EFFICIENCY AND OPTIMAL HEDGE RATIO OF THE ETHANOL MARKET IN THE US

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Overview

The aim of this paper is to study the biofuel price dynamic in the ethanol market in the US. Ethanol is derived from different agricultural products (cassava, corn, hemp, sugar beet or sugarcane) and has been increasingly added to gasoline blends for several reasons: (i) it helps to reduce green house gases emissions (GHG) in the transportation sector; (ii) produced with agricultural feedstock, ethanol can be seen as a renewable energy and (iii) from a technical point of view the use of ethanol boosts the octane numbers and leads to an improvement of the thermal engine efficiency. All these factors contributed to the development of ethanol's use worldwide. The ethanol market structure is already driven by the inclusion policy of the different countries, the energy prices and more especially by the evolution of the crude oil prices and by the regulatory framework. But recent changes prove that production process (ethanol is derived from different agricultural products) could also impact the international market structure and the ethanol price dynamics. The ethanol prices registered up and down since 2007 and the range of prices has extended from 1.47 USD per gallon to more than 4.00 USD per gallon following the volatility observed during this period of time in the energy and agricultural prices. Futures contracts on corn based ethanol were launched on floor based trading on March, 23th 2005 on the CBOT and in 2006 the exchange launched the ethanol contract on electronic platform which contribute to increase the liquidity within the market. Our main assumption relates to the fact that futures market can help in understanding the ethanol price dynamic during the period of instability and that it can exacerbate the dynamic observed in the ethanol market during tension periods whereas it won't appear as a determinant factor during "normal" or bearish period. By first using statistical and econometrical tools, we attempt to identify the long term relationship between ethanol spot prices and the prices of futures contracts on the Chicago Board of Trade (CBOT). Subsequently we model the short term dynamics between these two prices and on this basis a Markov Switching Vectorial Error Correction Model (MS-VECM) with two distinct state: a standard non-volatile state and a crisis state with volatility has been estimated. In addition we assess for each week the optimal hedge ratio in order to minimise the variance of the trader's portfolio.

Methods

The assumption developed in this article lead us to adopt a specific econometric methodology based on non-linear models, a Markov chain model which allows for changes in the short run and volatility dynamic. We estimate a Markov Switching Vectorial Error Correction model (MS-VECM) including a multivariate Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) error structure. This specification allows the coefficients, both in the short-run and volatility processes, to switch between two distinct states (standard state and crisis state). Hamilton (1989) proposes the Markov Switching models while Krolzig (1999) extends this specification for vector autoregressive model. The main contributions of this work are threefold. First, we are able to analyse both market efficiency and dynamic hedge ratio concerning the ethanol market for the first time. Second, we include adjustment to long-term equilibrium and regimes shifts, as Alizadeh et al. (2008), asymmetric behavior of variance process, as Brooks et al. (2002), as well as regime switching short-run dynamic between spot and futures prices, as Salvador and Arago (2014) to estimate optimal hedge ratio. Third, we will able to discriminate between the different hedge ratios estimated from different specifications in terms of variance reduction and utility rise using in-sample and out-of-sample tests.

Results

During the previous decades and especially in the initial phase of construction of the ethanol futures market, the main objective was to attract and concentrate the liquidity required for commercial traders to achieve hedging activities. Nevertheless, the rise in transaction volumes has been accompanied by a concentration of traders' liquidity on the shortest maturity contracts exchanged in the commodity markets. This factor has been observed and studied in the past (Lautier, 2005), and for the WTI market in the U.S. (Hache and Lantz, 2013). For ethanol futures prices, we observed between 2008 and 2016 a decrease in transaction volumes as contract terms grew longer, and a virtual absence of liquidity for long term contracts (compared to short term maturity). In fact, the inadequate information available at any given moment t on contracts whose maturity period is greater than one year does not give traders the incentives to trade in the market. In consequence, the liquidity for distant contracts a maturity greater than 5 months decreases sharply. Moreover the maturity greater than 2 months registered a sharp decline in transaction volumes after 2012. We estimate the MS-VEC model with two states applied to both the mean and the variance equations. These two states refer to low and high volatility regime. As expected, linear model presents several non significant coefficients due to the existence of regime shifts. The two coefficients measuring the speed of adjustment to the long-run equilibrium, are significant and negative. In addition, the higher coefficient for spot prices highlights its faster adjustment to the long-term equilibrium compared to futures prices. This result is in line with the price discovery role of futures markets. The nonlinear specification provides more information concerning the relations between spot and futures prices of ethanol with many significant coefficients and all residual diagnostics confirm that the nonlinear model is well specified. Concerning the nonlinear model results, all adjustment coefficients are negative and significant. In each states, the spot prices adjust to equilibrium more than futures prices, highlighting the role of futures markets in the price discovery process.

Conclusions

Our results are three-fold. First, the long-term equilibrium in the ethanol market is well explained by the Garbade and Silber (1983) theory about efficiency in storable commodity markets, compare to the Figuerola-Ferretti and Gonzalo (2010) model, with a price discovery process from futures to spot prices. Second, this result is only valid during the 2008-2011 period. Since 2011, the ethanol market alternates between long-term backwardation and contango. Third, our different specifications allow us to estimate a large variety of dynamic hedge ratios which need to be analyse.

References

Alizadeh, A.H., Nomikos, N.K., Pouliasis, P.K., 2008, ”A Markov Regime Switching Approach for Hedging Energy Commodities”, Journal of Banking and Finance, Vol. 32, Is. 9, pp. 1970-1983.

Brooks, C., Henry, O.T., Persand, G., 2002, ”The Effect of Asymmetries on the Optimal Hedge Ratios”, Journal of Business, Vol.75, Is. 2, pp. 333-352.

Dark, J., 2015, ”Futures Hedging with Markov Switching Vector Error Correction FIEGARCH and FIAPARCH”, Journal of Banking Finance, Vol. 61, pp. S269-S285.

Dickey, D.A., Fuller, W.A., 1981, ”Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root”, Econometrica, Vol. 49, Is. 4, pp. 1057-1072.

Figuerola-Ferretti, I., Gonzalo, J., 2010, ”Modelling and Measuring Price Discovery in Commodity Markets”, Journal of Econometrics, Vol. 158, Is. 1, pp. 95-107.

Garbade, K.D., Silber, W.L., 1983, ”Price Movements and Price Discovery in Futures and Cash Markets”, Review of Economics and Statistics, Vol. 65, Is. 2, pp. 289-297

Hache, E., Lantz, F., 2013, ”Speculative Trading and Oil Price Dynamic: A Study of the WTI Market”, Energy Economics, Vol. 36, pp.334-340.

Hamilton, J.D., 1989, ”A new Approach to the Economic Analysis of Non-Stationary Time Series and Business Cycle”, Econometrica, Vol. 57, Is. 2, pp. 357-384.

Johansen, S., 1988, ”Statistical Analysis of Cointegrating Vectors”, Journal of Economic Dynamics and Control, Vol. 12, Is. 2-3, pp. 231-254.

Johansen, S., 1995, ”Likelihood-Based Inference in Cointegrated Vector Autoregressive Models”, Oxford University Press, Oxford.

Krolzig, H.M., 1999, ”Statistical Analysis of Cointegrated VAR Processes with Markovian Regime Shifts”, Department of Economics, University of Oxford, unpublished manuscript.

Lautier, D., 2005, ”Term Structure Models of Commodity Prices: a Review”. Journal of Alternernative Investments, Vol. 8, Is. 1, pp. 42-64.

Lamoureux, C.G., Lastrapes, W.D., 1990, ”Persistence in Variance, Structural Change, and the GARCH Model”, Journal of Business and Economic Statistics, Vol. 8, Is. 2, pp. 225-234.

Lee, H., Yoder, J.K., 2007a, ”A Bivariate Markov Regime Switching GARCH Approach to Estimate Time Varying Minimum Variance Hedge Ratio”, Applied Economics, Vol. 39, Is. 10, pp. 1253-1265.

Lien, D., Tse, Y.K., 2002, ”Some Recent Developments in Futures Hedging”, Journal of Economic Surveys, Vol. 16, Is. 3, pp. 357-396.

Phillips, P.C.B., Perron, P., 1988, ”Testing for a Unit Root in Time Series Regression”, Biometrika, Vol. 75, Is. 2, pp. 335-346.

Salvador, E., Arago, V., 2014, ”Measuring Hedging Effectiveness of Index Futures contracts: Do Dynamic Models outperform Static Models? A regime-switching approach”, Journal of Futures Markets, Vol. 34, Is. 4, pp. 374-398.

Working, H., 1948, ”Theory of Inverse Carrying Charge of Futures Markets”, Journal of Farm Economics, Vol. 30, Is. 1, pp. 1-28.