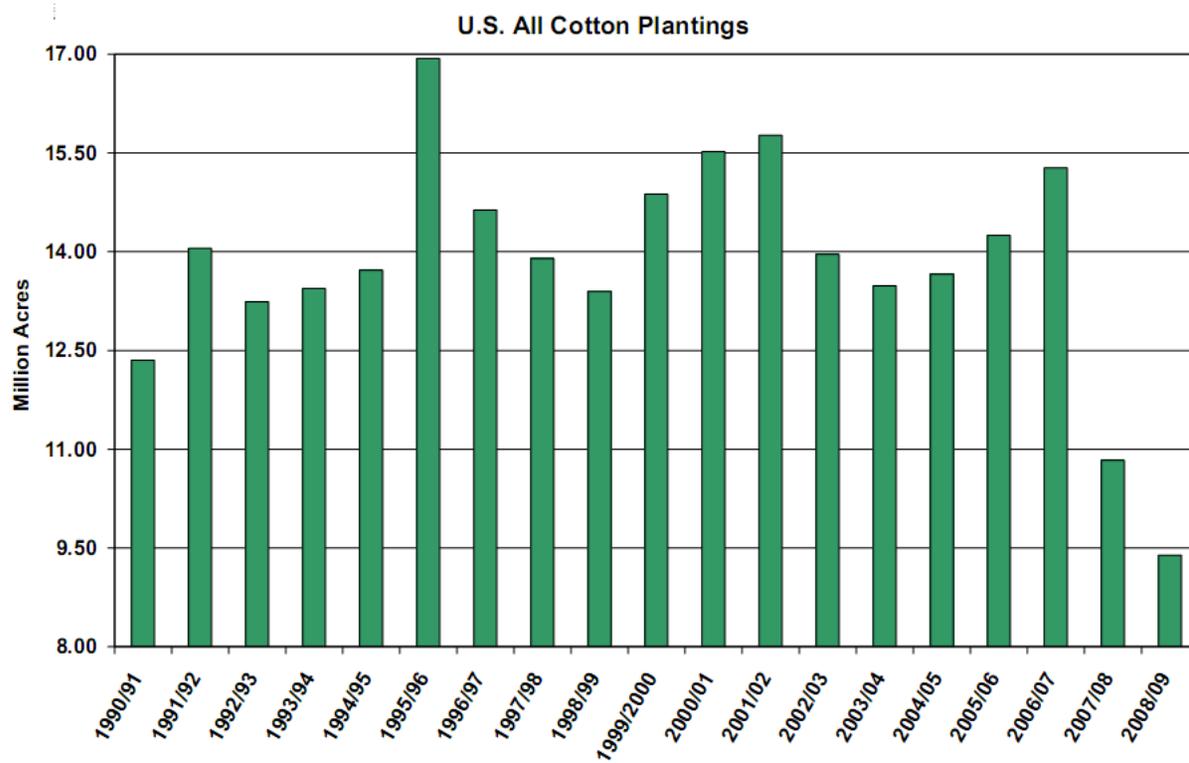


Figure 6: US All Cotton Plantings. Source: Fenton/CFTC

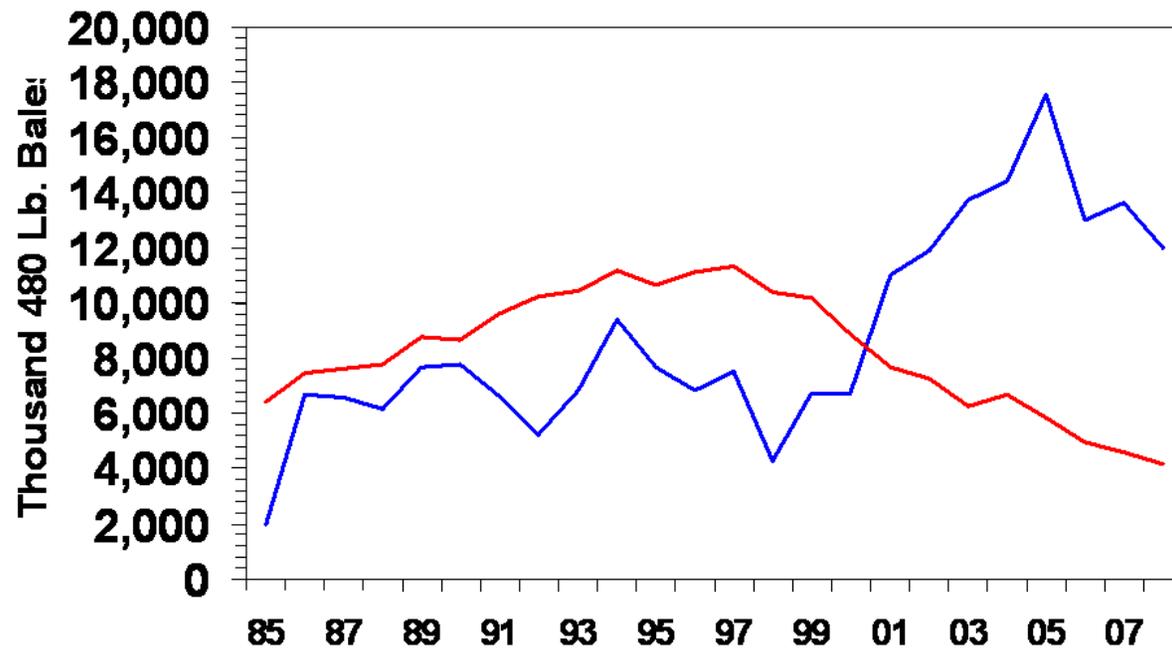


Figure 7: U.S. Cotton Domestic Use vs. U.S. Exports 1985/86 – 2008/09

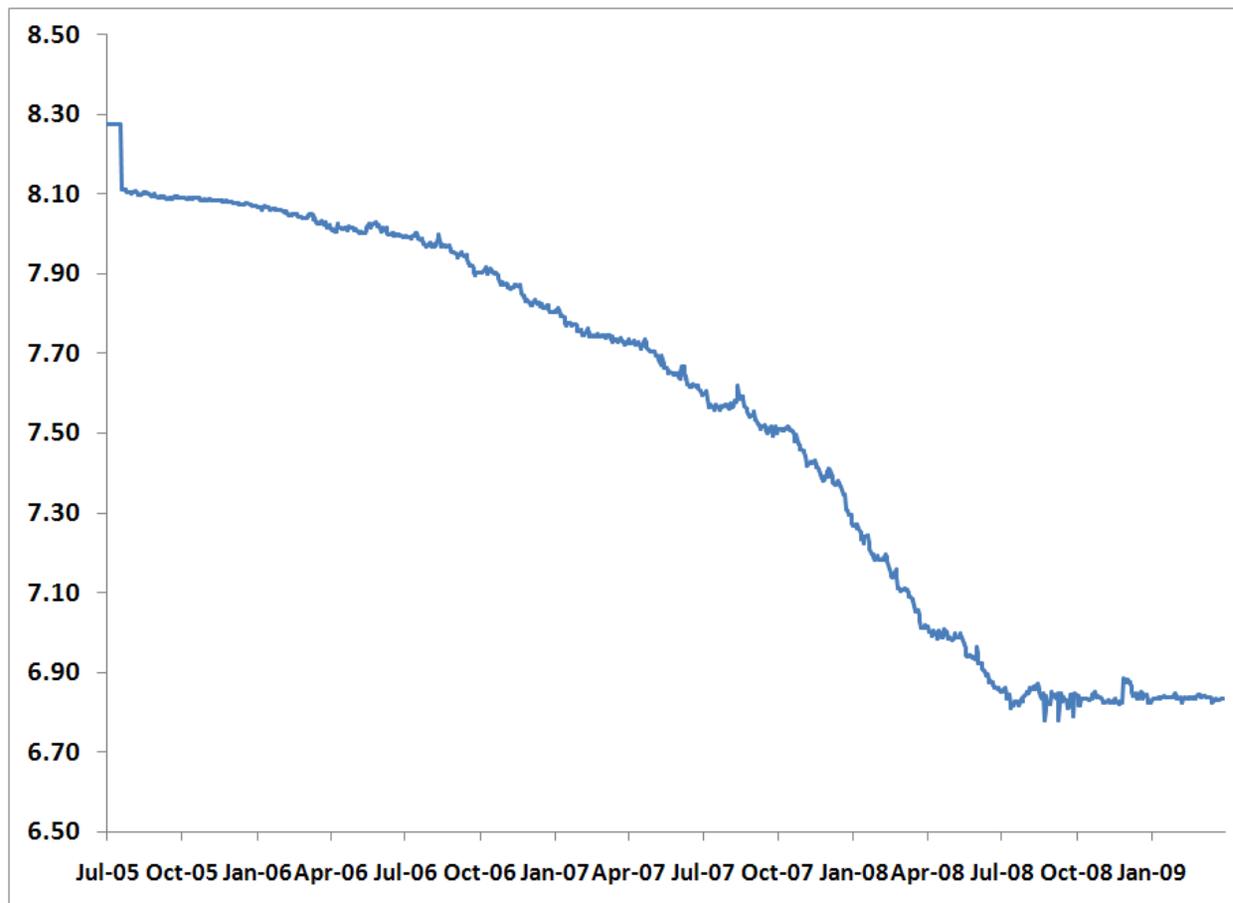


Figure 8: Daily Chinese Yuan to One US Dollar, 7/10/2005 to 4/3/2009. Source: Federal Reserve Bank of St. Louis database (FRED).

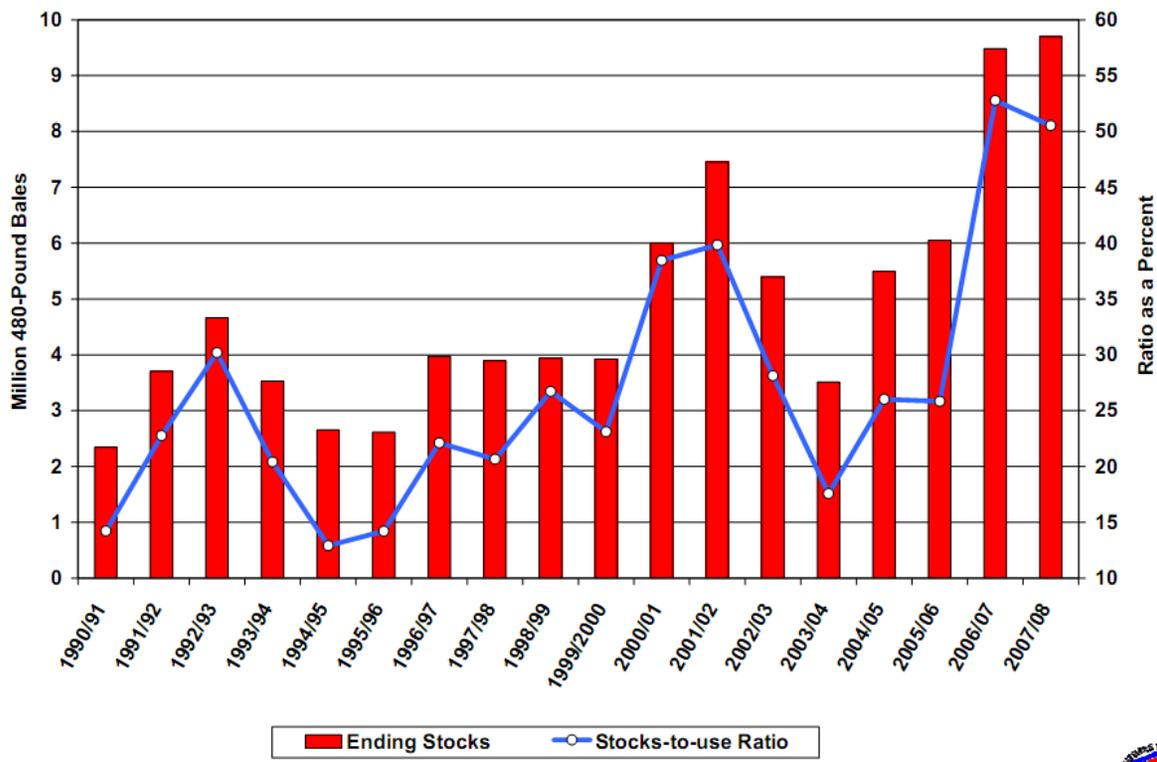


Figure 9: U.S. Cotton Ending Stocks and Stocks-to-use Ratio. Source: Fenton using USDA-ERS.

Table 1: Descriptive statistics

Variable	Mean	Standard deviation	Skewness	Kurtosis	Minimum	Maximum
Futures price (c/lb)	64.23	11.52	0.091	3.056	28.52	116.88
Ending stocks	5.132	1.941	0.628	2.70	1.7	10.2
Total use	17.999	1.963	0.527	2.775	14.6	23.0
Stocks-to-use ratio	28.48	10.18	0.673	3.129	7.870	55.14
Exports	796.18	458.74	1.034	4.089	126	2542
Yuan-US Dollar exchange rate	7.682	1.064	-1.368	3.271	4.971	8.725
Plantings	13,792.16	1,812.241	-1.106	4.640	8100	16,931.4
Number of Commercial Longs	62.38	13.154	0.196	2.358	36.25	94.75
Number of Commercial Shorts	50.69	8.107	0.0974	2.687	30.8	74.25
Trading volume	12,650.99	8,423.58	2.985	15.584	3,949	6,9061
Open interest	88,895.04	55,502.94	1.728	5.177	32,119	279,240
Non-commercial net long positions	-179.84	18,916.03	0.827	4.085	-33,224	66,903
Commercial net long positions	-3,636.45	21,258.04	-1.109	4.845	-84,094	33,418
Index trader net long positions	84,797.72	16,337.37	-0.312	3.823	51,058	111,288
Convenience yield*	0.0361	0.222	0.273	3.083	-0.508	0.925

Notes: * convenience yield is not an observed variable but rather is estimated from the data in the first-stage regression.

Table 2: Results of the second-stage regressions using economic and trader variables, 1990-2005

Variable	Effect on	Effect on	Effect on
	Convenience Yield	Excess Volatility	Price Log-Changes
	Estimate (standard error)	Estimate (standard error)	Estimate (standard error)
Constant	0.375 (0.162)	0.0037 (0.0001)	0.0323 (0.0807)
Time trend ($\times 100$)	-0.0238 (0.0351)	0.0393 (0.0049)	0.0001 (0.0002)
AR(1) term	0.648 (0.062)	0.210 (0.0184)	Nil
AR(2) term	Nil	0.482 (0.0186)	Nil
Sin1	-0.0169 (0.0183)	-0.182 (0.004)	0.0070 (0.0083)
Cos1	0.0313 (0.0138)	0.0230 (0.003)	0.0062 (0.0066)
Sin2	-0.0029 (0.0123)	0.0612 (0.0029)	-0.0045 (0.0075)
Cos2	0.0206 (0.0124)	-0.0017 (0.0001)	0.0039 (0.0061)
Number Long Comm ($\times 100$)	-0.154 (0.081)	0.0085 (0.00003)	-0.00070 (0.000455)
Number Short Comm ($\times 100$)	0.00433 (0.180)	0.0133 (0.0022)	0.0011 (0.00076)
Plantings ($\times 1,000$)	-0.01566 (0.012)	0.0001 (0.0001)	-2.949 (6.157)
Net Position Comm ($\times 100,000$)	0.0789 (0.0951)	-0.0141 (0.0001)	-0.0082 (0.00336)
Futures trading volume ($\times 1,000$)	-0.00443 (0.00334)	-0.0586 (0.0149)	-0.0012 (0.0013)
Exports ($\times 1,000$)	0.0215 (0.0361)	0.219 (1.098)	-0.00009 (0.099)
Inverse stocks-to-use ratio	0.355 (0.564)	0.763 (0.0228)	-0.0171 (0.494)
R²	66.5%	31.5%	15.1%

Notes: Results from a Newey-West regression with 6 lags. Dark-shaded cells indicate estimates for which the statistical significance is at the 99th percentile, while light-shaded cells indicate statistical significance at the 90th percentile. Number of time periods is T=182. *Source:* Authors' calculation.

Table 3: Results of the second-stage regressions using economic and trader variables, 2006-2009

Variable	Effect on	Effect on	Effect on
	Convenience Yield	Excess Volatility	Price Log-Changes
	Estimate (standard error)	Estimate (standard error)	Estimate (standard error)
Constant	0.818 (0.531)	0.847 (0.939)	-4.728 (0.969)
Time trend ($\times 100$)	Nil	-0.0016 (0.0023)	0.0121 (0.0024)
AR(1) term	0.212 (0.190)	Nil	Nil
AR(2) term	Nil	Nil	Nil
Sin1	-0.0508 (0.0246)	-0.0027 (0.0102)	0.0067 (0.0235)
Cos1	0.1089 (0.0374)	0.022 (0.0088)	-0.0017 (0.0096)
Sin2	0.0281 (0.0417)	-0.0058 (0.0076)	-0.0739 (0.0095)
Cos2	0.0311 (0.0373)	0.0008 (0.0087)	-0.0113 (0.0173)
Number Long Comm ($\times 100$)	-0.0069 (0.0065)	0.0038 (0.0015)	-0.0047 (0.0037)
Number Short Comm ($\times 100$)	-0.0019 (0.0048)	-0.0008 (0.0016)	-0.00068 (0.0013)
Net Position Comm ($\times 100,000$)	0.0196 (0.0119)	0.000047 (0.000033)	-0.00345 (0.00736)
Futures trading volume ($\times 1,000$)	0.0052 (0.0017)	-0.00059 (0.00046)	-0.0020 (0.0014)
Inverse stocks-to-use ratio	-3.247 (4.897)	0.1297 (1.336)	-0.3767 (2.669)
Yuan-USD exchange rate	-0.0394 (0.0353)	0.00037 (0.00056)	0.351 (0.0537)
Index Trader net position ($\times 100,000$)	-0.112 (0.0953)	-0.0861 (0.056)	0.00041 (0.00085)
R²	66.2%	48.9%	27.3%

Notes: Results from a Newey-West regression with 4 lags. Dark-shaded cells indicate estimates for which the statistical significance is at the 99th percentile, while light-shaded cells indicate statistical significance at the 90th percentile. Number of time periods is T=40. *Source:* Authors' calculation.