Assignment 4 : Learn products of Futures

Note:

See the "Answer to Assignment 4.xlsx" under the "reports" folder for Excel file model

We hold the physical power. We are facing the risk of decline power price. We can short product 1 (ERCOT North 345KV Real-Time Peak Fixed Price Future) to hedge the long position of physical power. But since Product 1 has no liquidation in the market, we can short product 2 to hedge our physical power position.

We hold physical power and are facing the risk of declining power prices. We can short Product 1 (ERCOT North 345KV Real-Time Peak Fixed Price Future) to hedge our long position in physical power. However, since Product 1 has no liquidation in the market, we can instead short Product 2 to hedge our physical power position.

Hedge by only using product2:

Short r contracts product2(r is the hedge ratio, r should be related to the heat rate)

The value of the portfolio at time t can be expressed as:

$$\Pi(t) = V_{physical}(t) - r \cdot H_H(t)$$

Where:

- $\Pi(t)$ is the portfolio value at time t.
- $V_{physical}(t)$ is the value of the physical power at time t.
- $H_H(t)$ is the price of the product2(Henry LD1 Futures) at time t.
- r is the hedging ratio.

When we use Product 2 to hedge our physical power position, our portfolio is also affected by the efficiency of transforming natural gas into electricity (heat ratio). Since the heat ratio also fluctuates, we need to hedge against the changing heat ratio. To do this, we should short Product 3 to hedge the risk of energy loss changes in electricity generation.

Hedge by only using product2 and product3:

Short r1 contracts product2

Short r2 contracts product3

The value of the portfolio at time t can be expressed as:

$$\Pi(t) = V_{physical}(t) - r1 \cdot H_H(t) - r2 \cdot H_{XPR}(t)$$

Where:

- $\Pi(t)$ is the portfolio value at time t.
- $V_{physical}(t)$ is the value of the physical power at time t.
- $H_H(t)$ is the price of the product2(Henry LD1 Futures) at time t.
- $H_H(t)$ is the price of the product3(ERCOT North 345kV Physical HR Peak HE 0700-2200) at time t.
- $r1$ is the hedging ratio of shorting product2
- $r2$ is the hedging ratio of shorting product3

Assume we have 10,000 MWh power on the hand, we need to buy 10,000 contracts product1(its contract size is 1 MW). Since product 1 is unavable, we need to build an equivalent portfolio by using product 2 and 3.

I consider the future price of energy power (Product 1) as equivalent to the price of physical power for easier calculation.

On the first day(Jan 26), we hold 10,000 MWh power, the value is

$$V_{physical}(0) = 24.62 * 10,000 = \$246,200$$

we short 36 contracts product2 (246,200/2.713/2500 = 36, contract Size of product2 is 2500 MMBtus)

we short 543 contracts product2 (246,200/9.075/50 = 543, contract Size of product3 is 50 MWh)

The value of the portfolio at time t can be expressed as:

$$\Pi(t) = 10,000 \cdot P_{physical}(t) - 36 \cdot 2500 \cdot P_H(t) - 543 \cdot 50 \cdot P_{XPR}(t)$$

On January 27, the energy price reached $24.5 per MWh, resulting in a physical holding value of \$245,000. We incurred a loss of $1,200 (\$246,200 - $245,000). From shorting 36 contracts of Product 2, we earned a profit of \$1,170, calculated as 36 contracts *2,500* ($2.713 -

\$2.7). From shorting 543 contracts of Product 3, we earned a profit of $20.39, calculated as 543 contracts * 50 * (\$9.0748 - $9.074). Overall, we incurred a total loss of $9.61.

By shorting 36 contracts of Product 2 and 543 contracts of Product 3, we effectively reduced our exposure to unfavorable price movements in the energy market.

Note:

From the data, we can easily find the relationship between the price of product1, product2 and product3. P(ERN) = P(H) * P(XPR), this is because the amout of output Eletricity = the amout of Input Heat / Heat rate

Summary

The data shows substantial fluctuations in profit and loss (PnL) without hedging strategy, with the worst day showing a potential loss of $13900 for a 10,000 MWh power holding. By using a hedging strategy with Henry LD1 Fixed Price Futures and ERCOT North 345kV Physical HR Peak HE, the volatility in daily PnL significantly decreased, with the PnL ranging from -\$659.94 to $632.68.

This hedge strategy effectively reduces the risk associated with the decline in energy prices by short positions in Henry LD1 Futures, and the change in heat rates by short positions in ERCOT North 345kV contracts. This approach offers a practical solution for electricity holders to mitigate the risks of decreasing energy prices when ERCOT North 345KV Real-Time Peak Fixed Price Future is not avaiable

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Self study:

ERCOT North 345KV Real-Time Peak Fixed Price Future:

- Monthly cash settled, average of daily prices (peak hour) by ERCOT
- Contract symbol: ERN
- Contract size: 1 MW (mega watt)
- Convention: $0.01 per MWh
- Trading time: 7:50 PM - 6:00 PM*
- Last Trading Day: The last Business Day of the Contract Period
- Final Payment Date: The sixth Clearing Organization business day following the Last Trading Day

Henry LD1 Fixed Price Future (Henry Hub Natural Gas Futures):

- Monthly cash settled, monthly price by NYMEX
- Contract symbol: H
- Contract size: 2500 MMBtus (Million British Thermal Units)
- Convention: $0.001 per MMBtu
- Last Trading Day: Three Business Days prior to the first calendar day of the Contract Period
- Final Payment Date: The first Clearing Organization business day following the Last Trading Day

ERCOT North 345kV Physical HR Peak HE 0700-2200

- Contract symbol: XPR
- Contract Size: 50 MW per hour
- unit: MMBTU/MWh
- Final Settlement: actual heat rate * Settlement Price
- Last Trading Day: The second to last business day of the month prior to the delivery month.
- Payment Dates: Payment due on the 20th of the month following the Delivery Period by wire transfer of Federal Funds

Locational Marginal Price (LMP):

- wholesale electric energy prices
- LMP = System Energy Price + Transmission Congestion Cost + Cost of Marginal Losses

Financial Transmission Right:

- It hedges the difference between the congestion components of the locational marginal prices (LMPs) of two pricing nodes

Short Term Market:

- day-ahead and real-time markets

Long Term Market (capacity market):

- revenues are paid regardless of whether energy is produced or not

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