EFFICIENCY MARKET HYPOTHESIS AND OPTIMAL HEDGE RATIO THE ETHANOL MARKET

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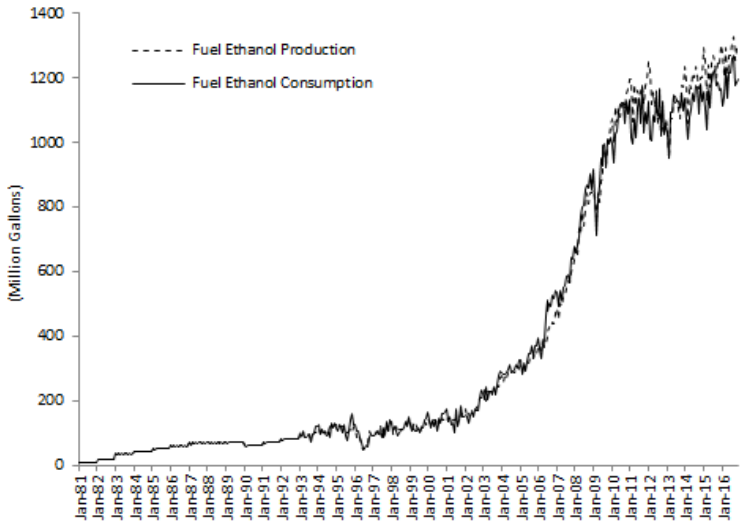
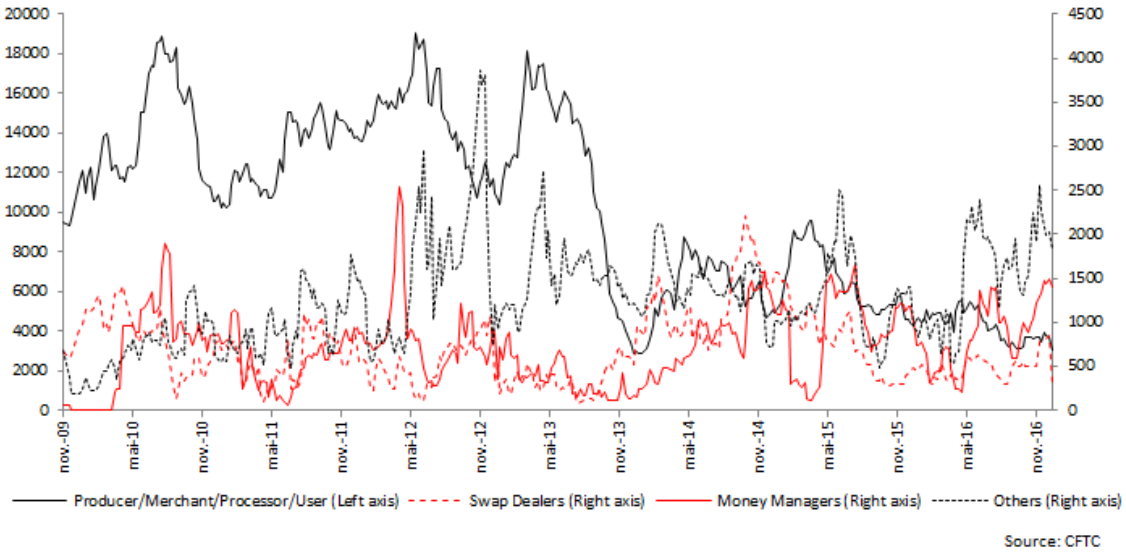
ETHANOL MARKET – EFFICIENCY AND HEDGING

Key facts

- Increase of ethanol production/consumption in the U.S. since the last decade
- Ethanol futures market opening on the CBOT in 2005
- Decrease of transaction volume since 2013, especially for commercial agents



Source: U.S. Energy Information Administration



Source: CFTC

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Motivation and Objectives of the paper

- To test the Efficiency Market Hypothesis
- To describe price relationships between spot and futures markets
- To provide a efficient hedging strategy for commercial agents
- To check the efficiency of a cross-hedging strategy with gasoline futures market
- To check the ability of the Nielsen (2010)'s non parametric cointegration procedure to improve the efficiency of the hedge ratio estimation compared to Johansen (1988)'s cointegration estimation

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Short Literature Review

- Kaldor (1939), Working (1948), Brennan (1958), Telser (1958): The cost-of-carry model

$$f_t^T = s_t + (r_t - \bar{s})(T - t)$$

- Garbade and Silber (1983): Validity of the unit relationship only in the long-term
  Information flow from futures to spot market

- Figuerola-Ferretti and Gonzalo (2010): To allow for non unit relationship by adding the convenience yield (y_t)

$$y_t = \gamma_1 s_t - \gamma_2 f_t$$

$$f_t^T = \frac{1 - \gamma_1}{1 - \gamma_2} s_t + \frac{(r_t - \bar{s})(T - t)}{1 - \gamma_2}$$

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- Ederington (1979): Hedge ratio (δ) with OLS estimation

$$\Delta S_t = c + \delta \Delta F_t + u_t$$

- Baillie and Myers (1991), Kroner and Sultan (1993): Time-varying hedge ratio

$$\delta_t | \Omega_{t-1} = \frac{\sigma_{t-1}(\Delta S_{t-1}, \Delta F_{t-1})}{\sigma^2_{t-1}(\Delta F_{t-1})}$$

- Kroner and Sultan (1993), Ghosh (1993), Chou et al. (1996), Lien (1996): Inclusion of the long-term relationship between spot and futures markets
- Brooks et al. (2002): Inclusion of the leverage effect (asymmetric response from past shocks)
- Lee and Yoder (2007): Inclusion of different regimes in the variance process (high/low volatility)
- Alizadeh et al. (2008): Inclusion of different regimes in the variance and mean processes

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- No studies on the Efficiency Market Hypothesis focused on the ethanol market
- Franken and Parcell (2003): Efficiency of cross-hedging with gasoline futures market
- Dahlgran (2009): Direct hedging outperforms cross-hedging with gasoline futures market

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Econometric model

$$\Delta X_t = \mu_{st} + \Gamma_{st}\Delta X_{t-1} + \Pi_{st}X_{t-1} + \varepsilon_{t,st}$$

$$\Pi_{st} = \alpha_{st}\beta'$$

$$\varepsilon_{t,st} \sim N(0, H_{t,st})$$

$$H_{t,st} = C'_{st}C_{st} + A'_{st}\varepsilon_{t-1}\varepsilon'_{t-1}A_{st} + B'_{st}H_{t-1}B_{st} + D'_{st}\eta_{t-1}\eta'_{t-1}D_{st}$$

$$st = \{1,2\}$$

$$P = \begin{pmatrix} P_{11} & P_{21} \\ P_{12} & P_{22} \end{pmatrix} = \begin{pmatrix} 1 - P_{12} & P_{21} \\ P_{12} & 1 - P_{21} \end{pmatrix}$$

$$f_{st}(X_t, \theta) = \frac{1}{2\pi}|H_{t,st}|^{-\frac{1}{2}}\exp\left(-\frac{1}{2}\varepsilon'_{t,st}H_{t,st}^{-1}\varepsilon_{t,st}\right)$$

$$f(X_t, \theta) = \sum_{st=1}^{2} \pi_{t,st} f_{st}(X_t, \theta)$$

$$L(\theta) = \sum_{t=1}^{T} \log(f(X_t, \theta))$$

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Results

- Existence of a long-term relationship (at 1% significance level) with a unit coefficient (at 10%)
- Information flow from futures to spot prices (at 10%)

Efficiency Market Hypothesis is valid but

- No long-term relationship during some periods (2009-2011 and 2013-2016)
- No unitary coefficient during some periods (2009-2014 and 2015-2016) that alternates between coefficient inferior and superior to one

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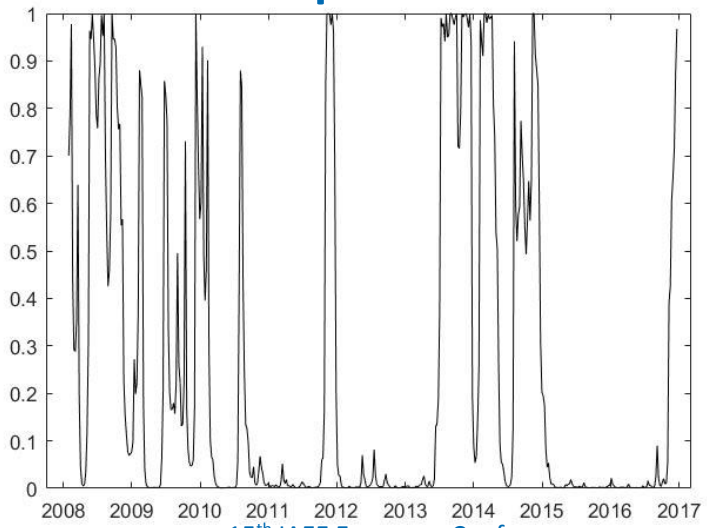
- No adjustment of the spot price if deviation from long-term equilibrium
- Slower adjustment to the equilibrium of futures price during high volatility periods
- No short-term relationship during low volatility periods
- Impact of futures price on spot price in the short-term during high volatility periods
- High volatility in 2008-2009 (low liquidity) and in 2013-2014 (exit of commercial agents)

Low relationship in the short-term



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- Direct hedging always more efficient than cross-hedging with gasoline futures market
- But cross-hedging strategy sometimes more efficient than situation without hedging strategy
- Model with long-term relationship, regime shifts and without leverage effect more efficient
- But not for all periods studied
- Multivariate GARCH model more efficient according to the out-of-sample simulation
- Best hedging strategies mainly with Johansen (1988)'s cointegration procedure

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Conclusion

- **Efficiency Market Hypothesis valid without unit coefficient**
- **Price discovery process from futures to spot prices in the long-term**
- **Ability of futures market to explain spot price dynamics during high volatility periods**
- **Direct hedging always more efficient than cross-hedging but with different econometric models depending on the considered period**
- **Good explanatory power for Nielsen (2010)'s cointegration procedure but not efficient for hedging**

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