The GB Electricity Market

Hostel ID:84

1 Problem Statement Overview

The GB electricity market, known for its liberalized and competitive environment, enables trading of electricity between generators, suppliers, and other market participants. Our focus is on the intraday spot market, where electricity prices can fluctuate significantly within the day. By analyzing these fluctuations from October 1, 2024, to December 31, 2024, our goal is to devise a trading strategy that leverages observed price volatility patterns.

2 Understanding the Market

The GB electricity market consists of two main segments: the wholesale market and the retail market. The wholesale market is where electricity is traded in bulk, either through contracts or on spot markets, while the retail market involves the sale of electricity to end consumers by suppliers.

2.1 The Intraday Spot Market

The intraday spot market in the GB electricity market operates within a framework that allows for the buying and selling of electricity on a short-term basis, typically on the same day or the next day. Prices in this market are particularly volatile due to several factors including demand and supply dynamics, availability of renewable energy sources like wind and solar, and unforeseen outages or fluctuations in generation.

Trading in the intraday spot market involves buying electricity when prices are low and selling when prices are high within the same trading day. This requires careful analysis of price trends and patterns, as well as a robust understanding of market drivers that can affect intraday prices.

3 Data Acquisition

We sourced our spot market data from Elexon, exporting multiple eight days data files. This data was then compiled and standardized into a single dataset, ensuring consistency and reliability for our analysis. The processed data forms the empirical basis for our trading strategy evaluation. The reference to the data has been provided in section 8.

4 Proposed Solution

Our proposed solution comprises three key components: Regime Identification, Trend Identification, and Trading Strategy formulation. These elements combine quantitative analysis and market intuition to capitalize on intraday price movements in the GB electricity market.

4.1 Regime Identification

Regime Identification involves assessing the current market condition—whether it is bullish, bearish, or stagnant. This is typically achieved using two primary statistical approaches, complemented by an external factor-based analysis.

- **Volatility Analysis using ATR:** We begin by analyzing past market data to assess volatility. The Average True Range (ATR) indicator is employed to quantify volatility levels, helping us establish the nature of the market.

- **CUSUM Method:** The Cumulative Sum (CUSUM) approach is utilized to predict the specific regime—bullish, bearish, or stagnant. This statistical method helps detect shifts in the mean level of the measured variable, which, in our case, is the price, thereby indicating a change in market conditions.

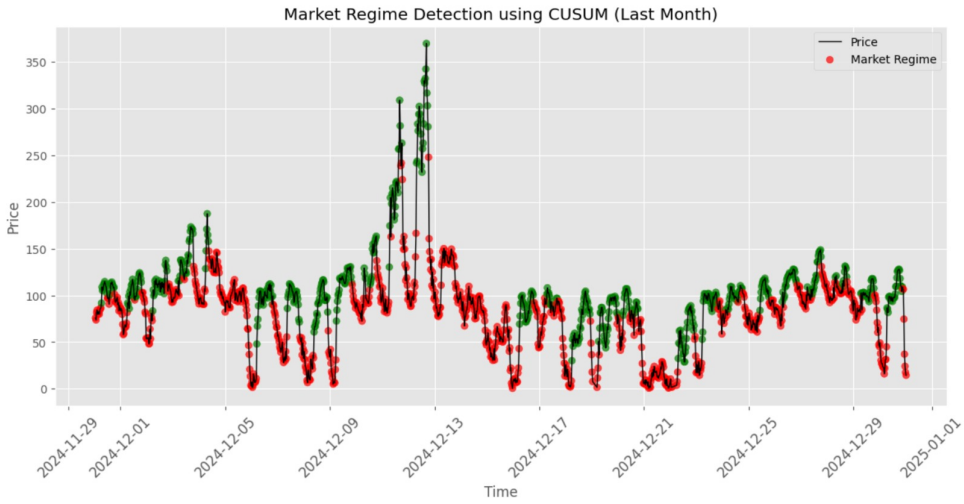


Figure 1: Market Regime Detection using CUSUM (Last Month)

- **Time Specific Demand:** With the help of research paper and news (reference 8.1) we recognize the influence of time-specific demand variations that influence the market. Typically, residential consumption increases significantly during the evening hours (i.e., from 3pm to 6pm), leading to higher electricity demand and early morning hours (i.e., from 1 am to 4 am) experience notably lower demand. Based on such observations, we classify times of day as likely to experience either bullish or bearish runs.

4.2 Trend Identification

To effectively capture market trends and significant price movements, we employ two primary technical analysis tools: Bollinger Bands and the Zig-Zag indicator.

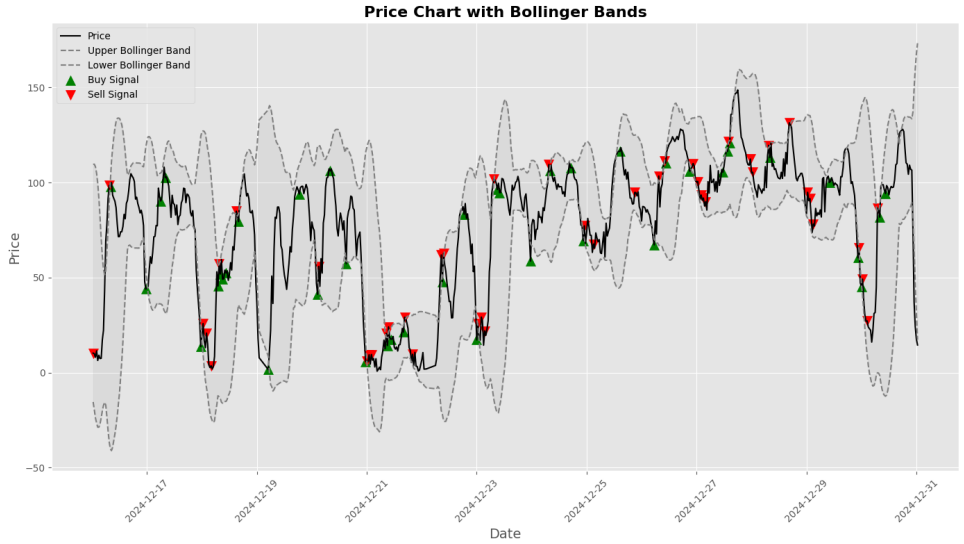


Figure 2: Trend identification based on Bollinger Bands and Zigzag lines

4.2.1 Bollinger Bands

Bollinger Bands are used to measure market volatility and identify potential overbought and oversold conditions. The bands consist of:

- **Upper Band** = SMA + 2 × STD
- **Lower Band** = SMA - 2 × STD
- **Middle Band** = SMA

Where SMA is the Simple Moving Average and STD is the Standard Deviation. These bands provide dynamic support and resistance levels, expanding and contracting based on underlying volatility. The trading implications are crucial; when prices move outside the bands, it often signals a mean reversion opportunity as prices tend to return within the bands.

4.2.2 Zig-Zag Indicator

The Zig-Zag indicator simplifies price movements by filtering out minor fluctuations and focusing only on significant changes, set by a predefined percentage threshold. This tool helps in identifying major swing highs and lows, thus clarifying trend directions. It is particularly useful in removing market noise and confirming trend continuations or reversals.

4.3 Trading Strategy

Our trading strategy is an integration of the regime and trend identification techniques. In particular, we have taken a intersection of both the signals predicted by CUSUM method and by the Trend Identification to maximise the success of our trades. This strategy allows us to synchronize our trading signals with prevailing market conditions, enhancing the likelihood of successful trades.

4.3.1 Signal Integration and Capital Allocation

The strategy involves weighting our capital investment based on the confirmation of signals from both the regime and trend identification techniques:

- **Capital Allocation during Bullish Hours:** If our hourly regime analysis predicts a bullish period and this is confirmed by a bullish signal from our trend tools (either a breakout above the Upper Bollinger Band with a Zig-Zag up or price remaining above SMA + 1 STD), we allocate 10% of our capital to the trade.
- **Standard Capital Allocation:** In other cases, such as a less definitive bullish or bearish signal, or during hours not identified as strongly bullish, we limit our capital exposure to 5% to reduce risk.

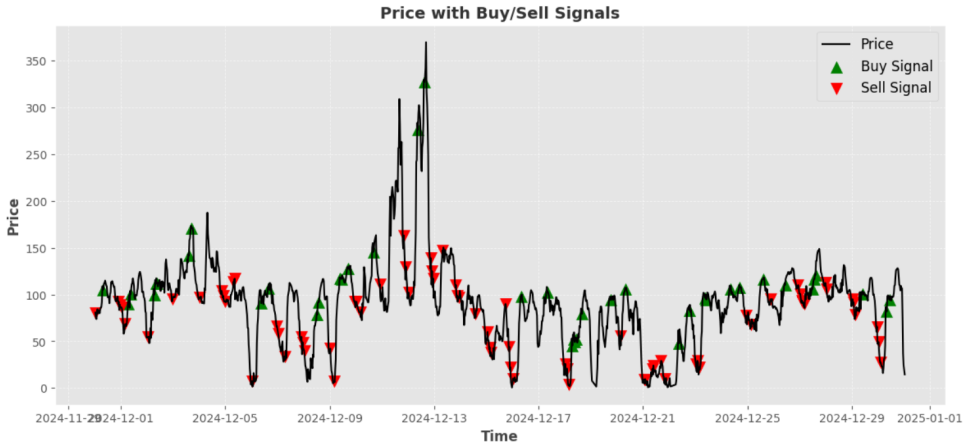


Figure 3: Signal and positions (long and short)

4.3.2 Risk Management

Considering the high volatility inherent in the GB electricity market, our strategy includes a rigorous risk management protocol using Value at Risk (VaR) calculations. VaR helps us determine the maximum potential loss in a set time frame, which guides our capital allocation decisions:

- **VaR Computations:** We calculate the VaR at a 95% confidence level to understand potential losses and adjust our capital allocation accordingly. This computation takes into account historical volatility and price trends to set thresholds for loss tolerance.
- **Profit Taking Strategy:** When a position reaches a profit of 5% or more, we proactively take profits by squaring off 60% of the position. This strategy allows us to secure a substantial part of the gains while still leaving a portion of the position to benefit from any potential further upside. We also adjust our stop-loss strategy by shifting the stop-loss to 2% from the new bar.
- **Stop-Loss Strategy:** If a position incurs a loss exceeding 2%, we square off the entire position immediately. This strict stop-loss criterion helps us minimize losses and preserve capital.

Overall Risk Mitigation Our comprehensive risk management strategy ensures that:

1. Trades are only executed when there is high confidence in both market regime and trend conditions.
2. Capital allocation is always proportional to the assessed risk, preventing over-leveraging in volatile conditions.
3. Losses are cut promptly to prevent capital depletion, preserving our ability to trade successfully over the long term.

5 Performance Metrics :

The performance of our trading strategy is evaluated based on several key metrics which demonstrate the efficiency and risk management capabilities of our approach. Below are the details of these metrics:

- **Annualized Sharpe Ratio:** The Sharpe Ratio, which measures the excess return per unit of deviation in an investment asset or a trading strategy, stands at 9.24. This indicates a high level of risk-adjusted performance compared to a risk-free asset.
- **Maximum Drawdown:** The maximum observed loss from a peak to a trough of a portfolio, before a new peak is achieved, is -7.25%. This reflects the largest potential decrease in value during the specified time period.
- **Annualized Volatility:** The volatility of the strategy, measured as the standard deviation of the annualized returns, is 54.02%. This metric indicates the degree of variation in returns over the period.
- **Sortino Ratio:** Similar to the Sharpe Ratio but only considering downside deviation, the Sortino Ratio for our strategy is 5.26. This ratio highlights the performance of our trading strategy while considering the risk of negative returns.
- **Returns :** The returns of the strategy over the period of 3 months is 327.42%.

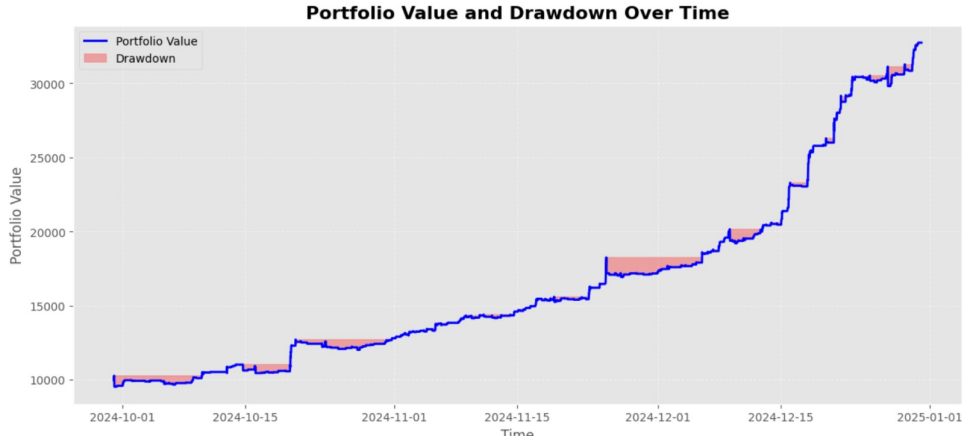


Figure 4: Portfolio Value starting from 10000 GBP along with Drawdown for 2 month period

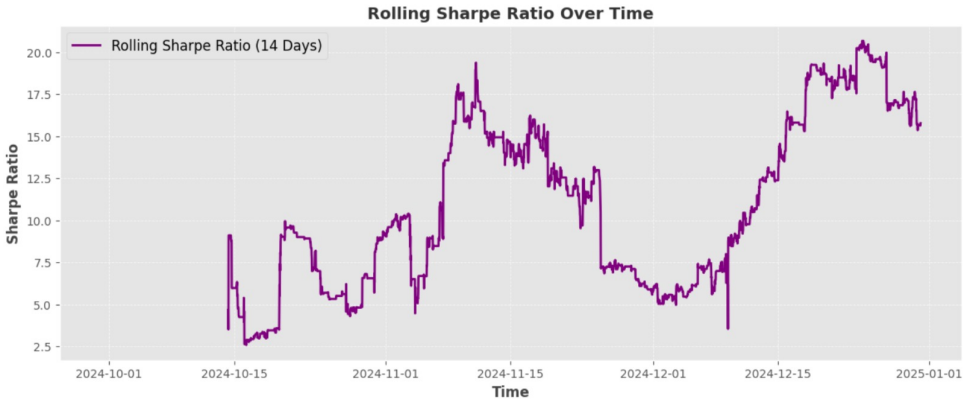
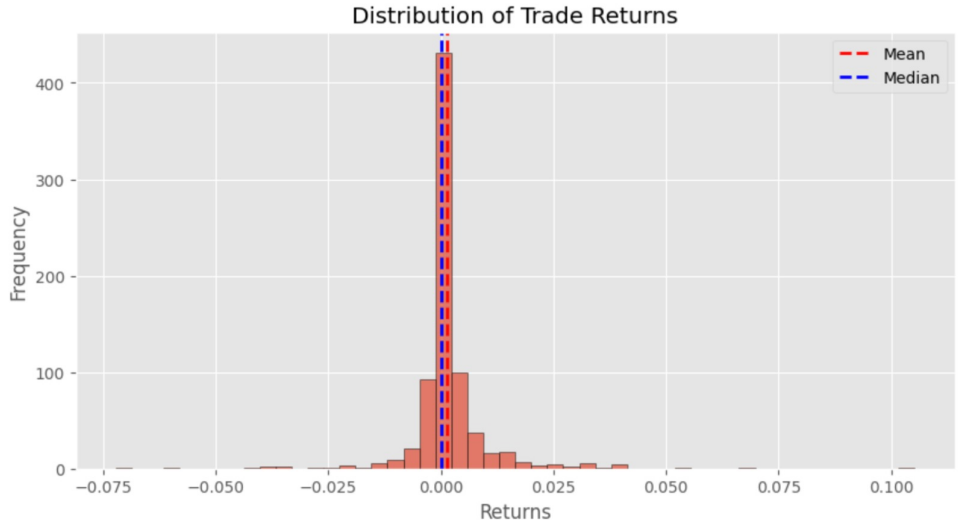


Figure 5: Sharpe Ratio

6 Hypothesis Testing Results

Our trading strategy has been statistically validated for effectiveness and profitability, as evidenced by our hypothesis testing:

- **T-test Statistic:** 3.86 with a P-value of 0.00012, confirming statistical significance at the 0.05 level.
- **Mean Return:** 0.00132 with a 95% Confidence Interval of [0.00063, 0.00197], indicating reliable positive returns.
- **Win Rate:** 40.90%, with a Profit Factor of 1.94, demonstrating profitability despite a win rate below 50%.
- **Profitability:** Total Profit of 2.10 exceeds Total Loss of 1.08, underscoring the strategy's overall profitability.



7 Look-Back Analysis by Data Cutting Method

We employed the data cutting method for look-back analysis to validate our trading strategy's robustness if free from lookahead bias. This approach involves dividing the historical data into segment and analyzing both independently and confirming that signals are consistent.

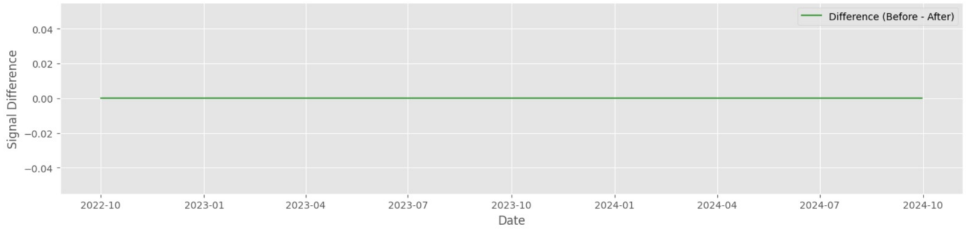


Figure 6: Plot of Before Signal - After Signal

8 References and Data:-

- Britain's Electricity Explained - 2024 Review
- Britain's Electricity Explained - 2023 Review
- 118 Discrete Data files (period 8 days)
- Combined CSV