

Written Exam Economics summer 2025

Financial Markets Microstructure

August 18, 2025

This exam question consists of 10 pages in total
Answers only in English.

A take-home exam paper cannot exceed 10 pages – and one page is defined as 2400 keystrokes

The paper must be uploaded as one PDF document. The PDF document must be named with exam number only (e.g. '1234.pdf') and uploaded to Digital Exam. Please write the exam number on your exam paper as well.

Use of AI tools is permitted. You must explain how you have used the tools. When text is solely or mainly generated by an AI tool, the tool used must be quoted as a source.

Be careful not to cheat at exams!

Exam cheating is for example if you:

- Copy other people's texts without making use of quotation marks and source referencing, so that it may appear to be your own text
- Use the ideas or thoughts of others without making use of source referencing, so it may appear to be your own idea or your thoughts
- Reuse parts of a written paper that you have previously submitted and for which you have received a pass grade without making use of quotation marks or source references (self-plagiarism)
- Receive help from others in contrary to the rules in the Faculty of Social Science's common part of the curriculum

You can read more about the rules on exam cheating on your Study Site and in the Faculty of Social Science's common part of the curriculum.

Exam cheating is always sanctioned by a written warning and expulsion from the exam in question. In most cases, the student will also be expelled from the University for one semester.

Final re-exam

Write up your responses to questions below and submit them to Digital Exam. The deadline to submit the responses is Aug 18, 21:00. No cooperation with other students is permitted.

Be concise, but show your work and explain your answers. Some questions may require you to make additional assumptions beyond those provided in the question; be clear about the assumptions you make. Some questions are open ended in that they may not have a unique correct answer. You are allowed to refer to textbooks, lecture notes, slides, problem sets, etc.

Problem 1: Inventory risk and demand for liquidity

Consider a Kyle model with inventory risk and no informed trading that we considered in class. How does the dealer's pricing schedule in that model depend on the variance of the incoming market order, σ_u^2 ? Explain the intuition behind this result and which modelling assumptions are responsible for this conclusion.

Problem 2: Kyle model with public information acquisition

Consider a single-period Kyle model, where the speculator does not know the asset's fundamental value v perfectly, but instead decides how much to *publicly* invest in a noisy signal about v . In particular, suppose that before submitting an order, the speculator chooses σ_s^2 , pays cost $c(\sigma_s^2)$, and then receives signal $s \sim \mathcal{N}(v, \sigma_s^2)$. All other agents in the market (specifically, the market-maker) observe the speculator's choice of σ_s^2 .

After that, the game proceeds as in the regular Kyle model. The speculator chooses their trade size, $x \in \mathbb{R}$, to maximize their expected profit $\Pi_I \equiv \mathbb{E}[x(v - p)]$. The noise traders submit a random market order $u \sim \mathcal{N}(0, \sigma_u^2)$. The competitive dealer observes the aggregate order imbalance $q = x + u$ and quotes a price $p(q)$ at which they are willing to absorb it. All agents have a common prior belief that $v \sim \mathcal{N}(\mu, \sigma_v^2)$.

One can verify that for a given signal precision σ_s^2 and speculator's strategy $x(s) = \beta(s - \mu)$ for some β , the competitive dealer's price schedule is given by $p(q) = \mu + \lambda q$ with $\lambda = \frac{\beta \sigma_v^2}{\beta^2 \sigma_v^2 + \beta^2 \sigma_s^2 + \sigma_u^2}$. One can then verify that the speculator indeed optimally trades according to $x(s) = \beta(s - \mu)$ with $\beta = \frac{1}{2\lambda} \cdot \frac{\sigma_v^2}{\sigma_v^2 + \sigma_s^2}$.

1. Give a plausible justification to the assumption that the speculator's choice of σ_s^2 is *observable* to other market participants.
2. Solve for equilibrium speculator's trading aggressiveness β and the price impact λ in terms of model parameters and σ_s^2 .
3. Calculate the speculator's expected trading profit for given σ_s^2, σ_v^2 .
4. Suppose now the speculator's information cost is given by $c(\sigma_s^2) = \frac{\gamma}{\sqrt{\sigma_s^2}}$ for some information cost parameter γ . Derive the amount of information $\tau_s \equiv \frac{1}{\sigma_s^2}$ the speculator acquires as a function of $\lambda, \gamma, \sigma_v^2$.
5. How does the speculator's information choice depend on γ, σ_v^2 , and σ_u^2 in equilibrium? Explain.
6. Answer intuitively: after committing publicly to some level of σ_s^2 , would the speculator want to secretly change σ_s^2 ? Why or why not? Explain.

Problem 3: Frozen Concentrated Orange Juice

Read a brochure about the Frozen Concentrated Orange Juice (FCOJ) future market attached at the end of this exam text. Answer the following questions.

1. According to the brochure, what are the two main goals of the FCOJ future market?
2. According to the brochure, what two types of traders participate in the FCOJ future markets? Which of these traders, do you think, are more likely to have informational advantage?
3. The figure on p.1 of the report shows that orange crop utilization for sake of producing FCOJ has been steadily declining in both absolute and relative terms during 1992–2011. The last Figure on p.3 of the report, however, shows that both trading volume and open interest in FCOJ futures has remained steady during that period. So the FCOJ market has been declining, but the FCOJ futures market has not. Propose an explanation for this discrepancy. How does it relate to market goals you identified in question 1?



Frozen Concentrated Orange Juice

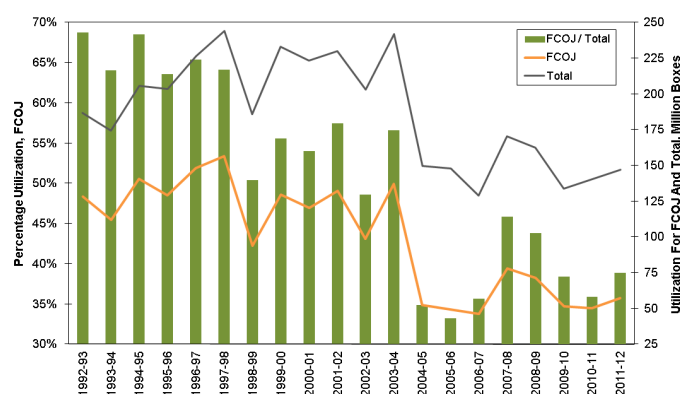
IntercontinentalExchange® (ICE®) became the center of global trading in “soft” commodities with its acquisition of the New York Board of Trade (NYBOT) in 2007. Now known as ICE Futures U.S.®, the exchange offers futures and options on futures on soft commodities including coffee, cocoa, sugar, cotton and frozen concentrated orange juice (FCOJ).

FCOJ futures have traded in New York since 1966, first on the New York Cotton Exchange, then on the successor New York Board of Trade and now on ICE Futures U.S. Options on FCOJ futures were introduced in 1985. Futures and options on futures have been used by the domestic and global citrus and juice industries to price and hedge transactions. ICE Futures U.S. is the exclusive global market for FCOJ futures and options.

THE ORANGE JUICE MARKET

FCOJ represents a combined triumph of academic research, agriculture and marketing. It was developed at the University of Florida's Citrus Research and Education Center in 1948. FCOJ competes with two other forms of juice not squeezed directly at the point of consumption: reconstituted liquid juice and not-from-concentrate, or NFC, juice. While NFC juices surpassed FCOJ in market share during the 1980s, the readily storable and easy-to-ship FCOJ remains the industry's pricing benchmark. Even though the share of Florida's orange crop going to FCOJ has declined compared to other types of juice, FCOJ remains the most visible price discovery mechanism for the industry. Ultimately, the importance of the juice industry to Florida's citrus growers cannot be overestimated; approximately 90% of the crop goes into juice in all forms.

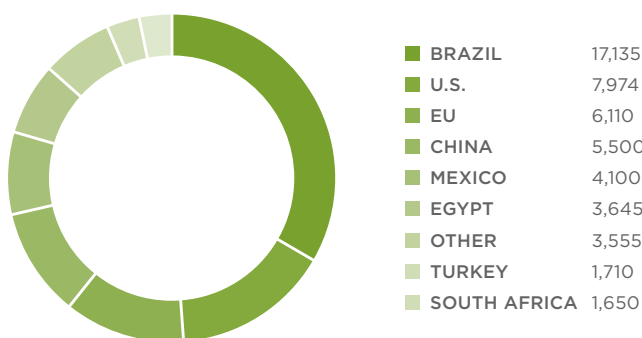
USDA FLORIDA ORANGE CROP UTILIZATION



Source: Florida Department of Citrus

While Brazil is the largest global supplier of oranges, Florida dominates U.S. production. Global demand for orange juice has attracted strong supply growth from the European Union, China and Mexico in recent years.

2006 WORLD ORANGE PRODUCTION 1,000 METRIC TONS

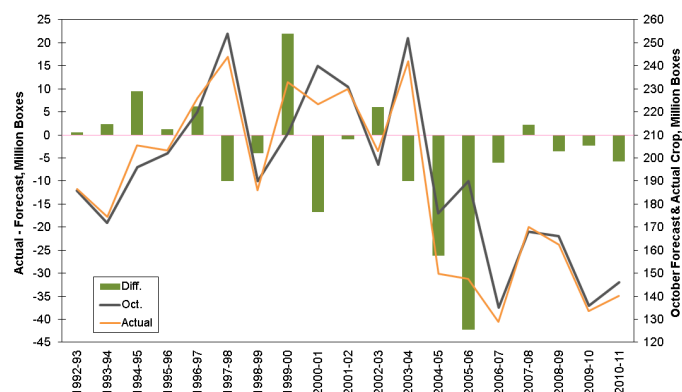


Source: Florida Department of Citrus

The citrus and orange juice markets share an odd characteristic with many other grain, oilseed and soft markets: the difficulty even experts have in assessing supply. Why this should be true in an age of satellite reconnaissance is not clear. After all, trees do not sneak into groves when no one is looking, and both the groves and the health of the trees in them are visible from both the ground and the air.

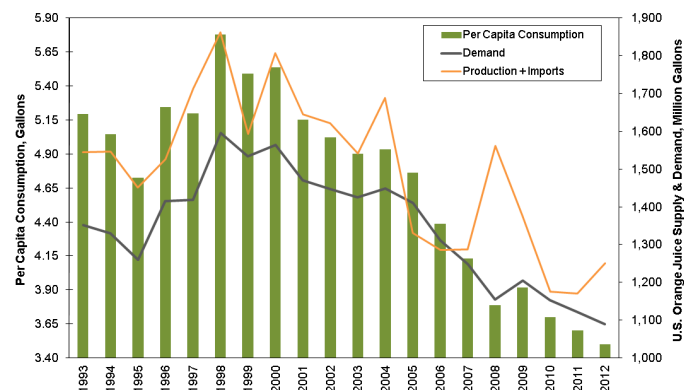
The U.S. Department of Agriculture makes a production estimate each October for the forthcoming crop year. While the Department's forecast errors from the 2003-04 crop year onward have been on the negative side (with the exception of the 2007-2008 crop year), a general decline in the crop produced and occasional supply shocks from key import sources such as Brazil have contributed to a series of price increases even though per capita consumption of orange juice has been declining steadily.

USDA FLORIDA ORANGE CROP FORECAST AND ACTUAL PRODUCTION



Source: U.S. Department of Agriculture

USDA ORANGE JUICE SUPPLY AND DEMAND ESTIMATES

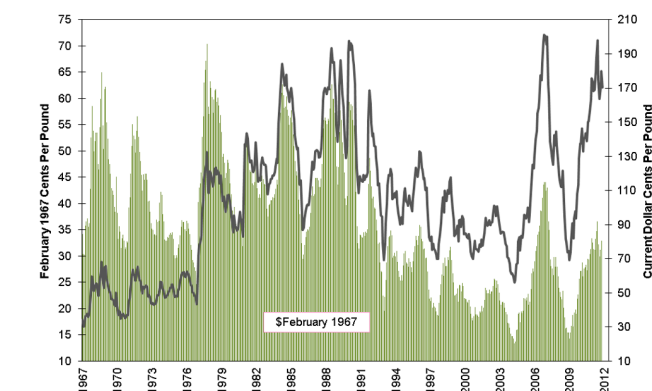


Source: U.S. Department of Agriculture

The volatile nature of FCOJ pricing is what makes this market so vital for hedgers and so interesting for speculators. The market is prone to sharp price spikes in anticipation of weather-related disruptions in supply, including freezes and hurricanes, and to retracements of those spikes when the damage was not as bad as feared initially, or when imports of FCOJ from Brazil and other suppliers enter the U.S. market. In January 2012, the market established an all-time high when the U.S. Food and Drug Administration denied entry to some Brazilian imports following discovery of traces of a fungicide prohibited for use in oranges.

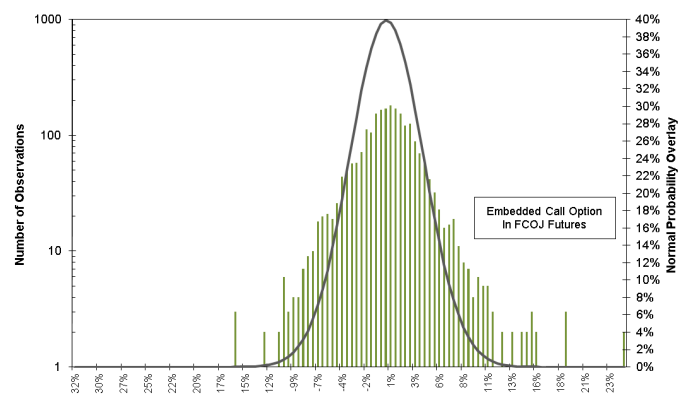
The nature of FCOJ prices over time can be viewed in two ways. The first perspective is a simple price chart in current- and constant-dollar terms. The second perspective is weekly percentage changes compared to a normal probability distribution. Here the preponderance of price spikes shows up as both the very positive "skew," or shift to the right, and as the greater-than-expected number of large positive returns. A long position in FCOJ futures is in many ways equivalent to owning a call option on a supply disruption.

EVEN CONSTANT-DOLLAR FROZEN CONCENTRATED ORANGE JUICE PRICES ARE VOLATILE



Source: CRB-Infotech CD-ROM

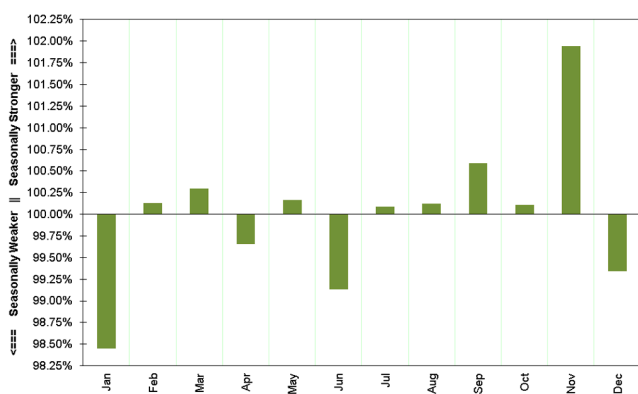
WEEKLY RETURNS SKEWED HEAVILY TO UPDATE



Source: CRB-Infotech CD-ROM

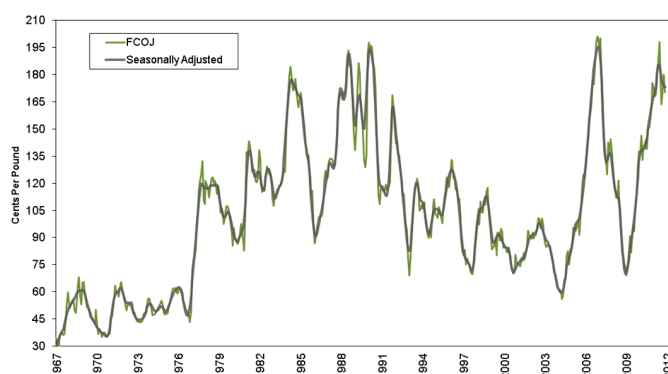
If FCOJ prices are in fact an embedded call option, do we see some seasonal distortions in their pricing structure? The answer here is rather surprising in one respect and reassuring in another. Not only are the seasonal divisors for FCOJ prices amongst the weakest of all agricultural commodities - in fact, they are not statistically significant at a rigorous 1% level - the seasonally adjusted price chart for FCOJ shows just how efficient the market has been in moderating price swings. This is what we hope for in any stored commodity. A seasonal analysis indicates the strongest month for FCOJ futures is November, the time when traders are hedging against a freeze. The seasonally weakest month is January, when many "freeze-protection" trades are lifted.

MONTHLY SEASONALITY FOR FCOJ FUTURES



Source: CRB-Infotech CD-ROM

FCOJ FUTURES MARKET EFFICIENT IN MODERATING SEASONAL SWINGS

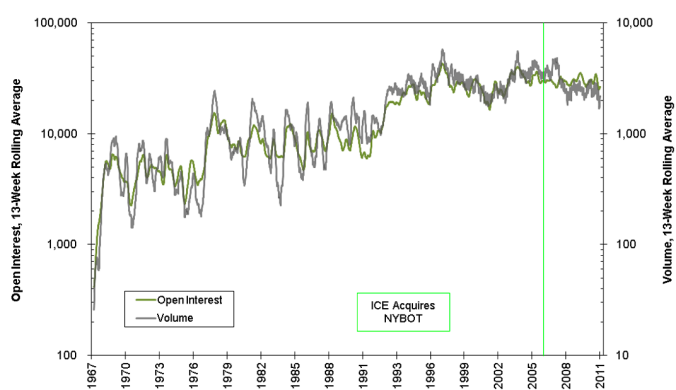


Source: CRB-Infotech CD-ROM

FCOJ TRADING AT ICE FUTURES U.S.

This price history and market structure demonstrates clearly why juice sellers such as grocery chains and juice processors should hedge price risks, and why FCOJ futures and options have been so successful over the contracts' lives. The success of the contract grew even as the physical nature of the orange juice market shifted from FCOJ to NFC. Commodity trading advisors and commodity-based hedge funds like the contract not only for its trading opportunities, but also because of its diversifying properties vis-à-vis other commodity futures.

LONG-TERM SUCCESS OF FROZEN CONCENTRATED ORANGE JUICE CONTRACT



Source: CRB-Infotech CD-ROM

ICE FUTURES U.S. FROZEN CONCENTRATED ORANGE JUICE CONTRACT

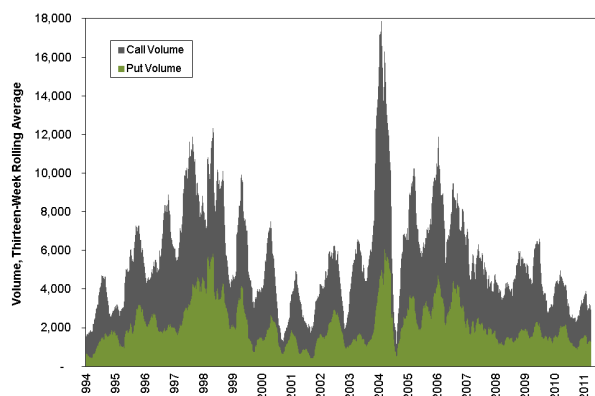
The ICE Futures U.S. FCOJ futures contract is for the physical delivery of USDA frozen concentrate, not less than 62.5° Brix, to an exchange-licensed warehouse in Florida, New Jersey or Delaware.

[Contract specifications including fees, margins and delivery standards](#)

Options on the FOCJ futures contract are also available. Each futures contract has options that settle into that contract along with a serial option expiring in the month prior to the futures contract. For example, the January future has both a December and a January option priced thereto. Option strikes are spaced 5 cents apart. The last trading day is the third Friday of the month preceding the named option month.

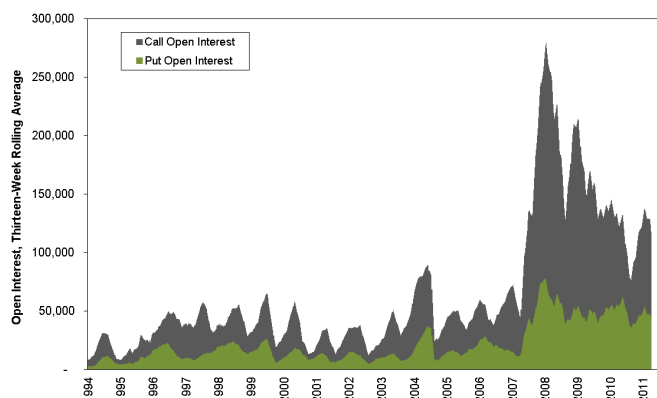
Options trading volume and open interest on the FCOJ futures contract have stayed at a high level, with surges around weather-related events such as the 2004 hurricane season in Florida. Options tend to be used by two groups of sophisticated traders. The first is commercial participants hedging their physical positions. The second is experienced speculative traders.

LONG-TERM SUCCESS OF FCOJ OPTIONS: VOLUME



Source: ICE Futures U.S.

LONG-TERM SUCCESS OF FCOJ OPTIONS: OPEN INTEREST



Source: ICE Futures U.S.

TRADING ICE FUTURES U.S. FCOJ FUTURES AND OPTIONS

Futures markets exist for the purposes of price discovery and risk transfer. Price discovery requires buyers and sellers to meet in a competitive marketplace; prices resulting from each transaction signal to other traders what a given commodity might be worth.

Anyone approved by a clearing member or futures commission merchant can participate in the price discovery process, regardless of their participation in the citrus and juice business. A market participant who is not in the citrus, juice-packing or retail business will be classified as a non-commercial or speculative trader. A market participant active in those businesses will be classified as a commercial trader or hedging trader. For a speculator, the price discovery trade is simple and straightforward; if you believe the price of FCOJ will rise, you “go long” a futures contract; if you believe the price of FCOJ will fall, you “go short” a futures contract.

These same market views can be expressed in options as well. If you believe prices will rise, you can buy a call option, sell a put option or engage in a large number of spread trades tailored to your specific price view and risk acceptance. If you believe prices will fall, you can buy a put option, sell a call option or engage in a different set of spread trades. A long call (put) option is the right, but not the obligation, to go long (short) the underlying future at the strike price at or by expiration. A short call (put) option is the obligation to deliver (take delivery) of the underlying future at or by the expiration if that option is exercised.

Hedgers use ICE FCOJ options frequently. Producers can set a floor beneath a selling price with long put options, and buyers can establish a ceiling over costs with long call options, among other strategies.

In a futures trade, you and the counterparty to your trade will post initial or original margin with your futures commission merchant or clearing member. Minimum margins are set by ICE Futures U.S., and your futures commission merchant may require additional funds. Margin schedule

There are no margin requirements for long option positions. Margin requirements for short option positions vary according to the relationship between the option strike price and the futures price.

If the market moves in your favor — higher for a long position (or commitment to take delivery of FCOJ or to offset the contract by selling it prior to delivery), or lower for a short position (or commitment to deliver FCOJ or to offset the contract by buying it prior to delivery) - the equity in your account will increase. You may withdraw these funds down to the “maintenance margin” level, depending on your account agreement.

If the market moves adversely - lower for a long position or higher for a short position - your futures commission merchant will require

you to post additional funds, called variation margin, to sustain your maintenance margin level. These “margin calls” assure both your futures commission merchant and ICE Clear U.S.®, the exchange clearing house, that you can perform according to your contractual commitment. All futures accounts are marked-to-market daily, and participants deficient in margin obligations may have positions liquidated involuntarily.

As the designated clearing house, ICE Clear U.S. serves as the counterparty to every futures contract traded on ICE Futures U.S. The clearing house clears trades matched by ICE Futures U.S. and guarantees performance in delivery even if a trader defaults. The financial integrity and anonymity provided by ICE Clear U.S. are increasingly important in the financial system.

What do the financial flows look like in a futures trade? Let's say a five-contract futures position is initiated at 217.00¢ per pound and the market rises to 218.30¢ per pound on the following trading day.

- For the long position, the gain is:
 $5 \text{ contracts} \times [218.30 - 217.00] / \text{contract} \times \$1.50 \text{ per } .01¢ = \975
- For the short position, the loss is equal and opposite:
 $5 \text{ contracts} \times [217.00 - 218.30] / \text{contract} \times \$1.50 \text{ per } .01¢ = -\975

If we reverse the price path, we reverse the gains and losses. Let's change the starting price to 216.50¢ per pound and have the market decline to 214.25¢ per pound the next day.

- For the long position, the loss is:
 $5 \text{ contracts} \times [214.25 - 216.50] / \text{contract} \times \$1.50 \text{ per } .01¢ = -\$1,687.50$
- For the short position, the gain is equal and opposite:
 $5 \text{ contracts} \times [216.50 - 214.25] / \text{contract} \times \$1.50 \text{ per } .01¢ = \$1,687.50$

Options traders see the same directional profit and loss profiles relative to price, but the actual profit and loss is subject to a range of additional factors, including market volatility, time to expiration, interest rates and the relationship between the current futures price and the option's strike price.

RISK TRANSFER

Risk transfer is the second purpose of a futures market. Any producer of FCOJ, any holder of FCOJ inventories, or any party at risk to the price of FCOJ declining can seek protection in the futures markets. These participants are long the market and can offset risk by going short a futures contract. Any juice packer or retailer at risk to the price of FCOJ increasing is short the market and can offset risk by going long a futures contract.

The mechanics and financial flows are identical to those outlined above. A FCOJ producer at risk to prices falling can acquire a financial asset, the short futures position, which will rise in value as the market declines. The opposite is true for a juice packer at risk to prices rising; there a long futures position will rise in value as the market rises.

While the financial flows should offset the economic gains and losses of the physical FCOJ position, there are two important things to remember. First, even though futures prices converge to cash prices at expiration, the convergence process is subject to what is called “basis risk” or differences resulting from changes in hedging demand and location of the FCOJ. Certified stock reports.

Second, while the economic gains on, for example, a warehouse full of FCOJ are real, they are not realized until the FCOJ is sold. If this inventory is hedged with a short futures position and the market rises, the beneficial owner will have to keep posting additional funds in the margin account.

Nothing in the above discussion of hedging indicates when or at what price to hedge. This is one of the reasons options are valuable to hedgers. While the FCOJ producer may wish to have downside protection or a price floor, that same producer probably wants to participate in any future price increases.

The producer concerned about a decline in the value of FCOJ between now and the time he expects to be able to sell his inventory could buy a January 215¢ put option, which is the right, but not the obligation, to receive a short position in a January future at 215¢ for 8.65¢, or approximately \$1,298. The purchased put guarantees the producer the right to sell the January future for an effective price of 206.35¢ per pound (the 215¢ strike price less the premium paid of 8.65¢). This right gives him protection if FCOJ prices have fallen by the expiry of the January option, but at the same time preserves his ability to profit should the price of FCOJ move higher over the period.

The juice packer wishing to cap the price of FCOJ, but not be exposed to margin calls if the price continues to rise, can do an opposite trade and buy a January 220¢ call option, which is the right, but not the obligation, to receive a long position in a January future at 220¢ for 8.40¢, or approximately \$1,260. The purchased call gives the juice packer the right to buy the January future at an effective price of 228.40¢ per pound (again, the strike price of 220¢ cents plus the premium paid of 8.40¢), offering protection against an unfavorable rise in the price of FCOJ while preserving the ability to take advantage if prices decline.

It should be noted that the risk profile for sellers of options is dramatically different than for buyers of options. For buyers, the risk of an option is limited to the premium or purchase price paid to buy the option. For sellers, the risk profile is unknown and can be potentially quite large.

Options can become complex very quickly, with trading influenced by variables including time remaining to contract expiration, underlying commodity volatility, short-term interest rates and a host of expected movements collectively called "the Greeks."

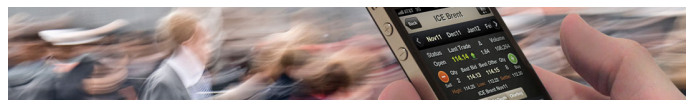
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