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Is Petrobras Options Market Efficient? A Study Using the Delta-Gamma Neutral Strategy

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ABSTRACT

This study aims to verify if the Petrobras options market is efficient in its weak form. For this purpose, this work tries to make profits on a systematic basis through delta-gamma neutral strategies using the firm's stocks and options. In order to simulate the strategy as it would be used in the real world, we built order books every five minutes considering all buy and sell orders sent for both the underlying asset and its options. We apply the strategy when we observe distortions between implied volatilities extracted from the options. The results show evidence that the Petrobras options market is not efficient, since in 371 day-trade transactions (with an average investment of R$81,000 and an average holding time of one hour and thirteen minutes), 85% of the options strategies were profitable and the average return was 0.49%, which corresponds to more than 1600% of the highest interbank interest rate for the period.

RESUMEN

El objetivo de este trabajo es verificar si el mercado de opciones de Petrobras, en su forma débil, es eficiente. Para lograrlo, tratamos de obtener la utilidad sistemáticamente mediante la estrategia Delta-Gama-Neutra, utilizando la acción preferencial de la empresa y sus opciones de compra. Para simular la estrategia tal como sería utilizada en el mundo real, construimos los libros de las ofertas a cada cinco minutos, considerando todas las órdenes de compra y venta, enviadas tanto para el activo objeto como para las opciones. La estrategia se implementa cuando observamos las distorciones existentes entre las volatilidades implícitas extraídas de las opciones. Los resultados muestran que existen evidencias de que el mercado de opciones de Petrobras no es eficiente, ya que en 371 operaciones de day-trade realizadas, con una inversión promedio de R$81 mil y tiempo medio de uma hora y trece minutos, el retorno medio fue de 0,49%—lo que corresponde a más de 1600% del mayor tasa interbancaria del período, siendo que 85% de las estrategias fueron rentables.

RESUMO

Este trabalho tem como objetivo verificar se o mercado de opções da Petrobras é eficiente em sua forma fraca. Para isso, tenta-se obter lucro sistematicamente por meio da estratégia Delta-Gama-Neutra utilizando a ação preferencial da empresa e suas opções de compra. Para se simular a estratégia tal como ela seria empregada no mundo real, construímos os livros de ofertas a cada cinco minutos considerando todas as ordens de compra e venda enviadas tanto para o ativo-objeto quanto para as opções. A estratégia é realizada quando observamos distorções entre as volatilidades implícitas extraídas das opções. Os resultados mostram que há evidências de que o mercado de opções de Petrobras não é eficiente, uma vez que em 371 operações de day-trade realizadas, com investimento médio de R$81 mil e tempo médio de uma hora e treze minutos, o retorno médio foi de 0,49%—o que corresponde a mais de 1600% do maior CDI-over do período, sendo que 85% das estratégias foram lucrativas

KEYWORDS:

Delta-gamma neutral strategy | implied volatility | market efficiency | options

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Notes

Exponential weighted moving average, also known in the econometric literature as integrated GARCH (1,1)—IGARCH (1,1)—with null constant. This model is widely used in the financial market. See, for example, Riskmetrics™ (1996).

Delta and gamma are the first and second order measures of the sensitivity of the price of the portfolio in relation to the price of the underlying stock.

In particular, the impact of the Greek theta is practically nil due to the short term positions used in this work.

In April 2013, there was a change in the layout of the file that contains the orders generated by the Brazilian stock exchange, which makes the proper construction of the book impossible (more details in Section 2).

“Bid” is the word referring to the highest buying price of the order book, while “ask” refers to the lowest selling offer.

The better known expression, volatility smile, is used when the graph of the implied volatility against the strike price is U-shaped (the implied volatility is lower for options at the money and gets progressively larger when the option moves in the money or out of the money). This shape is common for FX options, but sometimes is found for stock options. In most cases for stock options (mainly in the US market), the implied volatility decreases the higher the strike price.

One of the B-S assumptions is that the stock prices have a log-normal distribution.

See, for example, Gabaix (2012), Gourio (2012), and Wachter (2013) for models that incorporate disaster risk to explain stock price volatility. Seo and Watcher (2015) explained why the implied volatilities for options depend on strike prices using a pricing model with stochastic disaster risk.

Section 2 will talk about the criteria for carrying out the strategy, including the distance of the volatilities.

The Black model is the version of the B-S model used to price futures options.

ftp://ftp.bmf.com.br/marketdata.

As described in Raju (2012), the strategy is also feasible with puts; however, these type of options were not included in this study because, in general, they did not have sufficient liquidity in the Brazilian market during the study period.

The options with the shortest maturity are usually those with the highest liquidity.

More specifically, the information that was removed is the “date and time of the offer modification” and “number of modified offer.”

The first book of the day is built five minutes after the start of trading and, the last, five minutes before the closing bell.

These simplifications only bring more restrictions to the strategy, i.e., less likelihood of the gamma-delta neutral strategy being successful.

www.cetip.com.br.

The rate that should be used as the risk-free interest rate in a pricing model is the fixed rate to maturity of the option. However, because the difference is small (since the options are short-term), there is no harm in using the one-day interbank interest rate.

We chose the EWMA model to be the central volatility of this strategy because this methodology is widely used in the financial market. Further, the comparison of EWMA using daily returns with implied volatility is simple, because for calculating the volatility for a period t all that is necessary is to multiply the EWMA volatility by . The EWMA used in this work is the standard one, with decay parameter equal to 0.94.

The Implied Volatility 1 (VIMP1) is calculated with the ask price of the option, since it will be purchased, while the Implied Volatility 2 (VIMP2) is calculated on the bid price of the option, since this option will be sold. The sequence to carry out the strategy is always VIMP1 < EWMA < VIMP2.

The distance used between the volatilities should not be too low, since the market already assigns different implied volatilities to the underlying asset for different option

strikes in order to resolve the distortions generated by the assumptions of the B-S model. Thus, if the distance between the volatilities is small, there is less likelihood that the option prices really reflect distortions.

We could also implement the position without using a “central” volatility (in this study, EWMA volatility), i.e., entering into the position when the distance between the implied volatilities is greater than a certain limit.

For example, consider a long position in 100 options with a strike price of 10, a short position in 300 options at a strike price of 12 and a long position in 100 of the underlying asset. In this transaction, for the 300 options sold, 100 are covered with the underlying asset and 100 are covered with the long options (since these options have lower strike price than the short options). Thus, the value of the margin in this case is 100 (number of uncovered options sold) x 12 (strike price of these options), R$1200.

Margin required by CBLC (Brazilian Clearing and Depository Corporation) for the position during the study period.

Name commonly used in the financial market for the average value of a trade.

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