Ichimoku Indicator Theory

The **Ichimoku Kinko Hyo** (Ichimoku Cloud) is a comprehensive technical indicator designed to provide insights into trend direction, momentum, and potential support/resistance levels. It consists of five key components:

1. **Tenkan-sen (Conversion Line)**

2. **Kijun-sen (Base Line)**

3. **Senkou Span A (Leading Span A)**

4. **Senkou Span B (Leading Span B)**

5. **Chikou Span (Lagging Span)**

Each component is calculated using past price data and plotted on the chart to provide a holistic view of market conditions. Below is a breakdown of each component's mathematical formula and its interpretation:

1. Tenkan-sen (Conversion Line)

Formula:

$$Tenkan - sen = \frac{9 - period\ high + 9 - period\ low}{2}$$

Explanation:
The Tenkan-sen is the average of the highest high and lowest low over the last 9 periods (typically 9 trading days). It acts as a short-term trend indicator:

- If the price is above the Tenkan-sen, it suggests a bullish trend.

- If the price is below the Tenkan-sen, it indicates a bearish trend.

- A crossover between Tenkan-sen and Kijun-sen often serves as a buy/sell signal.

2. Kijun-sen (Base Line)

Formula:

$$Kijun - sen = \frac{26 - period\ high + 26 - period\ low}{2}$$

Explanation:
The Kijun-sen is the average of the highest high and lowest low over the last 26 periods. It acts as a medium-term trend indicator and is often used to confirm the direction of the market:

- If the price is above the Kijun-sen, it indicates the potential for further upward movement.

- If the price is below the Kijun-sen, it indicates the potential for a downward trend.

- The Kijun-sen can also act as a dynamic support or resistance level.

3. Senkou Span A (Leading Span A)

Formula:

$$Senkou\ Span\ A = \frac{Tenkan - sen + Kijun - sen}{2}\ \ (shifted\ 26\ periods\ forward)$$

Explanation:
Senkou Span A is the average of the Tenkan-sen and Kijun-sen, projected 26 periods ahead. It forms one boundary of the Ichimoku Cloud (also known as the **Kumo**), representing future support or resistance:

- When the price is above the Kumo, it indicates a bullish market.

- When the price is below the Kumo, it signals a bearish market.

4. Senkou Span B (Leading Span B)

Formula:

$$Senkou\ Span\ B = \frac{52 - period\ high + 52 - period\ low}{2}\ \ (shifted\ 26\ periods\ forward)$$

Explanation:
Senkou Span B is the average of the highest high and lowest low over the past 52 periods, projected 26 periods ahead. It forms the other boundary of the Kumo and tends to represent stronger support/resistance compared to Senkou Span A:

- If Senkou Span A is above Senkou Span B, the cloud is bullish.

- If Senkou Span A is below Senkou Span B, the cloud is bearish.

5. Chikou Span (Lagging Span)

Formula:

$$Chikou\ Span = Current\ Close\ Price\ (shifted\ 26\ periods\ into\ the\ past)$$

Explanation:
The Chikou Span represents the current closing price, plotted 26 periods in the past. It is used to gauge market momentum and confirm trends:

- If the Chikou Span is above the price 26 periods ago, it confirms bullish momentum.

- If the Chikou Span is below the price 26 periods ago, it confirms bearish momentum.

Ichimoku Trading Strategy

- **Buy Signal**: A common buy signal occurs when the **Tenkan-sen** crosses above the **Kijun-sen**, especially if the price is above the Kumo (Cloud). The Chikou Span should also confirm the bullish momentum by being above the price.

- **Sell Signal**: A sell signal is triggered when the **Tenkan-sen** crosses below the **Kijun-sen**, especially if the price is below the Kumo. The Chikou Span should be below the price, confirming bearish momentum.

Visualization of Ichimoku Components

- **Cloud (Kumo)**: The area between Senkou Span A and Senkou Span B forms the Kumo. This cloud is crucial for identifying future support/resistance and trend direction. A thick cloud implies stronger support/resistance, while a thin cloud represents weaker levels.

- **Crossovers**: The crossovers between Tenkan-sen and Kijun-sen can signal potential buying or selling opportunities. These crossovers are more reliable if confirmed by the position of the price relative to the Kumo and the Chikou Span's position.

Interpretation

The Ichimoku system is designed to provide a more complete view of the market, taking into account trend direction, momentum, and potential reversal points. When the Ichimoku components align, they offer traders insights into when to enter or exit trades based on trend strength and momentum shifts.

The Ichimoku indicator is particularly popular in volatile markets like forex because it allows traders to see at a glance where support and resistance levels are, and whether the trend is likely to continue or reverse.

```python
In [1]:  # Step 1: Import necessary libraries
         import pandas as pd
         import numpy as np
         import yfinance as yf
         import matplotlib.pyplot as plt

         # Step 2: Fetch USD/JPY daily data from Yahoo Finance
         ticker = 'USDJPY=X'
         data = yf.download(ticker, start='2022-01-01', end='2024-08-31')
         data = data[['Close']]  # Keep only the closing price
         data.dropna(inplace=True)

         # Step 3: Define a function to calculate the Ichimoku indicator components
         def ichimoku(df):
             # Tenkan-sen (Conversion Line): (9-period high + 9-period low) / 2
             high_9 = df['High'].rolling(window=9).max()
             low_9 = df['Low'].rolling(window=9).min()
             df['Tenkan_sen'] = (high_9 + low_9) / 2

             # Kijun-sen (Base Line): (26-period high + 26-period low) / 2
             high_26 = df['High'].rolling(window=26).max()
             low_26 = df['Low'].rolling(window=26).min()
             df['Kijun_sen'] = (high_26 + low_26) / 2

             # Senkou Span A (Leading Span A): (Tenkan-sen + Kijun-sen) / 2, plotted 26 periods ahead
             df['Senkou_span_A'] = ((df['Tenkan_sen'] + df['Kijun_sen']) / 2).shift(26)

             # Senkou Span B (Leading Span B): (52-period high + 52-period low) / 2, plotted 26 periods ahead
             high_52 = df['High'].rolling(window=52).max()
             low_52 = df['Low'].rolling(window=52).min()
             df['Senkou_span_B'] = ((high_52 + low_52) / 2).shift(26)

             # Chikou Span (Lagging Span): Close plotted 26 periods in the past
             df['Chikou_span'] = df['Close'].shift(-26)

             return df

         # Add high and low prices for Ichimoku calculation
         data['High'] = data['Close'].rolling(window=9).max()
```

```python
data['Low'] = data['Close'].rolling(window=9).min()

# Step 4: Calculate the Ichimoku components
data = ichimoku(data)

# Step 5: Define the trading logic
# Buy when the Tenkan-sen crosses above the Kijun-sen
# Sell when the Tenkan-sen crosses below the Kijun-sen

def trading_strategy(df):
    df['Signal'] = 0  # Default signal
    df['Signal'][df['Tenkan_sen'] > df['Kijun_sen']] = 1  # Buy signal
    df['Signal'][df['Tenkan_sen'] < df['Kijun_sen']] = -1  # Sell signal
    df['Position'] = df['Signal'].shift()  # Lag to avoid look-ahead bias
    df.dropna(inplace=True)
    return df

data = trading_strategy(data)

# Step 6: Calculate strategy returns
data['Returns'] = np.log(data['Close'] / data['Close'].shift(1))
data['Strategy_Returns'] = data['Returns'] * data['Position']

# Step 7: Calculate cumulative returns
data['Cumulative_Market_Returns'] = data['Returns'].cumsum().apply(np.exp)
data['Cumulative_Strategy_Returns'] = data['Strategy_Returns'].cumsum().apply(np.exp)

# Step 8: Plot cumulative returns
plt.figure(figsize=(12, 8))
plt.plot(data['Cumulative_Market_Returns'], label='Market Returns (Buy & Hold)')
plt.plot(data['Cumulative_Strategy_Returns'], label='Strategy Returns (Ichimoku)')
plt.title('Cumulative Returns: Ichimoku vs Market (USD/JPY)')
plt.xlabel('Date')
plt.ylabel('Cumulative Returns')
plt.legend()
plt.grid(True)
plt.show()

# Step 9: Backtesting: Visualize buy/sell signals on price chart
plt.figure(figsize=(14, 8))
plt.plot(data.index, data['Close'], label='Close Price', alpha=0.6)
```
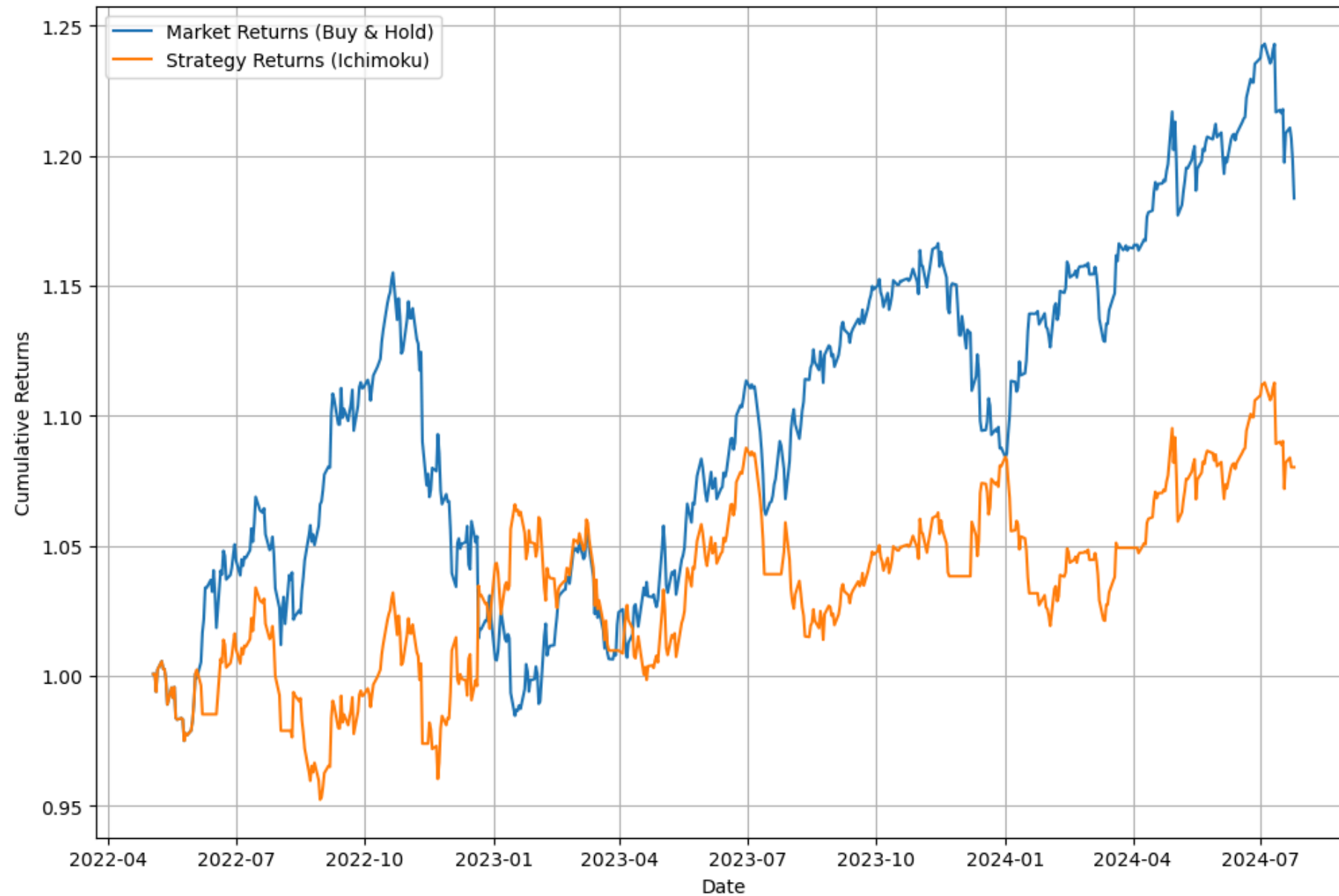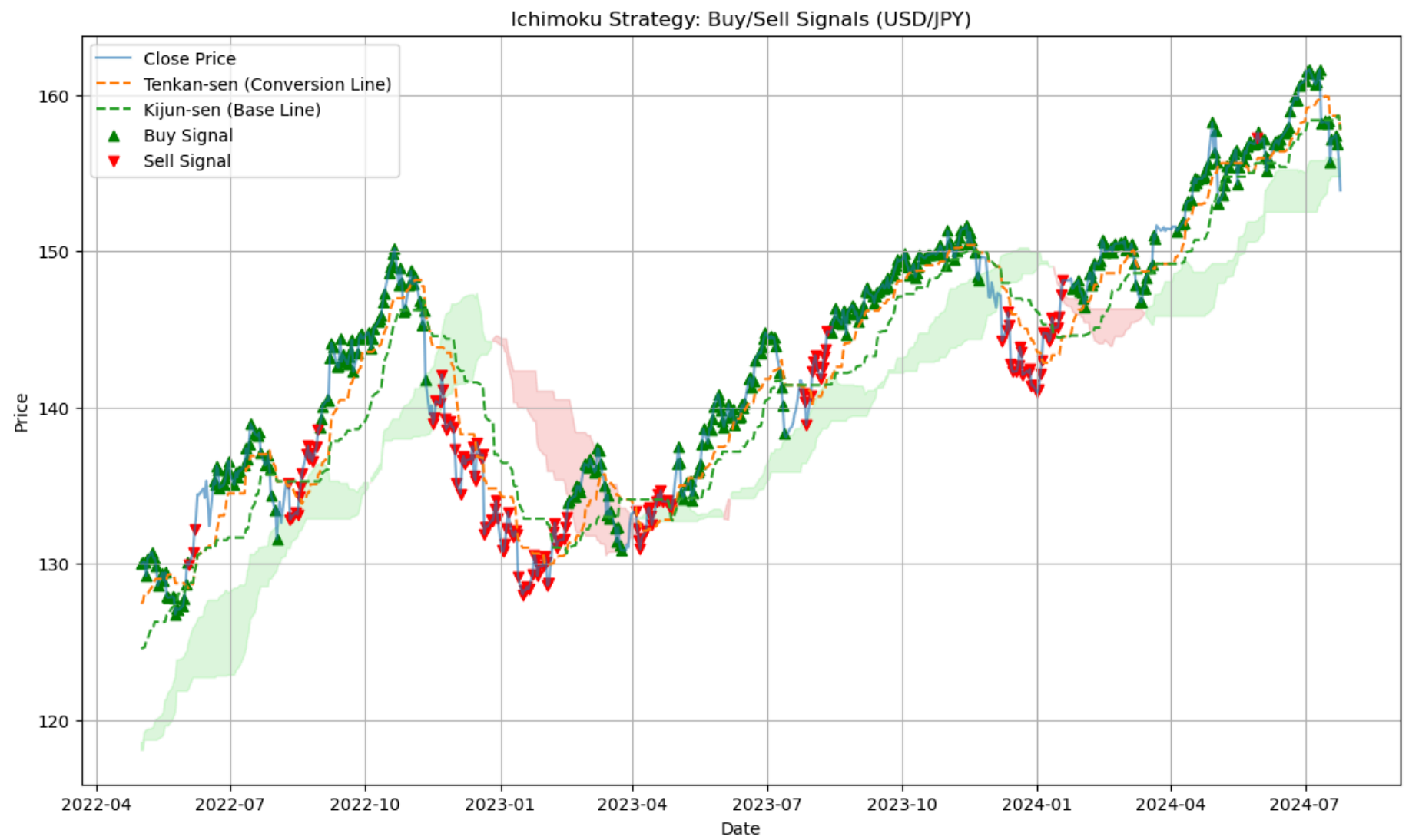
```python
plt.plot(data.index, data['Tenkan_sen'], label='Tenkan-sen (Conversion Line)', linestyle='--')
plt.plot(data.index, data['Kijun_sen'], label='Kijun-sen (Base Line)', linestyle='--')
plt.fill_between(data.index, data['Senkou_span_A'], data['Senkou_span_B'],
                 where=data['Senkou_span_A'] >= data['Senkou_span_B'], color='lightgreen', alpha=0.3)
plt.fill_between(data.index, data['Senkou_span_A'], data['Senkou_span_B'],
                 where=data['Senkou_span_A'] < data['Senkou_span_B'], color='lightcoral', alpha=0.3)
plt.scatter(data.index[data['Position'] == 1],
            data['Close'][data['Position'] == 1], marker='^', color='g', label='Buy Signal', alpha=1)
plt.scatter(data.index[data['Position'] == -1],
            data['Close'][data['Position'] == -1], marker='v', color='r', label='Sell Signal', alpha=1)
plt.title('Ichimoku Strategy: Buy/Sell Signals (USD/JPY)')
plt.xlabel('Date')
plt.ylabel('Price')
plt.legend()
plt.grid(True)
plt.show()
```

Cumulative Returns: Ichimoku vs Market (USD/JPY)

Ichimoku Strategy: Buy/Sell Signals (USD/JPY)

In [ ]: