

GMTv1.02_BULLwithoutSniper

August 30, 2024

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[38]: # Import necessary libraries for the simulation, data manipulation, and
      ↪ visualization.

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numba
import json
from datetime import datetime

# Configuration for consistent visualizations across the notebook.
plt.rcParams['figure.figsize'] = (14, 7)
np.random.seed(42) # Set a seed for reproducibility of random number generation.
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[39]: # Load and validate JSON configuration files
      """
      Loads a JSON file from the specified path and returns the parsed data.
      If the file is not found or the content is not valid JSON, returns None.

      Parameters:
      file_path (str): The path to the JSON configuration file.

      Returns:
      dict or None: Parsed JSON data if successful, None otherwise.
      """

def load_json(file_path):
    try:
        with open(file_path, 'r') as file:
            data = json.load(file)
        return data
    except (FileNotFoundError, json.JSONDecodeError):
        return None
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[40]: # =====
# TradingPool Class
"""
This class models a basic liquidity pool in a decentralized exchange, similar to
↳ those used in Uniswap.
It uses the constant product formula ( $x * y = k$ ) to manage the relationship
↳ between two assets (ETH and TKN),
ensuring that their product remains constant during swaps.

Attributes:
    eth_reserves (float): Current amount of ETH in the pool.
    tkn_reserves (float): Current amount of TKN in the pool.
    k (float): The constant product of the reserves (eth_reserves *
↳ tkn_reserves).
    lp_fees_eth (float): Accumulated ETH fees for liquidity providers.
    lp_fees_tkn (float): Accumulated TKN fees for liquidity providers.
    tkn_hard_cap (float): Maximum allowable TKN reserves in the pool to prevent
↳ overflow.
"""
class TradingPool:
    def __init__(self, initial_eth, initial_tkn, tkn_hard_cap=10000):
        """
        Initializes the trading pool with initial reserves of ETH and TKN tokens.
        The product of the initial reserves (k) is calculated to enforce the
↳ constant product formula.

        Parameters:
            initial_eth (float): Initial amount of ETH in the pool.
            initial_tkn (float): Initial amount of TKN in the pool.
            tkn_hard_cap (float): Maximum allowed TKN in the pool, default is 10000.
        """
        self.eth_reserves = initial_eth
        self.tkn_reserves = initial_tkn
        self.k = self.eth_reserves * self.tkn_reserves # Constant product to
↳ ensure balanced liquidity
        self.lp_fees_eth = 0 # Initial liquidity provider fee balance in ETH
        self.lp_fees_tkn = 0 # Initial liquidity provider fee balance in TKN
        self.tkn_hard_cap = tkn_hard_cap # Cap to prevent excessive TKN reserves

    # =====
    # SWAP
    """
    This method handles swaps between ETH and TKN, adhering to the constant
↳ product formula ( $x * y = k$ ).
    It allows users to swap one asset for another while maintaining the balance
↳ of the pool.

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Parameters:
amount_eth (float): Amount of ETH to swap, default is 0.
amount_tkn (float): Amount of TKN to swap, default is 0.

Returns:
float: Amount of the opposite asset received in the swap, adjusted for
↳slippage.
"""

def swap(self, amount_eth=0, amount_tkn=0):
    """
    Executes a swap operation based on the constant product formula, with
    ↳slippage and fee considerations.

    Parameters:
    amount_eth (float): The amount of ETH being swapped for TKN. Defaults to
    ↳0 if TKN is provided.
    amount_tkn (float): The amount of TKN being swapped for ETH. Defaults to
    ↳0 if ETH is provided.

    Returns:
    float: The amount of the opposite asset obtained from the swap, after
    ↳slippage and fees.
    """
    if amount_eth > 0:
        trade_ratio = amount_eth / self.eth_reserves
    elif amount_tkn > 0:
        trade_ratio = amount_tkn / self.tkn_reserves
    else:
        trade_ratio = 0

    # Increase slippage factor for larger trades
    slippage_factor = 0.003 + (trade_ratio * 0.01) # 1% additional slippage
    ↳for large trades

    if amount_eth > 0:
        tkn_out = self._eth_to_tkn(amount_eth) * (1 - slippage_factor)
        tkn_out = min(tkn_out, self.tkn_reserves)
        if tkn_out <= 0:
            return 0
        self.eth_reserves += (amount_eth * (1 - slippage_factor))
        self.tkn_reserves -= tkn_out
        self.lp_fees_eth += (amount_eth * slippage_factor)
        return tkn_out

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elif amount_tkn > 0:
    eth_out = self._tkn_to_eth(amount_tkn) * (1 - slippage_factor)
    eth_out = min(eth_out, self.eth_reserves)
    if eth_out <= 0:
        return 0
    self.tkn_reserves += (amount_tkn * (1 - slippage_factor))
    self.eth_reserves -= eth_out
    self.lp_fees_tkn += (amount_tkn * slippage_factor)
    return eth_out

return 0

# =====
# ETH to TKN
"""
    This private method calculates the amount of TKN tokens received for a given
    ↪ETH input,
        using the constant product formula. It simulates the real-world scenario
    ↪where the price of TKN
        increases as more ETH is added to the pool (reflecting a typical
    ↪demand-supply relationship).

    Parameters:
    amount_eth (float): The amount of ETH being swapped.

    Returns:
    float: The amount of TKN tokens received.
    """

def _eth_to_tkn(self, amount_eth):
    """
        Computes the TKN output for a given amount of ETH based on the constant
    ↪product formula.
        This method assumes a 0.3% fee (commonly used in AMMs like Uniswap).

    Parameters:
    amount_eth (float): The amount of ETH being input to the pool.

    Returns:
    float: The calculated amount of TKN to be returned.
    """
    effective_eth = amount_eth * 0.997 # Apply a 0.3% fee, leaving 99.7% of
    ↪the ETH for the swap
    new_eth_reserve = self.eth_reserves + effective_eth # Hypothetical new
    ↪ETH reserve after the swap

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        new_tkn_reserve = self.k / new_eth_reserve # Calculate the new TKN
→reserve using the constant product formula
        tkn_out = self.tkn_reserves - new_tkn_reserve # Determine how much TKN
→will be taken out
        return tkn_out

# =====
# TKN to ETH
"""
    This private method calculates the amount of ETH received for a given TKN
→input,
    mirroring the ETH to TKN swap logic but in reverse. It uses the same
→constant product formula
    to maintain market equilibrium.

    Parameters:
    amount_tkn (float): The amount of TKN being swapped.

    Returns:
    float: The amount of ETH received.
    """

def _tkn_to_eth(self, amount_tkn):
    """
        Computes the ETH output for a given amount of TKN based on the constant
→product formula.
        This method also assumes a 0.3% fee, aligning with typical AMM fee
→structures.

        Parameters:
        amount_tkn (float): The amount of TKN being input to the pool.

        Returns:
        float: The calculated amount of ETH to be returned.
        """
        effective_tkn = amount_tkn * 0.997 # Apply a 0.3% fee, leaving 99.7% of
→the TKN for the swap
        new_tkn_reserve = self.tkn_reserves + effective_tkn # Hypothetical new
→TKN reserve after the swap
        new_eth_reserve = self.k / new_tkn_reserve # Calculate the new ETH
→reserve using the constant product formula
        eth_out = self.eth_reserves - new_eth_reserve # Determine how much ETH
→will be taken out
        return eth_out

# =====

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# Get Price Eth per TKN
"""
    This method returns the current price of ETH in terms of TKN.
    It reflects the ratio of ETH to TKN in the reserves, which is the simplest
    way to determine the price
    in an AMM like Uniswap.

    Returns:
    float: The price of ETH per TKN.
    """

def get_price_eth_per_tkn(self):
    """
        Returns the current ETH price in terms of TKN by dividing the ETH
        reserves by the TKN reserves.

        Returns:
        float: The calculated price of 1 ETH in TKN.
        """
    return self.eth_reserves / self.tkn_reserves

def get_price_tkn_per_eth(self):
    """
        Returns the current TKN price in terms of ETH by dividing the TKN
        reserves by the ETH reserves.

        Returns:
        float: The calculated price of 1 TKN in ETH.
        """
    return self.tkn_reserves / self.eth_reserves

# =====
# Aggregate LP Fees
"""
    This method aggregates and returns the total liquidity provider fees
    accumulated in the pool.

    LPs typically earn a share of the trading fees in decentralized exchanges,
    so this function
    is crucial for tracking those earnings.

    Returns:
    tuple: Total ETH and TKN fees accumulated.
    """

def aggregate_lp_fees(self):
    """

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    Returns the cumulative liquidity provider fees in both ETH and TKN,
    allowing LPs to understand
    their earnings over time.

    Returns:
    tuple: A tuple of (ETH fees, TKN fees) accumulated in the pool.
    """
    return self.lp_fees_eth, self.lp_fees_tkn

# =====
# Calculate Price Impact
"""
    This method calculates the price impact of a given trade size in either ETH
    or TKN.

    Price impact refers to the change in the asset's price due to the trade, a
    crucial factor
    in decentralized finance (DeFi) trading strategies.

    Parameters:
    trade_size_eth (float): Amount of ETH to trade, default is 0.
    trade_size_tkn (float): Amount of TKN to trade, default is 0.

    Returns:
    float: The price impact of the trade.
    """

def calculate_price_impact(pool, trade_size_eth=0, trade_size_tkn=0):
    """
    Computes the price impact of a trade based on the current reserves and
    the trade size,
    using a more aggressive slippage model to reflect real-world conditions.

    Parameters:
    trade_size_eth (float): The size of the ETH trade.
    trade_size_tkn (float): The size of the TKN trade.

    Returns:
    float: The calculated price impact as a proportion of the current
    reserves.
    """
    if trade_size_eth > 0:
        new_eth_reserves = pool.eth_reserves + trade_size_eth
        new_tkn_reserves = pool.k / new_eth_reserves
        price_impact = abs((pool.tkn_reserves - new_tkn_reserves) / pool.
        tkn_reserves)
    elif trade_size_tkn > 0:

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        new_tkn_reserves = pool.tkn_reserves + trade_size_tkn
        new_eth_reserves = pool.k / new_tkn_reserves
        price_impact = abs((pool.eth_reserves - new_eth_reserves) / pool.
↪eth_reserves)
    else:
        price_impact = 0

    # Implement more aggressive slippage by increasing the impact factor.
    return price_impact * 1.5 # Increase slippage to better reflect large ↪
↪trade impacts

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[41]: class Participant:

    def __init__(self, eth_balance, tkn_balance, initial_eth_price, ↪
↪initial_tkn_price):
        """
        Initializes a Participant with initial balances and the prices at the ↪
↪start of the experiment.

        Args:
        eth_balance (float): Initial ETH balance.
        tkn_balance (float): Initial TKN balance.
        initial_eth_price (float): The initial price of ETH in USD.
        initial_tkn_price (float): The initial price of TKN in USD.
        """
        self.eth_balance = eth_balance
        self.tkn_balance = tkn_balance

        # Initialize initial balances
        self.initial_eth_balance = eth_balance
        self.initial_tkn_balance = tkn_balance

        # Initialize prices
        self.initial_eth_price = initial_eth_price
        self.initial_tkn_price = initial_tkn_price

        # Calculate the initial USD balance
        self.initial_usd_balance = (self.initial_eth_balance * self.
↪initial_eth_price) + \
                                (self.initial_tkn_balance * self.
↪initial_tkn_price)

        # Initialize trade volumes
        self.total_eth_swapped = 0 # Total ETH swapped during the simulation
        self.total_tkn_swapped = 0 # Total TKN swapped during the simulation

        # Initialize trade history

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        self.trade_history = [] # List to keep a record of all trades made by
→ the participant

def buy(self, pool, amount_eth):
    """
    Executes a trade where the participant uses ETH to buy TKN from the pool.
    The trade is limited by the participant's current ETH balance.

    Parameters:
    pool (TradingPool): The pool that the participant will trade with.
    amount_eth (float): The amount of ETH the participant wants to trade for
→ TKN.
    """
    amount_eth = min(amount_eth, self.eth_balance) # Ensure participant
→ doesn't spend more ETH than they have
    tkn_received = pool.swap(amount_eth=amount_eth) # Perform the swap on
→ the pool and receive TKN
    if tkn_received > 0:
        self.eth_balance -= amount_eth # Deduct the spent ETH from the
→ balance
        self.tkn_balance += tkn_received # Add the received TKN to the
→ balance
        self._log_trade("buy", amount_eth, tkn_received) # Log the trade
→ for record-keeping
        self.total_eth_swapped += amount_eth # Track total ETH used for
→ swaps

def sell(self, pool, amount_tkn):
    """
    Executes a trade where the participant sells TKN to receive ETH from the
→ pool.
    The trade is limited by the participant's current TKN balance.

    Parameters:
    pool (TradingPool): The pool that the participant will trade with.
    amount_tkn (float): The amount of TKN the participant wants to trade for
→ ETH.
    """
    amount_tkn = min(amount_tkn, self.tkn_balance) # Ensure participant
→ doesn't sell more TKN than they have
    eth_received = pool.swap(amount_tkn=amount_tkn) # Perform the swap on
→ the pool and receive ETH
    if eth_received > 0:
        self.tkn_balance -= amount_tkn # Deduct the spent TKN from the
→ balance

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        self.eth_balance += eth_received # Add the received ETH to the
↪balance
        self._log_trade("sell", eth_received, amount_tkn) # Log the trade
↪for record-keeping
        self.total_tkn_swapped += amount_tkn # Track total TKN used for
↪swaps

    def calculate_roi(self):
        """
        Computes the participant's return on investment (ROI) in percentage
↪terms.

        This is done by comparing the current USD balance of the participant
↪(ETH and TKN holdings converted to USD)
        with their initial USD balance.

        Returns:
        float: The ROI as a percentage. Positive values indicate profit,
↪negative values indicate loss.
        """
        # Calculate the initial value of ETH and TKN in USD
        initial_eth_value_usd = self.initial_eth_balance * self.initial_eth_price
        initial_tkn_value_usd = self.initial_tkn_balance * self.initial_tkn_price

        # Total initial USD balance
        initial_usd_balance = initial_eth_value_usd + initial_tkn_value_usd

        # Calculate the current value of ETH and TKN in USD
        current_eth_value_usd = self.eth_balance * self.get_current_eth_price()
        current_tkn_value_usd = self.tkn_balance * self.get_current_tkn_price()

        # Total current USD balance
        current_usd_balance = current_eth_value_usd + current_tkn_value_usd

        # Calculate ROI as the percentage change from the initial USD balance
        roi = ((current_usd_balance - initial_usd_balance) /
↪initial_usd_balance) * 100

        return roi

    def _log_trade(self, trade_type, eth_amount, tkn_amount):
        """
        Records the details of each trade made by the participant, including the
↪time of trade,
        the type of trade, the amount of ETH and TKN involved, and the
↪participant's balance after the trade.

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Parameters:
trade_type (str): The type of trade ('buy' or 'sell').
eth_amount (float): The amount of ETH involved in the trade.
tkn_amount (float): The amount of TKN involved in the trade.
"""
self.trade_history.append({
    'time': datetime.now(), # Timestamp of the trade
    'type': trade_type, # Type of trade ('buy' or 'sell')
    'eth_amount': eth_amount, # Amount of ETH involved in the trade
    'tkn_amount': tkn_amount, # Amount of TKN involved in the trade
    'eth_balance': self.eth_balance, # Participant's ETH balance after
→ the trade
    'tkn_balance': self.tkn_balance # Participant's TKN balance after
→ the trade
})

def get_current_eth_price(self):
    """
    Provides the current price of ETH in USD. In this simulation, the price
→ is fixed at $2500,
    but in a real-world scenario, this value would be dynamically fetched
→ from a market API.

    Returns:
    float: The fixed price of ETH in USD for the simulation.
    """
    return 2500 # Placeholder value, should be dynamically updated in a
→ real application

def get_current_tkn_price(self):
    """
    Provides the current price of TKN in USD. In this simulation, the price
→ is fixed at $2,
    but in a real-world scenario, this value would be dynamically fetched
→ from a market API.

    Returns:
    float: The fixed price of TKN in USD for the simulation.
    """
    return 2 # Placeholder value, should be dynamically updated in a real
→ application

```

```

[42]: class Strategy:
    """
    The `Strategy` class serves as a base class for implementing various trading
→ strategies.

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    Each strategy is associated with a participant, who holds balances of ETH
    ↪ and TKN, and can execute trades based on specific triggers.

    This class is designed to be extended by subclasses that define specific
    ↪ trading logic.
    """

    def __init__(self, name, initial_eth, initial_tkn, initial_eth_price,
    ↪ initial_tkn_price):
        """
        Constructor for the Strategy class.

        This initializes the strategy with a unique name and sets up a
    ↪ participant
        with initial balances of ETH and TKN.

        Parameters:
        name (str): The name of the strategy.
        initial_eth (float): The initial ETH balance allocated to the
    ↪ participant.
        initial_tkn (float): The initial TKN balance allocated to the
    ↪ participant.
        """
        self.name = name # Name of the strategy for identification purposes
        self.participant = Participant(initial_eth, initial_tkn,
    ↪ initial_eth_price, initial_tkn_price)

    def execute(self, pool, current_price, market_conditions):
        """
        Main execution method for the strategy.

        This method checks if the strategy's trigger conditions are met using
        the `calculate_trigger` method. If the trigger is activated, it proceeds
        to execute a trade via the `perform_trade` method.

        Parameters:
        pool (TradingPool): The trading pool with which to interact for
    ↪ executing trades.
        current_price (float): The current price of ETH in the market.
        market_conditions (dict): A dictionary containing relevant market
    ↪ conditions.
        """
        if self.calculate_trigger(current_price, market_conditions):
            self.perform_trade(pool, current_price, market_conditions)

    def perform_trade(self, pool, current_price, market_conditions):
        """

```

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    Abstract method for performing trades.

    This method must be overridden by any subclass of `Strategy`. It defines
    ↳ the
        specific actions to be taken when the strategy decides to execute a
    ↳ trade.

    Parameters:
        pool (TradingPool): The trading pool to interact with for executing
    ↳ trades.
        current_price (float): The current price of ETH in the market.
        market_conditions (dict): A dictionary containing relevant market
    ↳ conditions.

    Raises:
        NotImplementedError: If the subclass does not implement this method.
        """
    raise NotImplementedError("Each strategy must implement the
    ↳ perform_trade method.")

def calculate_trigger(self, current_price, market_conditions):
    """
    Abstract method for determining if a trade should be executed.

    This method must be overridden by any subclass of `Strategy`. It defines
    the logic to decide when the strategy should perform a trade based on
    current market conditions.

    Parameters:
        current_price (float): The current price of ETH in the market.
        market_conditions (dict): A dictionary containing relevant market
    ↳ conditions.

    Returns:
        bool: True if the trigger condition is met, otherwise False.

    Raises:
        NotImplementedError: If the subclass does not implement this method.
        """
    raise NotImplementedError("Each strategy must implement the
    ↳ calculate_trigger method.")

def evaluate_performance(self):
    """
    Evaluates the strategy's success by calculating the participant's Return
    ↳ on Investment (ROI).

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        This method provides a way to assess how well the strategy has performed
        by returning the ROI, which is computed based on the participant's
        ↪initial
        and current balances converted to USD.

        Returns:
        float: The ROI percentage for the strategy.
        """
        return self.participant.calculate_roi()

```

```

[43]: # Strategy Implementations
      """
      This section defines various trading strategies that participants can use in a
      ↪game-theory-based trading environment.
      Each strategy extends the `Strategy` base class and implements specific logic to
      ↪decide when to buy or sell TKN and ETH
      based on market conditions. The goal for each participant is to maximize their
      ↪USD holdings.
      """
      class BullStrategy(Strategy):
          """
          The BullStrategy is an active trading strategy that buys TKN during
          ↪perceived bullish conditions.
          The strategy buys TKN when the current price is below the EMA but also looks
          ↪for opportunities to sell during upward trends.
          """

          MIN_ETH_THRESHOLD = 0.001 # Minimum ETH balance threshold to continue
          ↪trading

          def __init__(self, name, initial_eth, initial_tkn, initial_eth_price,
          ↪initial_tkn_price):
              super().__init__(name, initial_eth, initial_tkn, initial_eth_price,
          ↪initial_tkn_price)

          def perform_trade(self, pool, current_price, market_conditions):
              if self.calculate_trigger(current_price, market_conditions):
                  if current_price < market_conditions['ema'] and self.participant.
          ↪eth_balance > self.MIN_ETH_THRESHOLD:
                      amount_to_trade = round(self.participant.eth_balance * 0.5, 8)
                      print(f"{self.name}: Actively buying TKN with {amount_to_trade}
          ↪ETH at price {current_price}")
                      self.participant.buy(pool, amount_to_trade)
                  elif current_price > market_conditions['ema'] * 1.02 and self.
          ↪participant.tkn_balance > 0:

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        tkn_to_sell = round(self.participant.tkn_balance * 0.5, 8)
        print(f"{self.name}: Selling {tkn_to_sell} TKN at price_{current_price} to realize profits")
        self.participant.sell(pool, tkn_to_sell)
        self.update_balance()

    def calculate_trigger(self, current_price, market_conditions):
        return current_price < market_conditions['ema'] or current_price > market_conditions['ema'] * 1.02

    def update_balance(self):
        if self.participant.eth_balance < self.MIN_ETH_THRESHOLD:
            self.participant.eth_balance = 0
            print(f"{self.name}: Updated ETH balance is {self.participant.eth_balance}")

class BearStrategy(Strategy):
    """
        The BearStrategy is a defensive trading strategy that primarily sells TKN during perceived bearish conditions.
        The strategy sells TKN when the current price is above the SMA and avoids aggressive buying.
        It only buys during extreme market dips when the price is significantly below the SMA.
    """

    MIN_TKN_THRESHOLD = 0.001 # Minimum TKN balance threshold to continue trading
    DIP_THRESHOLD = 0.95 # Buy only if the price drops below 95% of the SMA, indicating a market dip

    def __init__(self, name, initial_eth, initial_tkn, initial_eth_price, initial_tkn_price):
        super().__init__(name, initial_eth, initial_tkn, initial_eth_price, initial_tkn_price)

    def perform_trade(self, pool, current_price, market_conditions):
        if self.calculate_trigger(current_price, market_conditions):
            if current_price > market_conditions['sma'] and self.participant.tkn_balance > self.MIN_TKN_THRESHOLD:
                amount_to_trade = round(self.participant.tkn_balance * 0.5, 8)
                print(f"{self.name}: Actively selling {amount_to_trade} TKN at price {current_price}")
                self.participant.sell(pool, amount_to_trade)
            elif current_price < market_conditions['sma'] * self.DIP_THRESHOLD and self.participant.eth_balance > 0:

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        amount_to_trade = round(self.participant.eth_balance * 0.1, 8)
→ # Buy very conservatively
        print(f"{self.name}: Cautiously buying TKN with
→ {amount_to_trade} ETH at price {current_price} during a major dip")
        self.participant.buy(pool, amount_to_trade)
        self.update_balance()

    def calculate_trigger(self, current_price, market_conditions):
        # Trigger on significant price deviations from the SMA
        return current_price > market_conditions['sma'] or current_price <
→ market_conditions['sma'] * self.DIP_THRESHOLD

    def update_balance(self):
        if self.participant.tkn_balance < self.MIN_TKN_THRESHOLD:
            self.participant.tkn_balance = 0
            print(f"{self.name}: Updated TKN balance is {self.participant.
→ tkn_balance}")

class DcaStrategy(Strategy):
    """
    The Dollar-Cost Averaging (DCA) Strategy involves consistently investing a
→ fixed amount of ETH daily,
    regardless of the current market price, to reduce the impact of volatility
→ over time.
    The strategy should end with 0 ETH by fully investing each day.
    """

    def __init__(self, name, initial_eth, initial_tkn, initial_eth_price,
→ initial_tkn_price, daily_investment):
        super().__init__(name, initial_eth, initial_tkn, initial_eth_price,
→ initial_tkn_price)
        self.daily_investment = daily_investment

    def perform_trade(self, pool, current_price, market_conditions):
        while self.participant.eth_balance > 0:
            if self.participant.eth_balance >= self.daily_investment:
                self.participant.buy(pool, self.daily_investment)
            else:
                self.participant.buy(pool, self.participant.eth_balance) # Use
→ all remaining ETH if it's less than the daily investment

    def calculate_trigger(self, current_price, market_conditions):
        return True

```



```

class HarvesterStrategy(Strategy):
    """
        The HarvesterStrategy focuses on periodically taking profits by selling a
        ↳portion of the participant's TKN holdings.
        This strategy sells 20% of the TKN balance whenever the participant holds
        ↳any TKN, effectively harvesting profits over time.
    """

    MIN_TKN_THRESHOLD = 0.001 # Minimum TKN balance threshold to continue
    ↳trading

    def __init__(self, name, initial_eth, initial_tkn, initial_eth_price,
    ↳initial_tkn_price):
        super().__init__(name, initial_eth, initial_tkn, initial_eth_price,
    ↳initial_tkn_price)

    def perform_trade(self, pool, current_price, market_conditions):
        tkn_to_sell = round(self.participant.tkn_balance * 0.2, 8)
        if tkn_to_sell > self.MIN_TKN_THRESHOLD:
            print(f"{self.name}: Selling {tkn_to_sell} TKN at price
    ↳{current_price}")
            self.participant.sell(pool, tkn_to_sell)
            self.update_balance()

    def calculate_trigger(self, current_price, market_conditions):
        return self.participant.tkn_balance > self.MIN_TKN_THRESHOLD

    def update_balance(self):
        if self.participant.tkn_balance < self.MIN_TKN_THRESHOLD:
            self.participant.tkn_balance = 0
            print(f"{self.name}: Updated TKN balance is {self.participant.
    ↳tkn_balance}")

class DoveStrategy(Strategy):
    """
        The DoveStrategy is a conservative strategy that buys TKN when both the
        ↳simple moving average (SMA) and
        the exponential moving average (EMA) indicate the price is low. This dual
        ↳confirmation aims to reduce the risk of buying too early.
        The strategy is designed to be cautious, executing small trades only under
        ↳favorable conditions.
    """

    def __init__(self, name, initial_eth, initial_tkn, initial_eth_price,
    ↳initial_tkn_price):

```

```

        super().__init__(name, initial_eth, initial_tkn, initial_eth_price,
↪initial_tkn_price)

    def perform_trade(self, pool, current_price, market_conditions):
        max_trade_eth = self.participant.eth_balance * 0.02 # Using 2% of
↪available ETH per trade
        if max_trade_eth > 0 and self.calculate_trigger(current_price,
↪market_conditions):
            print(f"{self.name}: Cautiously buying TKN with {max_trade_eth} ETH
↪at price {current_price}")
            self.participant.buy(pool, max_trade_eth)

    def calculate_trigger(self, current_price, market_conditions):
        conservative_factor = 0.97 # 3% below both the SMA and EMA
        return (current_price < market_conditions['sma'] * conservative_factor
↪and
                current_price < market_conditions['ema'] * conservative_factor)

class HawkStrategy(Strategy):
    """
    The HawkStrategy is an aggressive, profit-targeting strategy. The
↪participant buys TKN when the strategy is initiated and
    sells when the price reaches a specified profit target. The entry price is
↪recorded to calculate when the profit target is met.
    """

    def __init__(self, name, initial_eth, initial_tkn, initial_eth_price,
↪initial_tkn_price, target_profit):
        super().__init__(name, initial_eth, initial_tkn, initial_eth_price,
↪initial_tkn_price)
        self.target_profit = target_profit
        self.entry_price = None

    def perform_trade(self, pool, current_price, market_conditions):
        if self.entry_price is None:
            self.entry_price = current_price
            self.participant.buy(pool, self.participant.eth_balance)
        elif current_price >= self.entry_price * (1 + self.target_profit):
            print(f"{self.name}: Selling all TKN at price {current_price} after
↪reaching profit target")
            self.participant.sell(pool, self.participant.tkn_balance)

    def calculate_trigger(self, current_price, market_conditions):
        return self.entry_price is None or current_price >= self.entry_price *
↪(1 + self.target_profit)

```

```
[44]: # Simulation Execution - Function to simulate ETH price using Geometric Brownian
      ↪ Motion (GBM).
      """
      This section defines functions to simulate the price path of ETH over time using
      ↪ Geometric Brownian Motion (GBM).
      GBM is a mathematical model commonly used in finance to model stock prices and
      ↪ other financial instruments.
      It assumes that the logarithm of the price follows a Brownian motion with drift.
      """

      # =====
      # Simulate Eth price using GBM
      """
      Simulates ETH prices using a Geometric Brownian Motion (GBM) model.

      Parameters:
      initial_price (float): Starting price of ETH.
      days (int): Number of days to simulate.
      mu (float): Expected return (drift) of the ETH price.
      sigma (float): Volatility (standard deviation) of the ETH price.
      mean_reversion_level (float, optional): Level to which price may revert, default
      ↪ is None.

      Returns:
      list: Simulated ETH prices over the given number of days.
      """

      def simulate_eth_price_gbm(initial_price, days, mu, sigma,
      ↪ mean_reversion_level=None):
          """
          Simulates the price of ETH over a specified number of days using the GBM
          ↪ model with optional mean reversion.

          Parameters:
          initial_price (float): The initial price of ETH at the start of the
          ↪ simulation.
          days (int): The number of days to simulate.
          mu (float): The drift coefficient, representing the expected daily return of
          ↪ ETH.
          sigma (float): The volatility coefficient, representing the standard
          ↪ deviation of returns.
          mean_reversion_level (float, optional): The price level to which the price
          ↪ reverts over time, if provided.

          Returns:
          list: A list of simulated ETH prices over the specified number of days.
```

```

"""
dt = 1 / 365 # Time increment (1 day)
prices = [initial_price] # List to store simulated prices, starting with
↳ the initial price

for _ in range(days):
    # Generate a random shock based on the normal distribution, representing
↳ daily returns
    shock = np.random.normal(loc=mu * dt, scale=sigma * np.sqrt(dt))
    # Calculate the new price using the GBM formula:  $S(t+1) = S(t) * \exp(\text{shock})$ 
↳ exp(shock)
    price = prices[-1] * np.exp(shock)

    # If mean reversion is specified, adjust the price towards the mean
↳ reversion level
    if mean_reversion_level is not None:
        reversion_adjustment = (mean_reversion_level - price) * 0.1 # 10%
↳ adjustment towards mean level
        price += reversion_adjustment

    prices.append(price) # Append the new price to the list

return prices # Return the list of simulated prices

# =====
# Function to simulate market conditions based on GBM.
"""
Simulates market conditions, particularly the price path of ETH.

Parameters:
market_conditions (str or dict): JSON file path or dict containing simulation
↳ parameters.
days (int): Number of days to simulate.

Returns:
list: Simulated ETH prices over the given number of days.
"""

def simulate_market_conditions(market_conditions, days):
    """
    Simulates the price of ETH over a specified number of days using a Geometric
↳ Brownian Motion model.

    This function allows for the configuration of market conditions either via a
↳ JSON file or directly as a dictionary.

    Parameters:

```

```

    market_conditions (str or dict): If a string is provided, it is assumed to
    ↳ be a file path to a JSON file
                                     containing the simulation parameters ('mu'
    ↳ and 'volatility').
                                     If a dictionary is provided, it directly
    ↳ contains these parameters.
    days (int): The number of days to simulate.

Returns:
list: A list of simulated ETH prices over the specified number of days.
"""
# Load parameters from a JSON file if a file path is provided
if isinstance(market_conditions, str): # Check if market_conditions is a
    ↳ file path
        with open(market_conditions, 'r') as file:
            config = json.load(file) # Load the JSON file into a dictionary
            print("Loaded JSON config:", config) # Debugging statement to confirm
    ↳ the configuration was loaded
            mu = config['market_conditions']['mu'] # Expected return (drift) from
    ↳ the JSON config
            sigma = config['market_conditions']['volatility'] # Volatility from the
    ↳ JSON config
        else:
            # Default parameters if no file is provided or if market_conditions is
    ↳ directly passed as a dictionary
            mu = market_conditions.get('mu', 0.1) # Drift factor, default to 10%
    ↳ annual return
            sigma = market_conditions.get('volatility', 0.3) # Volatility, default
    ↳ to 30% annual volatility

dt = 1 / 365 # Daily time step for the simulation
eth_prices = [2500] # Starting ETH price, for example purposes

for _ in range(1, days):
    # Calculate the daily price change using the GBM formula:
    # Price change =  $S(t) * (\mu * dt + \sigma * \epsilon * \sqrt{dt})$ 
    # Where  $\epsilon$  is a random variable from a standard normal distribution
    price_change = eth_prices[-1] * (mu * dt + sigma * np.random.normal() *
    ↳ np.sqrt(dt))
    eth_prices.append(eth_prices[-1] + price_change) # Update the ETH price
    ↳ list with the new price

return eth_prices # Return the list of simulated ETH prices

```

```

[45]: # =====
      # Function to execute the simulation and return relevant data.

```

```

"""
Runs the trading simulation over the specified number of days using the given
↳ strategies.

Parameters:
strategy_instances (list): List of strategy objects to execute.
pool (TradingPool): The trading pool to interact with.
market_conditions (dict): The market conditions for the simulation.
days (int): Number of days to simulate.

Returns:
tuple: Various statistics from the simulation including price history, trade
↳ counts, and more.
"""

def run_simulation(strategy_instances, pool, market_conditions, days):
    """
    Executes a simulation of ETH trading strategies over a specified number of
    ↳ days.

    The simulation tracks ETH prices, strategy executions, and the state of the
    ↳ trading pool.

    It calculates important metrics such as price impacts, impermanent loss, and
    ↳ liquidity provider fees.

    Parameters:
    strategy_instances (list): A list of instantiated strategy objects.
    pool (TradingPool): The trading pool that strategies will interact with.
    market_conditions (dict): Market conditions, possibly containing parameters
    ↳ like drift (mu) and volatility (sigma).
    days (int): The number of days to run the simulation.

    Returns:
    tuple: Contains the following:
    - eth_price_history (list): The daily ETH prices over the simulation
    ↳ period.
    - tkn_price_history (list): The daily TKN prices over the simulation
    ↳ period.
    - trade_counts (dict): The count of trades executed by each strategy.
    - eth_reserves_over_time (list): The ETH reserves in the pool over time.
    - tkn_reserves_over_time (list): The TKN reserves in the pool over time.
    - lp_fees_over_time (list): The accumulated liquidity provider fees over
    ↳ time.
    - impermanent_losses (list): The calculated impermanent losses over time.
    - price_impacts (list): The price impacts caused by trades over time.

```

```

        - detailed_logs (list): Detailed logs of trades including day, strategy,
        ↳action, and slippage.
        """

        # Simulate ETH prices over the given number of days using the specified
        ↳market conditions.
        eth_prices = simulate_market_conditions(market_conditions, days)

        # Initialize data structures to store simulation results
        eth_price_history = []
        tkn_price_history = []
        trade_counts = {strategy.name: 0 for strategy in strategy_instances}
        eth_reserves_over_time = []
        tkn_reserves_over_time = []
        lp_fees_over_time = []
        impermanent_losses = []
        price_impacts = []
        detailed_logs = [] # Initialize detailed logs for recording trade details

        # Calculate initial pool values for impermanent loss
        initial_eth = pool.eth_reserves
        initial_tkn = pool.tkn_reserves

        # Loop over each day to execute the simulation
        for day in range(days):
            current_eth_price = eth_prices[day]
            current_tkn_price = 1 / current_eth_price # Assuming inverse
            ↳relationship for TKN price

            # Store the prices in their respective lists
            eth_price_history.append(current_eth_price)
            tkn_price_history.append(current_tkn_price)

            market_state = {
                'ema': np.mean(eth_prices[max(0, day - 10):day+1]),
                'sma': np.mean(eth_prices[max(0, day - 30):day+1]),
                'last_price': eth_prices[day-1] if day > 0 else current_eth_price,
                'current_day': day
            }

            # Execute each strategy for the current day
            for strategy in strategy_instances:
                # Calculate price impact before executing the trade
                price_impact = pool.calculate_price_impact(trade_size_eth=strategy.
                ↳participant.eth_balance)
                strategy.execute(pool, current_eth_price, market_state) # Changed
                ↳from current_price to current_eth_price

```

```

trade_counts[strategy.name] += 1
price_impacts.append(price_impact)

# Log detailed information about the trade
if strategy.participant.trade_history:
    last_trade = strategy.participant.trade_history[-1]
    detailed_logs.append({
        "Day": day,
        "Strategy": strategy.name,
        "Action": last_trade['type'],
        "ETH_Swapped": last_trade['eth_amount'] if
↪last_trade['type'] == 'buy' else 0,
        "TKN_Swapped": last_trade['tkn_amount'] if
↪last_trade['type'] == 'sell' else 0,
        "USD_Value": last_trade['eth_amount'] * current_eth_price if
↪last_trade['type'] == 'buy' else last_trade['tkn_amount'] * (1/
↪current_eth_price),
        "Slippage": price_impact,
    })

    print(f"{strategy.name} Post-Execution ETH Balance: {strategy.
↪participant.eth_balance}, TKN Balance: {strategy.participant.tkn_balance}")

# Track daily simulation data
eth_reserves_over_time.append(pool.eth_reserves)
tkn_reserves_over_time.append(pool.tkn_reserves)
lp_fees_over_time.append(pool.aggregate_lp_fees())

# Calculate impermanent loss for the day
impermanent_loss = calculate_impermanent_loss(
    initial_eth=initial_eth,
    initial_tkn=initial_tkn,
    current_eth=pool.eth_reserves,
    current_tkn=pool.tkn_reserves,
    eth_price=current_eth_price,
    tkn_price=current_tkn_price
)
impermanent_losses.append(impermanent_loss)

# Return all gathered simulation data
return eth_price_history, tkn_price_history, trade_counts,
↪eth_reserves_over_time, tkn_reserves_over_time, lp_fees_over_time,
↪impermanent_losses, price_impacts, detailed_logs

```

```

[46]: # Performance Evaluation and Table Creation
      """

```



```

This section includes functions to evaluate the performance of each trading_
↳ strategy and to summarize the trades made during the simulation.
"""

# =====
# Function to evaluate the performance of each strategy.
"""
Evaluates the performance of each strategy after the simulation.

Parameters:
strategy_instances (list): List of strategy objects.

Returns:
list: List of tuples containing strategy names and their corresponding ROI.
"""

def evaluate_simulation(strategy_instances):
    """
    Evaluates the Return on Investment (ROI) for each strategy based on the_
    ↳ final state of their associated participants.

    Parameters:
    strategy_instances (list): A list of strategy objects that were used in the_
    ↳ simulation.

    Returns:
    list: A list of tuples, where each tuple contains the strategy name and its_
    ↳ corresponding ROI.
    """
    results = []
    for strategy in strategy_instances:
        roi = strategy.evaluate_performance() # Calculate the ROI
        results.append((strategy.name, roi)) # Store the strategy name and ROI_
        ↳ as a tuple in the results list
    return results

# =====
# Function to summarize trades made by each strategy.
"""
Summarizes the trades made by each strategy during the simulation.

Parameters:
strategy_instances (list): List of strategy objects.

Returns:
dict: Summary of ETH and TKN swapped by each strategy.

```

```

"""

def summarize_trades(strategy_instances):
    """
    Creates a summary of the trades made by each strategy during the simulation.

    The summary includes the total amount of ETH and TKN swapped by each
    ↪strategy.

    Parameters:
    strategy_instances (list): A list of strategy objects that were used in the
    ↪simulation.

    Returns:
    dict: A dictionary where each key is a strategy name, and the value is
    ↪another dictionary
        with the total amount of ETH and TKN swapped by that strategy.
    """
    summary = {}
    for strategy in strategy_instances:
        eth_swapped = sum(trade['eth_amount'] for trade in strategy.participant.
        ↪trade_history)
        tkn_swapped = sum(trade['tkn_amount'] for trade in strategy.participant.
        ↪trade_history)
        summary[strategy.name] = {'ETH Swapped': eth_swapped, 'TKN Swapped':
        ↪tkn_swapped}
    return summary

```

```

[47]: # Create final balances table for all strategies.
"""
Creates a DataFrame summarizing the final balances of ETH, TKN, and ROI for each
↪strategy.

Parameters:
strategy_instances (list): List of strategy objects.

Returns:
pd.DataFrame: DataFrame containing final balances and ROI for each strategy.
"""

def create_final_balances_table(strategy_instances, pool):
    """
    Generates a summary table containing the final ETH and TKN balances,
    as well as the calculated USD balance for each strategy after the simulation.

    Parameters:

```

strategy_instances (list): A list of strategy objects used in the simulation.
pool (TradingPool): The trading pool used in the simulation, needed to
calculate TKN price.

Returns:

pd.DataFrame: A DataFrame summarizing the final ETH and TKN balances,
final USD balance, and placeholder for Sharpe Ratio for each
strategy.

```

"""
data = []
for strategy in strategy_instances:
    # Get the current ETH price and calculate the TKN price
    current_eth_price = strategy.participant.get_current_eth_price()
    current_tkn_price = (pool.eth_reserves * current_eth_price) / pool.
    tkn_reserves

    # Calculate the final USD balance
    final_usd_balance = (strategy.participant.eth_balance *
    current_eth_price) + (strategy.participant.tkn_balance * current_tkn_price)

    # Ensure every strategy is included, regardless of balance
    data.append({
        'Strategy': strategy.name,
        'Final_ETH_Balance': strategy.participant.eth_balance,
        'Final_TKN_Balance': strategy.participant.tkn_balance,
        'Final_USD_Balance': final_usd_balance,
        'Sharpe_Ratio': np.nan # Placeholder; Sharpe Ratio can be added
    later if needed
    })

    # Convert the list of dictionaries to a DataFrame
    df = pd.DataFrame(data)

    return df

```

Create a table of total volume swapped per strategy.

"""

Creates a DataFrame summarizing the total volume of ETH and TKN swapped by each
strategy.

Parameters:

trade_summary (dict): Dictionary summarizing trade volumes for each strategy.

```

Returns:
pd.DataFrame: DataFrame summarizing ETH and TKN swapped by each strategy.
"""

def create_total_volume_swapped_table(trade_summary):
    """
    Generates a table summarizing the total volume of ETH and TKN swapped by
    ↪each strategy.

    Parameters:
    trade_summary (dict): A dictionary where keys are strategy names, and values
    ↪are dictionaries
                           containing 'ETH Swapped' and 'TKN Swapped' volumes.

    Returns:
    pd.DataFrame: A DataFrame summarizing the total volume of ETH and TKN
    ↪swapped by each strategy.
    """
    # Convert the trade summary dictionary to a DataFrame
    df = pd.DataFrame.from_dict(trade_summary, orient='index').fillna(0)
    df.index.name = 'Strategy' # Set the index name for the DataFrame
    return df # Return the DataFrame summarizing the total volume swapped

def update_total_volume_swapped(trade_summary, strategy_name, participant):
    """
    Updates the trade summary dictionary with the total ETH and TKN swapped by a
    ↪participant.

    Parameters:
    trade_summary (dict): The dictionary to update, keyed by strategy name.
    strategy_name (str): The name of the strategy being updated.
    participant (Participant): The participant whose swaps are being tracked.
    """
    if strategy_name not in trade_summary:
        trade_summary[strategy_name] = {'ETH Swapped': 0, 'TKN Swapped': 0}

    # Update the totals with the values from the participant
    trade_summary[strategy_name]['ETH Swapped'] += participant.total_eth_swapped
    trade_summary[strategy_name]['TKN Swapped'] += participant.total_tkn_swapped

# Create a table of ROI per strategy.
"""
Creates a DataFrame summarizing the ROI of each strategy.

Parameters:

```

results (list): List of tuples containing strategy names and their corresponding ROI.

Returns:

pd.DataFrame: DataFrame summarizing ROI for each strategy.

"""

```
def create_roi_per_strategy_table(results):
```

"""

Generates a table summarizing the Return on Investment (ROI) for each strategy.

Parameters:

results (list): A list of tuples, where each tuple contains a strategy name and its corresponding ROI.

Returns:

pd.DataFrame: A DataFrame summarizing the ROI for each strategy.

"""

Create a DataFrame from the list of results

```
df = pd.DataFrame(results, columns=['Strategy', 'ROI'])
```

Ensure that all strategies are included, even if they have no ROI data

```
if df.empty:
```

```
    df = pd.DataFrame({'Strategy': [], 'ROI': []})
```

```
return df # Return the DataFrame summarizing the ROI per strategy
```

```
# Impermanent Loss Calculation Function
```

"""

Calculates impermanent loss based on initial and current reserves of ETH and TKN.

Parameters:

initial_eth (float): Initial ETH reserve.

initial_tkn (float): Initial TKN reserve.

current_eth (float): Current ETH reserve.

current_tkn (float): Current TKN reserve.

eth_price (float): Current ETH price.

tkn_price (float): Current TKN price.

Returns:

float: Impermanent loss percentage.

"""

```
def calculate_impermanent_loss(initial_eth, initial_tkn, current_eth,
```

```
    current_tkn, eth_price, tkn_price):
```

"""

Calculates the impermanent loss experienced by a liquidity provider.

Parameters:

initial_eth (float): Initial amount of ETH in the pool.

initial_tkn (float): Initial amount of TKN in the pool.

current_eth (float): Current amount of ETH in the pool.

current_tkn (float): Current amount of TKN in the pool.

eth_price (float): Current market price of ETH.

tkn_price (float): Current market price of TKN.

Returns:

float: The percentage of impermanent loss.

"""

Calculate the initial value of the pool's reserves

`initial_value = initial_eth * eth_price + initial_tkn * tkn_price`

*# Calculate the value if the liquidity provider had held assets outside of
→ the pool*

`held_value = (initial_eth + initial_tkn / tkn_price) * eth_price`

Calculate the current value of the pool's reserves

`current_value = current_eth * eth_price + current_tkn * tkn_price`

If there are no reserves or values are zero, return zero impermanent loss

`if initial_value == 0 or current_value == 0:`

`return 0`

Calculate the impermanent loss as a percentage

`impermanent_loss = (held_value - current_value) / held_value * 100`

`return impermanent_loss`

Create a table of price history.

"""

*Creates a DataFrame summarizing the daily price history of ETH during the
→ simulation.*

Parameters:

price_history (list): List of ETH prices over time.

Returns:

pd.DataFrame: DataFrame containing the day and corresponding ETH price.

"""

`def create_price_history_table(price_history):`

"""

Generates a table that records the daily price of ETH over the simulation_
↳period.

Parameters:

price_history (list): A list of ETH prices recorded for each day of the_
↳simulation.

Returns:

pd.DataFrame: A DataFrame with columns 'Day' and 'Price', summarizing the_
↳ETH price history.

"""

Create a DataFrame from the price history data

```
df = pd.DataFrame({  
    'Day': range(len(price_history)),  
    'Price': price_history  
})
```

```
return df # Return the DataFrame containing the price history
```

Create a table tracking volatility over time.

"""

Creates a DataFrame tracking the volatility of ETH prices during the simulation.

Parameters:

price_history (list): List of ETH prices over time.

Returns:

pd.DataFrame: DataFrame containing the day and the corresponding annualized_
↳volatility.

"""

```
def create_volatility_tracking_table(price_history, window_size=30):
```

"""

Generates a table that tracks the volatility of ETH prices over the_
↳simulation period.

Volatility is calculated based on the daily percentage changes in ETH price,
using a rolling window to smooth the results.

Parameters:

price_history (list): A list of ETH prices recorded for each day of the_
↳simulation.

window_size (int): The window size for calculating rolling volatility._
↳Defaults to 30.

Returns:

```

    pd.DataFrame: A DataFrame with columns 'Day' and 'Volatility', showing the
    ↳ annualized volatility.
    """
    # Calculate daily returns
    returns = pd.Series(price_history).pct_change()

    # Calculate volatility using a rolling window; initial values where the
    ↳ window isn't full will have fewer data points
    volatility = returns.rolling(window=window_size, min_periods=1).std() * np.
    ↳ sqrt(365) # Annualized volatility

    # Replace NaN values with 0.0 for the first few days where there isn't
    ↳ enough data
    volatility.fillna(0.0, inplace=True)

    # Create a DataFrame to store the volatility data
    df = pd.DataFrame({
        'Day': range(len(volatility)),
        'Volatility': volatility
    })

    return df # Return the DataFrame containing volatility over time

# Create a table showing deviations from the mean reversion level.
"""
Creates a DataFrame tracking deviations of ETH prices from a mean reversion
↳ level during the simulation.

Parameters:
price_history (list): List of ETH prices over time.
mean_reversion_level (float): The mean reversion level to compare prices against.

Returns:
pd.DataFrame: DataFrame containing the day, ETH price, and deviation from the
↳ mean reversion level.
"""

def create_mean_reversion_table(price_history, mean_reversion_level):
    """
    Generates a table that tracks the deviation of ETH prices from a specified
    ↳ mean reversion level.

    Parameters:
    price_history (list): A list of ETH prices recorded for each day of the
    ↳ simulation.

```


*mean_reversion_level (float): The level to which prices are expected to
→revert.*

Returns:

*pd.DataFrame: A DataFrame with columns 'Day', 'Price', and
→'Deviation_from_Mean',
showing the daily deviations from the mean reversion level.*

"""

*# Calculate the deviation of each price from the mean reversion level
deviations = [price - mean_reversion_level for price in price_history]*

Create a DataFrame to store the deviations and price history

```
df = pd.DataFrame({  
    'Day': range(len(price_history)),  
    'Price': price_history,  
    'Deviation_from_Mean': deviations  
})
```

*return df # Return the DataFrame containing deviations from the mean
→reversion level*

Create a table of impermanent losses over time.

"""

*Creates a DataFrame summarizing impermanent losses for each day of the
→simulation.*

Parameters:

impermanent_losses (list): List of impermanent loss values over time.

Returns:

*pd.DataFrame: DataFrame containing the day and corresponding impermanent loss.
"""*

```
def create_impermanent_loss_table(impermanent_losses):
```

"""

*Generates a table that tracks the impermanent loss experienced by liquidity
→providers over time.*

*Impermanent loss is calculated for each day of the simulation based on
→changes in the pool's reserves.*

Parameters:

*impermanent_losses (list): A list of impermanent loss percentages recorded
→for each day of the simulation.*

Returns:

```

pd.DataFrame: A DataFrame with columns 'Day' and 'Impermanent_Loss',
showing the daily impermanent loss.
"""
# Create a DataFrame from the impermanent loss data
df = pd.DataFrame({
    'Day': range(len(impermanent_losses)),
    'Impermanent_Loss': impermanent_losses
})
return df # Return the DataFrame containing impermanent loss over time

# Create a table of total liquidity provider (LP) fees over time.
"""
Creates a DataFrame summarizing the accumulated LP fees (in ETH and TKN) for
each day of the simulation.

Parameters:
lp_fees_over_time (list): List of LP fees accumulated over time.

Returns:
pd.DataFrame: DataFrame containing the day and corresponding LP fees in ETH and
TKN.
"""

def create_total_lp_fees_table(lp_fees_over_time):
    """
    Generates a table that tracks the total liquidity provider fees accumulated
    over the simulation period.

    The fees are tracked separately for ETH and TKN, and recorded for each day.

    Parameters:
    lp_fees_over_time (list): A list of tuples, each containing the accumulated
    ETH and TKN fees for each day.

    Returns:
    pd.DataFrame: A DataFrame with columns 'Day', 'ETH_Fees', and 'TKN_Fees',
    showing the daily accumulated fees for liquidity providers.
    """
    # Create a DataFrame from the LP fees data
    df = pd.DataFrame(lp_fees_over_time, columns=['ETH_Fees', 'TKN_Fees'])
    df.index.name = 'Day' # Set the index name for the DataFrame
    return df # Return the DataFrame containing total LP fees over time

def calculate_sharpe_ratio(daily_returns, risk_free_rate=0.05):
    """
    Calculates the Sharpe Ratio for a series of daily returns.

```

```

Parameters:
daily_returns (list): A list of daily returns for the strategy.
risk_free_rate (float): The annual risk-free rate, default is 0.05 (5%).

Returns:
float: The Sharpe Ratio for the strategy.
"""
# Convert risk-free rate to a daily rate
daily_risk_free_rate = risk_free_rate / 365

# Calculate the excess returns
excess_returns = [r - daily_risk_free_rate for r in daily_returns]

# Calculate the mean of excess returns
mean_excess_return = np.mean(excess_returns)

# Calculate the standard deviation of excess returns
std_dev_excess_return = np.std(excess_returns)

# If the standard deviation is zero, return NaN for the Sharpe Ratio
if std_dev_excess_return == 0:
    return np.nan

# Calculate the Sharpe Ratio
sharpe_ratio = mean_excess_return / std_dev_excess_return
return sharpe_ratio

def calculate_daily_returns(strategy, price_history):
    """
    Calculates daily returns for a strategy based on its USD balance over time.

    Parameters:
    strategy (Strategy): The strategy instance.
    price_history (list): The list of ETH prices over the simulation period.

    Returns:
    list: A list of daily returns as percentages.
    """
    daily_returns = []
    initial_balance = strategy.participant.initial_usd_balance

    for day in range(1, len(price_history)):
        previous_day_balance = (strategy.participant.eth_balance *
    ↪price_history[day-1]) + \
                                (strategy.participant.tkn_balance * (1/
    ↪price_history[day-1]))

```

```

        current_day_balance = (strategy.participant.eth_balance * \
↪price_history[day]) + \
                                (strategy.participant.tkn_balance * (1/
↪price_history[day]))

        # Calculate the daily return
        daily_return = (current_day_balance - previous_day_balance) / \
↪previous_day_balance
        daily_returns.append(daily_return)

    return daily_returns

```

```

[48]: # Function to create a corrected final balances table for all strategies.
def create_corrected_final_balances_table(strategy_instances, price_history):
    """
    Generates a corrected summary table containing the final ETH and TKN
↪balances,
    as well as the calculated ROI for each strategy after the simulation.

    Parameters:
    strategy_instances (list): A list of strategy objects used in the simulation.

    Returns:
    pd.DataFrame: A DataFrame summarizing the final ETH and TKN balances,
                    final USD balance, and placeholder for Sharpe Ratio for each
↪strategy.
    """
    data = [] # Initialize an empty list to collect strategy data
    for strategy in strategy_instances:
        # Retrieve current prices
        current_eth_price = strategy.participant.get_current_eth_price()
        current_tkn_price = strategy.participant.get_current_tkn_price()

        # Calculate final USD balance
        final_usd_balance = (strategy.participant.eth_balance * \
↪current_eth_price) + (strategy.participant.tkn_balance * current_tkn_price)
        roi = strategy.participant.calculate_roi()

        # Calculate daily returns and Sharpe Ratio
        daily_returns = calculate_daily_returns(strategy, price_history)
        sharpe_ratio = calculate_sharpe_ratio(daily_returns)

        # Debugging: Print strategy details
        print(f"Strategy: {strategy.name}")
        print(f"    Final ETH Balance: {strategy.participant.eth_balance}")
        print(f"    Final TKN Balance: {strategy.participant.tkn_balance}")
        print(f"    Final USD Balance: {final_usd_balance}")

```

```

    print(f" ROI: {roi}")

    # Append strategy data to the list
    data.append({
        'Strategy': strategy.name, # Name of the strategy
        'Final_ETH_Balance': strategy.participant.eth_balance, # Final ETH_
↪balance after simulation
        'Final_TKN_Balance': strategy.participant.tkn_balance, # Final TKN_
↪balance after simulation
        'Final_USD_Balance': final_usd_balance, # Final USD balance after_
↪simulation
        'ROI': roi, # ROI percentage
        'Sharpe_Ratio': sharpe_ratio # Sharpe Ratio
    })

    df = pd.DataFrame(data) # Convert the list of data into a pandas DataFrame
    print("Final Balances DataFrame:\n", df) # Debugging: Print the final_
↪DataFrame
    return df # Return the DataFrame summarizing the final balances

# Function to create a corrected table of total volume swapped per strategy.
def create_corrected_total_volume_swapped_table(trade_summary):
    """
    Generates a corrected table summarizing the total volume of ETH and TKN_
↪swapped by each strategy.

    Parameters:
        trade_summary (dict): A dictionary where keys are strategy names, and values_
↪are dictionaries
                                containing 'ETH Swapped' and 'TKN Swapped' volumes.

    Returns:
        pd.DataFrame: A DataFrame summarizing the total volume of ETH and TKN_
↪swapped by each strategy.
    """
    # Convert the trade summary dictionary to a DataFrame
    df = pd.DataFrame.from_dict(trade_summary, orient='index')
    df.index.name = 'Strategy' # Set the index name for the DataFrame
    return df # Return the DataFrame summarizing the total volume swapped

# Function to create a corrected table of ROI per strategy.
def create_corrected_roi_per_strategy_table(results):
    """
    Generates a corrected table summarizing the Return on Investment (ROI) for_
↪each strategy.

```

```

    Parameters:
    results (list): A list of tuples, where each tuple contains a strategy name,
    ↪and its corresponding ROI.

    Returns:
    pd.DataFrame: A DataFrame summarizing the ROI for each strategy.
    """
    # Create a DataFrame from the list of results
    df = pd.DataFrame(results, columns=['Strategy', 'ROI'])
    return df # Return the DataFrame summarizing the ROI per strategy

# Function to display the corrected tables.
def display_corrected_tables(strategies, trade_summary, results):
    """
    Displays the corrected final balances, total volume swapped, and ROI per
    ↪strategy tables.

    This function generates and prints out the three corrected tables that
    ↪summarize
    the final results of the simulation.

    Parameters:
    strategies (list): A list of strategy objects used in the simulation.
    trade_summary (dict): A dictionary summarizing trade volumes for each
    ↪strategy.
    results (list): A list of tuples containing strategy names and their
    ↪corresponding ROI.

    Returns:
    None
    """
    # Generate the corrected final balances table
    final_balances_table_corrected =
    ↪create_corrected_final_balances_table(strategies)

    # Generate the corrected total volume swapped table
    total_volume_swapped_table_corrected =
    ↪create_corrected_total_volume_swapped_table(trade_summary)

    # Generate the corrected ROI per strategy table
    roi_per_strategy_table_corrected =
    ↪create_corrected_roi_per_strategy_table(results)

    # Display the corrected final balances table
    print("Corrected Final Balances Table")
    print(final_balances_table_corrected)

```

```

# Display the corrected total volume swapped table
print("\nCorrected Total Volume Swapped Table")
print(total_volume_swapped_table_corrected)

# Display the corrected ROI per strategy table
print("\nCorrected ROI per Strategy Table")
print(roi_per_strategy_table_corrected)

```

```

[49]: # Function to debug and verify the data structures.
def debug_and_verify_data(strategies, trade_summary, results):
    """
    Debugs and verifies the content of the data structures used in the
    ↪simulation.

    This function prints the details of the strategies, trade summary, and ROI
    ↪results
    to help in identifying any discrepancies or issues in the data.

    Parameters:
    strategies (list): A list of strategy objects used in the simulation.
    trade_summary (dict): A dictionary summarizing trade volumes for each
    ↪strategy.
    results (list): A list of tuples containing strategy names and their
    ↪corresponding ROI.

    Returns:
    None
    """
    print("Debugging Data Structures:")

    # Print details of each strategy in the strategies list
    for strategy in strategies:
        print(f"Strategy: {strategy.name}")
        print(f"  ETH Balance: {strategy.participant.eth_balance}") # Print the
        ↪ETH balance of the strategy
        print(f"  TKN Balance: {strategy.participant.tkn_balance}") # Print the
        ↪TKN balance of the strategy
        print(f"  ROI: {strategy.participant.calculate_roi()}") # Print the ROI
        ↪calculated for the strategy

    # Print the trade summary data structure
    print("\nTrade Summary:")
    for key, value in trade_summary.items():
        print(f"Strategy: {key}, Data: {value}") # Print the strategy name and
        ↪its corresponding trade data

```

```

    # Print the results data structure (ROI results)
    print("\nROI Results:")
    for result in results:
        print(f"Strategy: {result[0]}, ROI: {result[1]}") # Access the tuple by
        ↪ index and print the strategy name and ROI

# Update the display function to include debugging
def display_corrected_tables_with_debugging(strategies, trade_summary, results):
    """
        Displays the corrected tables and includes debugging information.

        This function first calls the debugging function to print the content of the
        ↪ data structures,
        and then generates and prints the corrected tables for final balances, total
        ↪ volume swapped,
        and ROI per strategy.

        Parameters:
        strategies (list): A list of strategy objects used in the simulation.
        trade_summary (dict): A dictionary summarizing trade volumes for each
        ↪ strategy.
        results (list): A list of tuples containing strategy names and their
        ↪ corresponding ROI.

        Returns:
        None
        """
    # Call the debug function to print and verify the data structures
    debug_and_verify_data(strategies, trade_summary, results)

    # Generate the corrected final balances table
    final_balances_table_corrected =
    ↪ create_corrected_final_balances_table(strategies)

    # Generate the corrected total volume swapped table
    total_volume_swapped_table_corrected =
    ↪ create_corrected_total_volume_swapped_table(trade_summary)

    # Generate the corrected ROI per strategy table
    roi_per_strategy_table_corrected =
    ↪ create_corrected_roi_per_strategy_table(results)

    # Display the corrected final balances table
    print("\nCorrected Final Balances Table")
    print(final_balances_table_corrected)

```



```

# Display the corrected total volume swapped table
print("\nCorrected Total Volume Swapped Table")
print(total_volume_swapped_table_corrected)

# Display the corrected ROI per strategy table
print("\nCorrected ROI per Strategy Table")
print(roi_per_strategy_table_corrected)

```

```

[50]: # Function to plot the ROI by strategy.
def plot_roi_by_strategy(results):
    """
    Plots a bar chart showing the Return on Investment (ROI) for each strategy.

    Parameters:
    results (list): A list of tuples where each tuple contains a strategy name,
    → and its corresponding ROI.
    """
    # Extract strategy names and their corresponding ROIs from the results
    strategy_names = [name for name, roi in results]
    rois = [roi for name, roi in results]

    # Plot the ROI for each strategy using a barplot
    sns.barplot(x=strategy_names, y=rois)
    plt.title('ROI by Strategy') # Title of the plot
    plt.ylabel('ROI (%)') # Label for the y-axis
    plt.xlabel('Strategy') # Label for the x-axis
    plt.xticks(rotation=45) # Rotate the strategy names for better readability
    plt.show() # Display the plot

# Function to plot the ETH price path over time.
def plot_price_path(price_history):
    """
    Plots the price path of ETH over the simulation period.

    Parameters:
    price_history (list): A list of ETH prices recorded for each day of the
    → simulation.
    """
    plt.plot(price_history) # Plot the ETH price over time
    plt.title('ETH Price Path Over Time') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('Price') # Label for the y-axis
    plt.show() # Display the plot

# Function to plot the volatility of ETH over time.
def plot_volatility_over_time(volatility_table):

```

```

"""
Plots the volatility of ETH over time, calculated using a rolling window.

Parameters:
price_history (list): A list of ETH prices recorded for each day of the
↳simulation.
"""

# Calculate daily returns and then compute volatility using a rolling window
plt.figure(figsize=(10, 6))
plt.plot(volatility_table['Day'], volatility_table['Volatility'],
↳color='blue', linewidth=2)
plt.title('Volatility Over Time')
plt.xlabel('Day')
plt.ylabel('Volatility (Annualized)')
plt.grid(True)
plt.show()

def simulate_market_conditions(market_conditions, days):
    """
    Simulates ETH price over a specified number of days using a Geometric
↳Brownian Motion model.
    """
    # Load or assign simulation parameters for drift and volatility
    mu = market_conditions.get('mu', 0.1)
    sigma = market_conditions.get('volatility', 0.3)
    initial_price = 2500
    eth_prices = simulate_eth_price_gbm(initial_price, days, mu, sigma)

    return eth_prices

def simulate_and_track_volatility(days, market_conditions):
    """
    Simulates the ETH market conditions and tracks the volatility over the
↳simulation period.

    Parameters:
    days (int): The number of days to simulate.
    market_conditions (dict): Parameters for the simulation.

    Returns:
    pd.DataFrame: A DataFrame tracking the volatility over the simulated period.
    """
    # Simulate ETH prices based on the given market conditions
    eth_prices = simulate_market_conditions(market_conditions, days)

    # Create a volatility tracking table
    volatility_table = create_volatility_tracking_table(eth_prices)

```

```

# Plot the volatility over time for visual confirmation
plot_volatility_over_time(volatility_table)

return volatility_table

# Function to plot the mean reversion dynamics of ETH prices.
def plot_mean_reversion(price_history, mean_reversion_level):
    """
    Plots the deviation of ETH prices from a specified mean reversion level over
    ↪time.

    Parameters:
    price_history (list): A list of ETH prices recorded for each day of the
    ↪simulation.
    mean_reversion_level (float): The level to which prices are expected to
    ↪revert.
    """
    # Calculate the deviation of each price from the mean reversion level
    deviations = [price - mean_reversion_level for price in price_history]
    plt.figure(figsize=(10, 6))
    plt.plot(deviations, color='purple') # Plot the deviations over time
    plt.title('Mean Reversion Dynamics') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('Deviation from Mean') # Label for the y-axis
    plt.grid(True)
    plt.show() # Display the plot

# Function to plot impermanent loss over time.
def plot_impermanent_loss_over_time(impermanent_losses):
    """
    Plots the impermanent loss experienced by liquidity providers over time.

    Parameters:
    impermanent_losses (list): A list of impermanent loss percentages recorded
    ↪for each day of the simulation.
    """
    plt.plot(impermanent_losses) # Plot the impermanent loss over time
    plt.title('Impermanent Loss Over Time') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('Impermanent Loss (%)') # Label for the y-axis
    plt.show() # Display the plot

# Function to plot ETH reserves over time.
def plot_eth_reserves_over_time(eth_reserves_over_time):
    """
    Plots the ETH reserves in the trading pool over time.

```

```

    Parameters:
    eth_reserves_over_time (list): A list of ETH reserves recorded for each day_
    ↪ of the simulation.
    """
    plt.plot(eth_reserves_over_time) # Plot the ETH reserves over time
    plt.title('ETH Reserves Over Time') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('ETH Reserves') # Label for the y-axis
    plt.show() # Display the plot

# Function to plot TKN reserves over time.
def plot_tkn_reserves_over_time(tkn_reserves_over_time):
    """
    Plots the TKN reserves in the trading pool over time.

    Parameters:
    tkn_reserves_over_time (list): A list of TKN reserves recorded for each day_
    ↪ of the simulation.
    """
    plt.plot(tkn_reserves_over_time) # Plot the TKN reserves over time
    plt.title('TKN Reserves Over Time') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('TKN Reserves') # Label for the y-axis
    plt.show() # Display the plot

```

[51]: # Function to plot a histogram of price changes.

```

def plot_tkn_price_path(tkn_price_history):
    """
    Plots the price path of TKN over the simulation period.

    Parameters:
    tkn_price_history (list): A list of TKN prices recorded for each day of the_
    ↪ simulation.
    """
    plt.plot(tkn_price_history) # Plot the TKN price over time
    plt.title('TKN Price Path Over Time') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('Price') # Label for the y-axis
    plt.show() # Display the plot

def plot_histogram_of_price_changes(price_history):
    """
    Plots a histogram of percentage changes in ETH prices during the simulation.

```

```

    Parameters:
    price_history (list): A list of ETH prices recorded for each day of the
    ↪simulation.
    """
    # Calculate daily percentage changes in price and drop any missing values (e.
    ↪g., first day has no change)
    price_changes = pd.Series(price_history).pct_change().dropna()

    # Plot the histogram of price changes with a kernel density estimate (KDE)
    ↪overlay
    sns.histplot(price_changes, kde=True, bins=50)
    plt.title('Histogram of Price Changes') # Title of the plot
    plt.xlabel('Percentage Change') # Label for the x-axis
    plt.ylabel('Frequency') # Label for the y-axis
    plt.show() # Display the plot

# Function to plot the distribution of slippage.
def plot_slippage_distribution(price_impacts):
    """
    Plots a histogram of slippage experienced during trades in the simulation.

    Parameters:
    price_impacts (list): A list of slippage values recorded for each trade in
    ↪the simulation.
    """
    # Plot the histogram of slippage with a KDE overlay
    sns.histplot(price_impacts, kde=True, bins=50)
    plt.title('Slippage Distribution') # Title of the plot
    plt.xlabel('Slippage') # Label for the x-axis
    plt.ylabel('Frequency') # Label for the y-axis
    plt.show() # Display the plot

# Function to plot the number of trades made by each strategy.
def plot_trade_count_by_strategy(trade_counts):
    """
    Plots a bar chart showing the number of trades executed by each strategy.

    Parameters:
    trade_counts (dict): A dictionary where keys are strategy names and values
    ↪are the number of trades executed.
    """
    # Extract strategy names and their corresponding trade counts
    strategies = list(trade_counts.keys())
    counts = list(trade_counts.values())

    # Plot the number of trades for each strategy using a barplot
    sns.barplot(x=strategies, y=counts)

```

```

plt.title('Trade Count by Strategy') # Title of the plot
plt.ylabel('Number of Trades') # Label for the y-axis
plt.xlabel('Strategy') # Label for the x-axis
plt.xticks(rotation=45) # Rotate the strategy names for better readability
plt.show() # Display the plot

# Function to plot ETH price history with SMA and EMA overlays.
def plot_price_history_with_sma_ema(price_history):
    """
    Plots the ETH price history with Simple Moving Average (SMA) and Exponential
    ↪ Moving Average (EMA) overlays.

    Parameters:
    price_history (list): A list of ETH prices recorded for each day of the
    ↪ simulation.
    """
    # Create a DataFrame to hold the price data
    df = pd.DataFrame({
        'Price': price_history
    })

    # Calculate the 30-day SMA and EMA
    df['SMA'] = df['Price'].rolling(window=30).mean()
    df['EMA'] = df['Price'].ewm(span=30, adjust=False).mean()

    # Plot the price, SMA, and EMA
    plt.plot(df['Price'], label='Price')
    plt.plot(df['SMA'], label='SMA (30)')
    plt.plot(df['EMA'], label='EMA (30)')
    plt.title('Price History with SMA/EMA') # Title of the plot
    plt.xlabel('Day') # Label for the x-axis
    plt.ylabel('Price') # Label for the y-axis
    plt.legend() # Add a legend to distinguish between Price, SMA, and EMA
    plt.show() # Display the plot

# Function to plot the final ETH balances by strategy.
def plot_final_eth_balances_by_strategy(final_balances_table):
    """
    Plots a bar chart showing the final ETH balances held by each strategy at
    ↪ the end of the simulation.

    Parameters:
    final_balances_table (pd.DataFrame): A DataFrame containing the final ETH
    ↪ balances for each strategy.
    """
    # Plot the final ETH balances for each strategy using a barplot
    sns.barplot(x='Strategy', y='Final_ETH_Balance', data=final_balances_table)

```

```

plt.title('Final ETH Balances by Strategy') # Title of the plot
plt.ylabel('ETH Balance') # Label for the y-axis
plt.xlabel('Strategy') # Label for the x-axis
plt.xticks(rotation=45) # Rotate the strategy names for better readability
plt.show() # Display the plot

# Function to plot the final TKN balances by strategy.
def plot_final_tkn_balances_by_strategy(final_balances_table):
    """
    Plots a bar chart showing the final TKN balances held by each strategy at
    ↪ the end of the simulation.

    Parameters:
    final_balances_table (pd.DataFrame): A DataFrame containing the final TKN
    ↪ balances for each strategy.
    """
    # Plot the final TKN balances for each strategy using a barplot
    sns.barplot(x='Strategy', y='Final_TKN_Balance', data=final_balances_table)
    plt.title('Final TKN Balances by Strategy') # Title of the plot
    plt.ylabel('TKN Balance') # Label for the y-axis
    plt.xlabel('Strategy') # Label for the x-axis
    plt.xticks(rotation=45) # Rotate the strategy names for better readability
    plt.show() # Display the plot

# Function to plot the final USD balances by strategy.
def plot_final_usd_balances_by_strategy(final_balances_table):
    """
    Plots a bar chart showing the final USD balances for each strategy, based on
    ↪ their ETH and TKN holdings.

    Parameters:
    final_balances_table (pd.DataFrame): A DataFrame containing the final USD
    ↪ balances for each strategy.
    """
    # Plot the final USD balances for each strategy using a barplot
    sns.barplot(x='Strategy', y='Final_USD_Balance', data=final_balances_table)
    plt.title('Final USD Balances by Strategy') # Title of the plot
    plt.ylabel('USD Balance') # Label for the y-axis
    plt.xlabel('Strategy') # Label for the x-axis
    plt.xticks(rotation=45) # Rotate the strategy names for better readability
    plt.show() # Display the plot

# Function to plot the total ETH swapped per strategy.
def plot_total_eth_swapped_per_strategy(total_volume_swapped_table):
    """
    Plots a bar chart showing the total volume of ETH swapped by each strategy
    ↪ during the simulation.

```

```

    Parameters:
    total_volume_swapped_table (pd.DataFrame): A DataFrame summarizing the total
    ↪ETH swapped by each strategy.
    """
    # Plot the total ETH swapped by each strategy using a barplot
    sns.barplot(x=total_volume_swapped_table.index, y='ETH Swapped',
    ↪data=total_volume_swapped_table)
    plt.title('Total ETH Swapped per Strategy') # Title of the plot
    plt.ylabel('Total ETH Swapped') # Label for the y-axis
    plt.xlabel('Strategy') # Label for the x-axis
    plt.xticks(rotation=45) # Rotate the strategy names for better readability
    plt.show() # Display the plot

# Function to plot the total TKN swapped per strategy.
def plot_total_tkn_swapped_per_strategy(total_volume_swapped_table):
    """
    Plots a bar chart showing the total volume of TKN swapped by each strategy
    ↪during the simulation.

    Parameters:
    total_volume_swapped_table (pd.DataFrame): A DataFrame summarizing the total
    ↪TKN swapped by each strategy.
    """
    # Plot the total TKN swapped by each strategy using a barplot
    sns.barplot(x=total_volume_swapped_table.index, y='TKN Swapped',
    ↪data=total_volume_swapped_table)
    plt.title('Total TKN Swapped per Strategy') # Title of the plot
    plt.ylabel('Total TKN Swapped') # Label for the y-axis
    plt.xlabel('Strategy') # Label for the x-axis
    plt.xticks(rotation=45) # Rotate the strategy names for better readability
    plt.show() # Display the plot

# Function to plot the performance of strategies over time in terms of ETH and
    ↪TKN holdings.
def plot_strategy_performance_over_time(strategy_instances, price_history):
    """
    Plots the performance of each strategy over time, showing their ETH and TKN
    ↪holdings throughout the simulation.

    Parameters:
    strategy_instances (list): A list of strategy objects used in the simulation.
    price_history (list): A list of ETH prices recorded for each day of the
    ↪simulation.
    """
    days = list(range(len(price_history)))

```



```

plt.figure(figsize=(14, 7))

for strategy in strategy_instances:
    eth_holdings = [entry['eth_balance'] for entry in strategy.participant.
    ↳trade_history]

    # If eth_holdings is shorter than the number of days, pad it with the
    ↳last known value
    if len(eth_holdings) == 0:
        # Handle the case where eth_holdings is empty, you can initialize it
        ↳with a default value if appropriate
        eth_holdings = [0] * len(days) # or any other default value you see
    ↳fit
    elif len(eth_holdings) < len(days):
        eth_holdings += [eth_holdings[-1]] * (len(days) - len(eth_holdings))
    else:
        eth_holdings = eth_holdings[:len(days)]

    plt.plot(days, eth_holdings, label=f'{strategy.name} ETH Holdings')

plt.title('Strategy Performance Over Time (ETH Holdings)')
plt.xlabel('Day')
plt.ylabel('ETH Holdings')
plt.legend()
plt.grid(True)
plt.show()

# Plot TKN Holdings over time
plt.figure(figsize=(12, 6)) # Set the figure size
for strategy in strategy_instances:
    # Check if the strategy has made trades and extract TKN holdings after
    ↳each trade
    if strategy.participant.trade_history:
        tkn_holdings = [trade['tkn_balance'] for trade in strategy.
    ↳participant.trade_history]
    else:
        # If no trades were made, assume initial balances throughout the
        ↳period
        tkn_holdings = [strategy.participant.tkn_balance] * len(days)

    # Pad TKN holdings to match the number of days, if necessary
    if len(tkn_holdings) != len(days):
        if len(tkn_holdings) < len(days):
            tkn_holdings += [tkn_holdings[-1]] * (len(days) -
    ↳len(tkn_holdings))

```

```

        else:
            tkn_holdings = tkn_holdings[:len(days)]

            plt.plot(days, tkn_holdings, label=f'{strategy.name} TKN Holdings') #
→Plot TKN holdings over time

            plt.title('Strategy Performance Over Time (TKN Holdings)') # Title of the
→plot
            plt.xlabel('Day') # Label for the x-axis
            plt.ylabel('TKN Holdings') # Label for the y-axis
            plt.legend() # Add a legend to distinguish between strategies
            plt.show() # Display the plot

```

```

[52]: def main():
    market_conditions = load_json('bull_market.json') # Load the correct JSON
→configuration file
    days = market_conditions['simulation_parameters']['days_of_simulation']
    initial_eth = market_conditions['simulation_parameters']['initial_pool_eth']
    initial_tkn = market_conditions['simulation_parameters']['initial_pool_tkn']

    # Get the initial ETH and TKN prices from the correct section
    initial_eth_price =
→market_conditions['market_conditions']['initial_eth_price']
    initial_tkn_price = 1 # Assuming initial TKN price is set to 1 as it's not
→in the JSON

    pool = TradingPool(initial_eth, initial_tkn)

    strategies = [
        BullStrategy("Bull", 10, 0, initial_eth_price, initial_tkn_price),
        BearStrategy("Bear", 10, 0, initial_eth_price, initial_tkn_price),
        DcaStrategy("DCA", 10, 0, initial_eth_price, initial_tkn_price,
→daily_investment=0.1),
        HarvesterStrategy("Harvester", 10, 100, initial_eth_price,
→initial_tkn_price),
        DoveStrategy("Dove", 10, 0, initial_eth_price, initial_tkn_price),
        HawkStrategy("Hawk", 10, 0, initial_eth_price, initial_tkn_price,
→target_profit=0.01),
    ]

    # Initialize trade summary dictionary
    trade_summary = {}

    # Run the simulation
    eth_price_history, tkn_price_history, trade_counts, eth_reserves_over_time,
→tkn_reserves_over_time, lp_fees_over_time, \

```

```

    impermanent_losses, price_impacts, detailed_logs = _
    ↪run_simulation(strategies, pool, market_conditions, days)

    # Evaluate the results
    results = evaluate_simulation(strategies)

    # Update trade summary with actual volumes
    for strategy in strategies:
        update_total_volume_swapped(trade_summary, strategy.name, strategy.
    ↪participant)

    # Generate a summary of trades made by each strategy
    trade_summary = summarize_trades(strategies)

    # Create various tables to summarize the simulation results
    price_history_table = create_price_history_table(eth_price_history)
    volatility_table = create_volatility_tracking_table(eth_price_history) #_
    ↪Create the volatility table here
    mean_reversion_table = create_mean_reversion_table(eth_price_history, _
    ↪mean_reversion_level=3000)
    final_balances_table = create_corrected_final_balances_table(strategies, _
    ↪eth_price_history) # Pass eth_price_history
    total_volume_swapped_table = create_total_volume_swapped_table(trade_summary)
    roi_per_strategy_table = create_roi_per_strategy_table(results)
    impermanent_loss_table = create_impermanent_loss_table(impermanent_losses)
    total_lp_fees_table = create_total_lp_fees_table(lp_fees_over_time)

    # Print the first few rows of each table for inspection
    print("Price History Table")
    print(price_history_table.head())
    print("\nVolatility Tracking Table")
    print(volatility_table.head())
    print("\nMean Reversion Table")
    print(mean_reversion_table.head())
    print("\nFinal Balances Table")
    print(final_balances_table.head())
    print("\nTotal Volume Swapped Table")
    print(total_volume_swapped_table.head())
    print("\nROI per Strategy Table")
    print(roi_per_strategy_table.head())
    print("\nImpermanent Loss Table")
    print(impermanent_loss_table.head())
    print("\nTotal LP Fees Table")
    print(total_lp_fees_table.head())

    # Return all relevant data, including strategies and the volatility table

```

```

    return strategies, eth_price_history, tkn_price_history,
    ↳final_balances_table, total_volume_swapped_table, results, price_impacts,
    ↳trade_counts, eth_reserves_over_time, tkn_reserves_over_time,
    ↳volatility_table, impermanent_losses

# Call main() and unpack the returned data
strategies, eth_price_history, tkn_price_history, final_balances_table,
    ↳total_volume_swapped_table, results, price_impacts, trade_counts,
    ↳eth_reserves_over_time, tkn_reserves_over_time, volatility_table,
    ↳impermanent_losses = main()

# Generate and display the plots
plot_roi_by_strategy(results)
plot_price_path(eth_price_history) # ETH price plot
plot_tkn_price_path(tkn_price_history) # New TKN price plot
plot_volatility_over_time(volatility_table) # Now volatility_table should be
    ↳defined
plot_mean_reversion(eth_price_history, mean_reversion_level=3000)
plot_impermanent_loss_over_time(impermanent_losses) # Now impermanent_losses
    ↳should be defined
plot_eth_reserves_over_time(eth_reserves_over_time)
plot_tkn_reserves_over_time(tkn_reserves_over_time)

# Additional Visualizations
plot_histogram_of_price_changes(eth_price_history)
plot_slippage_distribution(price_impacts)
plot_trade_count_by_strategy(trade_counts)
plot_price_history_with_sma_ema(eth_price_history)

# Added Visualizations
plot_final_eth_balances_by_strategy(final_balances_table)
plot_final_tkn_balances_by_strategy(final_balances_table)
plot_final_usd_balances_by_strategy(final_balances_table)
plot_total_eth_swapped_per_strategy(total_volume_swapped_table)
plot_total_tkn_swapped_per_strategy(total_volume_swapped_table)
plot_strategy_performance_over_time(strategies, eth_price_history)

```

```

Bull Post-Execution ETH Balance: 10, TKN Balance: 0
Bear Post-Execution ETH Balance: 10, TKN Balance: 0
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 20.0 TKN at price 2500
Harvester: Updated TKN balance is 80.0
Harvester Post-Execution ETH Balance: 10.078960121469235, TKN Balance: 80.0
Dove Post-Execution ETH Balance: 10, TKN Balance: 0
Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
Bull Post-Execution ETH Balance: 10, TKN Balance: 0
Bear: Updated TKN balance is 0

```

Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 16.0 TKN at price 2520.266038005257
 Harvester: Updated TKN balance is 64.0
 Harvester Post-Execution ETH Balance: 10.28815025352171, TKN Balance: 64.0
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 12.8 TKN at price 2515.4892411174633
 Harvester: Updated TKN balance is 51.2
 Harvester Post-Execution ETH Balance: 10.399835836386574, TKN Balance: 51.2
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 10.24 TKN at price 2541.8998064951365
 Harvester: Updated TKN balance is 40.96
 Harvester Post-Execution ETH Balance: 10.488415383054983, TKN Balance: 40.96
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2541.8998064951365 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 10
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 8.192 TKN at price 2604.1372679329706
 Harvester: Updated TKN balance is 32.768
 Harvester Post-Execution ETH Balance: 10.56438910889078, TKN Balance: 32.768
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2604.1372679329706 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 6.5536 TKN at price 2595.2907830960385
 Harvester: Updated TKN balance is 26.2144
 Harvester Post-Execution ETH Balance: 10.590011949746787, TKN Balance: 26.2144
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2595.2907830960385 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0

Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 5.24288 TKN at price 2586.4750173539264
 Harvester: Updated TKN balance is 20.97152
 Harvester Post-Execution ETH Balance: 10.610357142262364, TKN Balance: 20.97152
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2586.4750173539264 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 10
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 4.194304 TKN at price 2652.142641197207
 Harvester: Updated TKN balance is 16.777216000000003
 Harvester Post-Execution ETH Balance: 10.62660282297935, TKN Balance: 16.777216000000003
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2652.142641197207 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 10
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 3.3554432 TKN at price 2685.0319857376867
 Harvester: Updated TKN balance is 13.421772800000003
 Harvester Post-Execution ETH Balance: 10.639580116143676, TKN Balance: 13.421772800000003
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2685.0319857376867 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 10
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 2.68435456 TKN at price 2666.0409707318063
 Harvester: Updated TKN balance is 10.737418240000004
 Harvester Post-Execution ETH Balance: 10.649949655098272, TKN Balance: 10.737418240000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2666.0409707318063 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 10
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0

Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 2.14748365 TKN at price 2689.588557451925
 Harvester: Updated TKN balance is 8.589934590000004
 Harvester Post-Execution ETH Balance: 10.658237429725002, TKN Balance: 8.589934590000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2689.588557451925 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 10
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 1.71798692 TKN at price 2670.8193144922634
 Harvester: Updated TKN balance is 6.871947670000004
 Harvester Post-Execution ETH Balance: 10.664862627688137, TKN Balance: 6.871947670000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2670.8193144922634 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 1.37438953 TKN at price 2652.084764964638
 Harvester: Updated TKN balance is 5.497558140000004
 Harvester Post-Execution ETH Balance: 10.670159575420543, TKN Balance: 5.497558140000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2652.084764964638 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 10, TKN Balance: 0
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 1.09951163 TKN at price 2662.909900195288
 Harvester: Updated TKN balance is 4.398046510000004
 Harvester Post-Execution ETH Balance: 10.674395080521982, TKN Balance: 4.398046510000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2662.909900195288 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 5.0 ETH at price 2584.8041611833373
 Bull: Updated ETH balance is 5.0
 Bull Post-Execution ETH Balance: 5.0, TKN Balance: 1024.3716097324839
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

Harvester: Selling 0.8796093 TKN at price 2584.8041611833373
 Harvester: Updated TKN balance is 3.5184372100000036
 Harvester Post-Execution ETH Balance: 10.701499930562276, TKN Balance: 3.5184372100000036
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2584.8041611833373 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 2.5 ETH at price 2516.421418533736
 Bull: Updated ETH balance is 2.5
 Bull Post-Execution ETH Balance: 2.5, TKN Balance: 1397.092712512026
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.70368744 TKN at price 2516.421418533736
 Harvester: Updated TKN balance is 2.8147497700000037
 Harvester Post-Execution ETH Balance: 10.715080948574784, TKN Balance: 2.8147497700000037
 Dove: Cautiously buying TKN with 0.2 ETH at price 2516.421418533736
 Dove Post-Execution ETH Balance: 9.8, TKN Balance: 26.937779112046236
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 1.25 ETH at price 2494.9840852664915
 Bull: Updated ETH balance is 1.25
 Bull Post-Execution ETH Balance: 1.25, TKN Balance: 1556.9043510590604
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.56294995 TKN at price 2494.9840852664915
 Harvester: Updated TKN balance is 2.2517998200000036
 Harvester Post-Execution ETH Balance: 10.723552223542836, TKN Balance: 2.2517998200000036
 Dove: Cautiously buying TKN with 0.196 ETH at price 2494.9840852664915
 Dove Post-Execution ETH Balance: 9.604000000000001, TKN Balance: 50.75337271598886
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.625 ETH at price 2456.290099497565
 Bull: Updated ETH balance is 0.625
 Bull Post-Execution ETH Balance: 0.625, TKN Balance: 1630.7778607010675
 Bear: Cautiously buying TKN with 1.0 ETH at price 2456.290099497565 during a major dip
 Bear: Updated TKN balance is 111.98285059588832
 Bear Post-Execution ETH Balance: 9.0, TKN Balance: 111.98285059588832
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.45035996 TKN at price 2456.290099497565
 Harvester: Updated TKN balance is 1.8014398600000034
 Harvester Post-Execution ETH Balance: 10.730766562127792, TKN Balance: 1.8014398600000034
 Dove: Cautiously buying TKN with 0.19208000000000003 ETH at price 2456.290099497565
 Dove Post-Execution ETH Balance: 9.41192, TKN Balance: 71.40259008975258
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0

Bull: Actively buying TKN with 0.3125 ETH at price 2469.1170861677865
 Bull: Updated ETH balance is 0.3125
 Bull Post-Execution ETH Balance: 0.3125, TKN Balance: 1663.8810967340976
 Bear Post-Execution ETH Balance: 9.0, TKN Balance: 111.98285059588832
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.36028797 TKN at price 2469.1170861677865
 Harvester: Updated TKN balance is 1.4411518900000035
 Harvester Post-Execution ETH Balance: 10.735110276132136, TKN Balance: 1.4411518900000035
 Dove: Cautiously buying TKN with 0.1882384 ETH at price 2469.1170861677865
 Dove Post-Execution ETH Balance: 9.2236816, TKN Balance: 90.99267977037647
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.15625 ETH at price 2434.8281002071153
 Bull: Updated ETH balance is 0.15625
 Bull Post-Execution ETH Balance: 0.15625, TKN Balance: 1680.0207029926141
 Bear: Cautiously buying TKN with 0.9 ETH at price 2434.8281002071153 during a major dip
 Bear: Updated TKN balance is 201.59225120160886
 Bear Post-Execution ETH Balance: 8.1, TKN Balance: 201.59225120160886
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.28823038 TKN at price 2434.8281002071153
 Harvester: Updated TKN balance is 1.1529215100000036
 Harvester Post-Execution ETH Balance: 10.740821980232724, TKN Balance: 1.1529215100000036
 Dove: Cautiously buying TKN with 0.18447363200000003 ETH at price 2434.8281002071153
 Dove Post-Execution ETH Balance: 9.039207968000001, TKN Balance: 108.74672446053788
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.078125 ETH at price 2382.0777831395862
 Bull: Updated ETH balance is 0.078125
 Bull Post-Execution ETH Balance: 0.078125, TKN Balance: 1687.5314714708834
 Bear: Cautiously buying TKN with 0.81 ETH at price 2382.0777831395862 during a major dip
 Bear: Updated TKN balance is 276.8496782940634
 Bear Post-Execution ETH Balance: 7.289999999999999, TKN Balance: 276.8496782940634
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.2305843 TKN at price 2382.0777831395862
 Harvester: Updated TKN balance is 0.9223372100000037
 Harvester Post-Execution ETH Balance: 10.745815775996832, TKN Balance: 0.9223372100000037
 Dove: Cautiously buying TKN with 0.18078415936000003 ETH at price 2382.0777831395862
 Dove Post-Execution ETH Balance: 8.858423808640001, TKN Balance: 125.04993077378552
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.0390625 ETH at price 2438.204155275336

Bull: Updated ETH balance is 0.0390625
 Bull Post-Execution ETH Balance: 0.0390625, TKN Balance: 1691.0797542191058
 Bear Post-Execution ETH Balance: 7.289999999999999, TKN Balance:
 276.8496782940634
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.18446744 TKN at price 2438.204155275336
 Harvester: Updated TKN balance is 0.7378697700000036
 Harvester Post-Execution ETH Balance: 10.747970809178355, TKN Balance:
 0.7378697700000036
 Dove: Cautiously buying TKN with 0.17716847617280004 ETH at price
 2438.204155275336
 Dove Post-Execution ETH Balance: 8.6812553324672, TKN Balance:
 140.82120667401324
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.01953125 ETH at price 2430.241019672264
 Bull: Updated ETH balance is 0.01953125
 Bull Post-Execution ETH Balance: 0.01953125, TKN Balance: 1692.8555636204476
 Bear Post-Execution ETH Balance: 7.289999999999999, TKN Balance:
 276.8496782940634
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.14757395 TKN at price 2430.241019672264
 Harvester: Updated TKN balance is 0.5902958200000037
 Harvester Post-Execution ETH Balance: 10.749679148879913, TKN Balance:
 0.5902958200000037
 Dove Post-Execution ETH Balance: 8.6812553324672, TKN Balance:
 140.82120667401324
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.00976562 ETH at price 2433.485973660647
 Bull: Updated ETH balance is 0.00976563
 Bull Post-Execution ETH Balance: 0.00976563, TKN Balance: 1693.7196026862061
 Bear Post-Execution ETH Balance: 7.289999999999999, TKN Balance:
 276.8496782940634
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.11805916 TKN at price 2433.485973660647
 Harvester: Updated TKN balance is 0.4722366600000037
 Harvester Post-Execution ETH Balance: 10.751027713304085, TKN Balance:
 0.4722366600000037
 Dove Post-Execution ETH Balance: 8.6812553324672, TKN Balance:
 140.82120667401324
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.00488282 ETH at price 2380.299548536723
 Bull: Updated ETH balance is 0.004882810000000004
 Bull Post-Execution ETH Balance: 0.004882810000000004, TKN Balance:
 1694.1516022221126
 Bear: Cautiously buying TKN with 0.729 ETH at price 2380.299548536723 during a
 major dip
 Bear: Updated TKN balance is 339.9044589834965
 Bear Post-Execution ETH Balance: 6.560999999999999, TKN Balance:

339.9044589834965
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.09444733 TKN at price 2380.299548536723
Harvester: Updated TKN balance is 0.3777893300000037
Harvester Post-Execution ETH Balance: 10.754353420714224, TKN Balance:
0.3777893300000037
Dove: Cautiously buying TKN with 0.17362510664934402 ETH at price
2380.299548536723
Dove Post-Execution ETH Balance: 8.507630225817856, TKN Balance:
155.4523883187448
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Actively buying TKN with 0.00244141 ETH at price 2360.6854572765483
Bull: Updated ETH balance is 0.002441400000000003
Bull Post-Execution ETH Balance: 0.002441400000000003, TKN Balance:
1694.4001839156488
Bear: Cautiously buying TKN with 0.6561 ETH at price 2360.6854572765483 during a
major dip
Bear: Updated TKN balance is 393.8721586364794
Bear Post-Execution ETH Balance: 5.904899999999999, TKN Balance:
393.8721586364794
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.07555787 TKN at price 2360.6854572765483
Harvester: Updated TKN balance is 0.30223146000000367
Harvester Post-Execution ETH Balance: 10.75727352748017, TKN Balance:
0.30223146000000367
Dove: Cautiously buying TKN with 0.1701526045163571 ETH at price
2360.6854572765483
Dove Post-Execution ETH Balance: 8.337477621301499, TKN Balance:
169.12617386763296
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Actively buying TKN with 0.0012207 ETH at price 2365.448828846748
Bull: Updated ETH balance is 0.001220700000000003
Bull Post-Execution ETH Balance: 0.001220700000000003, TKN Balance:
1694.5388305309389
Bear: Cautiously buying TKN with 0.59049 ETH at price 2365.448828846748 during a
major dip
Bear: Updated TKN balance is 440.31036329137623
Bear Post-Execution ETH Balance: 5.314409999999999, TKN Balance:
440.31036329137623
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.06044629 TKN at price 2365.448828846748
Harvester: Updated TKN balance is 0.24178517000000366
Harvester Post-Execution ETH Balance: 10.7598369397625, TKN Balance:
0.24178517000000366
Dove Post-Execution ETH Balance: 8.337477621301499, TKN Balance:
169.12617386763296
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Actively buying TKN with 0.00061035 ETH at price 2323.7169307895133

Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.531441 ETH at price 2323.7169307895133 during a major dip
 Bear: Updated TKN balance is 480.82468629666425
 Bear Post-Execution ETH Balance: 4.782968999999999, TKN Balance: 480.82468629666425
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.04835703 TKN at price 2323.7169307895133
 Harvester: Updated TKN balance is 0.19342814000000366
 Harvester Post-Execution ETH Balance: 10.762081828509878, TKN Balance: 0.19342814000000366
 Dove: Cautiously buying TKN with 0.16674955242602998 ETH at price 2323.7169307895133
 Dove Post-Execution ETH Balance: 8.17072806887547, TKN Balance: 181.59945927229458
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.4782969 ETH at price 2338.106658373268 during a major dip
 Bear: Updated TKN balance is 516.013849281525
 Bear Post-Execution ETH Balance: 4.304672099999999, TKN Balance: 516.013849281525
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.03868563 TKN at price 2338.106658373268
 Harvester: Updated TKN balance is 0.15474251000000366
 Harvester Post-Execution ETH Balance: 10.764055667744731, TKN Balance: 0.15474251000000366
 Dove Post-Execution ETH Balance: 8.17072806887547, TKN Balance: 181.59945927229458
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.43046721 ETH at price 2316.7927510247796 during a major dip
 Bear: Updated TKN balance is 546.8891366458067
 Bear Post-Execution ETH Balance: 3.874204889999999, TKN Balance: 546.8891366458067
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0309485 TKN at price 2316.7927510247796
 Harvester: Updated TKN balance is 0.12379401000000366
 Harvester Post-Execution ETH Balance: 10.765785811615121, TKN Balance: 0.12379401000000366
 Dove Post-Execution ETH Balance: 8.17072806887547, TKN Balance: 181.59945927229458
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0

Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.38742049 ETH at price 2306.837138793162 during a major dip
 Bear: Updated TKN balance is 574.0807836719016
 Bear Post-Execution ETH Balance: 3.4867843999999986, TKN Balance: 574.0807836719016
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0247588 TKN at price 2306.837138793162
 Harvester: Updated TKN balance is 0.09903521000000366
 Harvester Post-Execution ETH Balance: 10.76730538028842, TKN Balance: 0.09903521000000366
 Dove Post-Execution ETH Balance: 8.17072806887547, TKN Balance: 181.59945927229458
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.34867844 ETH at price 2285.7699496912696 during a major dip
 Bear: Updated TKN balance is 598.0850016719025
 Bear Post-Execution ETH Balance: 3.1381059599999985, TKN Balance: 598.0850016719025
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.01980704 TKN at price 2285.7699496912696
 Harvester: Updated TKN balance is 0.07922817000000366
 Harvester Post-Execution ETH Balance: 10.76864173226055, TKN Balance: 0.07922817000000366
 Dove: Cautiously buying TKN with 0.1634145613775094 ETH at price 2285.7699496912696
 Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance: 192.7011139484933
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.3138106 ETH at price 2353.87451403987 during a major dip
 Bear: Updated TKN balance is 619.1733827239152
 Bear Post-Execution ETH Balance: 2.8242953599999985, TKN Balance: 619.1733827239152
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.01584563 TKN at price 2353.87451403987
 Harvester: Updated TKN balance is 0.06338254000000366
 Harvester Post-Execution ETH Balance: 10.769822020183069, TKN Balance: 0.06338254000000366
 Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance: 192.7011139484933
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.28242954 ETH at price 2354.02052821169 during

a major dip

Bear: Updated TKN balance is 637.8351361640699

Bear Post-Execution ETH Balance: 2.5418658199999986, TKN Balance:
637.8351361640699

DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

Harvester: Selling 0.01267651 TKN at price 2354.02052821169

Harvester: Updated TKN balance is 0.05070603000000366

Harvester Post-Execution ETH Balance: 10.770861365154053, TKN Balance:
0.05070603000000366

Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance:
192.7011139484933

Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0

Bull: Updated ETH balance is 0

Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462

Bear: Cautiously buying TKN with 0.25418658 ETH at price 2315.880048563109
during a major dip

Bear: Updated TKN balance is 654.402388136857

Bear Post-Execution ETH Balance: 2.2876792399999999, TKN Balance:
654.402388136857

DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

Harvester: Selling 0.01014121 TKN at price 2315.880048563109

Harvester: Updated TKN balance is 0.040564820000003665

Harvester Post-Execution ETH Balance: 10.771779064089962, TKN Balance:
0.040564820000003665

Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance:
192.7011139484933

Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0

Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462

Bear Post-Execution ETH Balance: 2.2876792399999999, TKN Balance:
654.402388136857

DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

Harvester: Selling 0.00811296 TKN at price 2346.629231763812

Harvester: Updated TKN balance is 0.03245186000000366

Harvester Post-Execution ETH Balance: 10.771905592877445, TKN Balance:
0.03245186000000366

Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance:
192.7011139484933

Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0

Bull: Updated ETH balance is 0

Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462

Bear: Cautiously buying TKN with 0.22876792 ETH at price 2302.702281881068
during a major dip

Bear: Updated TKN balance is 669.1314618753539

Bear Post-Execution ETH Balance: 2.0589113199999987, TKN Balance:
669.1314618753539

DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

Harvester: Selling 0.00649037 TKN at price 2302.702281881068

Harvester: Updated TKN balance is 0.025961490000003664

Harvester Post-Execution ETH Balance: 10.77269195537252, TKN Balance:
 0.025961490000003664
 Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance:
 192.7011139484933
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.20589113 ETH at price 2310.8999493062656
 during a major dip
 Bear: Updated TKN balance is 682.2433417784924
 Bear Post-Execution ETH Balance: 1.8530201899999987, TKN Balance:
 682.2433417784924
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0051923 TKN at price 2310.8999493062656
 Harvester: Updated TKN balance is 0.020769190000003664
 Harvester Post-Execution ETH Balance: 10.773390119959027, TKN Balance:
 0.020769190000003664
 Dove Post-Execution ETH Balance: 8.00731350749796, TKN Balance:
 192.7011139484933
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.18530202 ETH at price 2241.4856060315246
 during a major dip
 Bear: Updated TKN balance is 693.9288563461797
 Bear Post-Execution ETH Balance: 1.6677181699999988, TKN Balance:
 693.9288563461797
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00415384 TKN at price 2241.4856060315246
 Harvester: Updated TKN balance is 0.016615350000003665
 Harvester Post-Execution ETH Balance: 10.774010667166134, TKN Balance:
 0.016615350000003665
 Dove: Cautiously buying TKN with 0.1601462701499592 ETH at price
 2241.4856060315246
 Dove Post-Execution ETH Balance: 7.847167237348001, TKN Balance:
 202.71358346587965
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.16677182 ETH at price 2195.822529570429
 during a major dip
 Bear: Updated TKN balance is 704.3007552119318
 Bear Post-Execution ETH Balance: 1.5009463499999989, TKN Balance:
 704.3007552119318
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00332307 TKN at price 2195.822529570429
 Harvester: Updated TKN balance is 0.013292280000003664
 Harvester Post-Execution ETH Balance: 10.77456469113446, TKN Balance:

0.013292280000003664
Dove: Cautiously buying TKN with 0.15694334474696 ETH at price 2195.822529570429
Dove Post-Execution ETH Balance: 7.690223892601041, TKN Balance:
212.36836927204556
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Updated ETH balance is 0
Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
Bear: Cautiously buying TKN with 0.15009463 ETH at price 2203.2244227980777
during a major dip
Bear: Updated TKN balance is 713.4931898198877
Bear Post-Execution ETH Balance: 1.3508517199999988, TKN Balance:
713.4931898198877
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.00265846 TKN at price 2203.2244227980777
Harvester: Updated TKN balance is 0.010633820000003664
Harvester Post-Execution ETH Balance: 10.775058558576598, TKN Balance:
0.010633820000003664
Dove: Cautiously buying TKN with 0.1538044778520208 ETH at price
2203.2244227980777
Dove Post-Execution ETH Balance: 7.5364194147490196, TKN Balance:
221.6885302566568
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Updated ETH balance is 0
Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
Bear: Cautiously buying TKN with 0.13508517 ETH at price 2229.5323141975073
during a major dip
Bear: Updated TKN balance is 721.6490195225738
Bear Post-Execution ETH Balance: 1.2157665499999988, TKN Balance:
721.6490195225738
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.00212676 TKN at price 2229.5323141975073
Harvester: Updated TKN balance is 0.008507060000003664
Harvester Post-Execution ETH Balance: 10.775499164769816, TKN Balance:
0.008507060000003664
Dove Post-Execution ETH Balance: 7.5364194147490196, TKN Balance:
221.6885302566568
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Updated ETH balance is 0
Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
Bear: Cautiously buying TKN with 0.12157665 ETH at price 2236.1525092329434
during a major dip
Bear: Updated TKN balance is 728.9185229355696
Bear Post-Execution ETH Balance: 1.0941898999999988, TKN Balance:
728.9185229355696
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.00170141 TKN at price 2236.1525092329434
Harvester: Updated TKN balance is 0.006805650000003664
Harvester Post-Execution ETH Balance: 10.775890987083882, TKN Balance:

0.006805650000003664
Dove Post-Execution ETH Balance: 7.5364194147490196, TKN Balance:
221.6885302566568
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Updated ETH balance is 0
Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
Bear: Cautiously buying TKN with 0.10941899 ETH at price 2232.706975177926
during a major dip
Bear: Updated TKN balance is 735.4244187150455
Bear Post-Execution ETH Balance: 0.9847709099999988, TKN Balance:
735.4244187150455
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.00136113 TKN at price 2232.706975177926
Harvester: Updated TKN balance is 0.005444520000003663
Harvester Post-Execution ETH Balance: 10.77624082742137, TKN Balance:
0.005444520000003663
Dove Post-Execution ETH Balance: 7.5364194147490196, TKN Balance:
221.6885302566568
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Updated ETH balance is 0
Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
Bear: Cautiously buying TKN with 0.09847709 ETH at price 2222.7842256731824
during a major dip
Bear: Updated TKN balance is 741.250268219888
Bear Post-Execution ETH Balance: 0.8862938199999988, TKN Balance:
741.250268219888
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 0.0010889 TKN at price 2222.7842256731824
Harvester: Updated TKN balance is 0.004355620000003663
Harvester Post-Execution ETH Balance: 10.776553421999981, TKN Balance:
0.004355620000003663
Dove Post-Execution ETH Balance: 7.5364194147490196, TKN Balance:
221.6885302566568
Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
Bull: Updated ETH balance is 0
Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
Bear: Cautiously buying TKN with 0.08862938 ETH at price 2172.367800547104
during a major dip
Bear: Updated TKN balance is 746.4698430323833
Bear Post-Execution ETH Balance: 0.7976644399999988, TKN Balance:
746.4698430323833
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester Post-Execution ETH Balance: 10.776553421999981, TKN Balance:
0.004355620000003663
Dove: Cautiously buying TKN with 0.1507283882949804 ETH at price
2172.367800547104
Dove Post-Execution ETH Balance: 7.385691026454039, TKN Balance:
230.52936182847628

Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.07976644 ETH at price 2148.539238408839 during a major dip
 Bear: Updated TKN balance is 751.140836586267
 Bear Post-Execution ETH Balance: 0.7178979999999988, TKN Balance: 751.140836586267
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 10.776553421999981, TKN Balance: 0.004355620000003663
 Dove: Cautiously buying TKN with 0.1477138205290808 ETH at price 2148.539238408839
 Dove Post-Execution ETH Balance: 7.237977205924959, TKN Balance: 239.09700148283383
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.0717898 ETH at price 2133.6388006707934 during a major dip
 Bear: Updated TKN balance is 755.3018497816239
 Bear Post-Execution ETH Balance: 0.6461081999999988, TKN Balance: 755.3018497816239
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 10.776553421999981, TKN Balance: 0.004355620000003663
 Dove: Cautiously buying TKN with 0.14475954411849917 ETH at price 2133.6388006707934
 Dove Post-Execution ETH Balance: 7.0932176618064595, TKN Balance: 247.4047744061497
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear: Cautiously buying TKN with 0.06461082 ETH at price 2169.946566970787 during a major dip
 Bear: Updated TKN balance is 759.0108037391849
 Bear Post-Execution ETH Balance: 0.5814973799999988, TKN Balance: 759.0108037391849
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 10.776553421999981, TKN Balance: 0.004355620000003663
 Dove Post-Execution ETH Balance: 7.0932176618064595, TKN Balance: 247.4047744061497
 Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0
 Bull: Updated ETH balance is 0
 Bull Post-Execution ETH Balance: 0, TKN Balance: 1694.5866546047462
 Bear Post-Execution ETH Balance: 0.5814973799999988, TKN Balance: 759.0108037391849

DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 10.776553421999981, TKN Balance:
 0.004355620000003663

Dove Post-Execution ETH Balance: 7.0932176618064595, TKN Balance:
 247.4047744061497

Hawk Post-Execution ETH Balance: 9.567676579434925, TKN Balance: 0.0

Strategy: Bull

Final ETH Balance: 0

Final TKN Balance: 1694.5866546047462

Final USD Balance: 3389.1733092094923

ROI: -86.44330676316203

Strategy: Bear

Final ETH Balance: 0.5814973799999988

Final TKN Balance: 759.0108037391849

Final USD Balance: 2971.765057478367

ROI: -88.11293977008654

Strategy: DCA

Final ETH Balance: 0.0

Final TKN Balance: 4992.313915535055

Final USD Balance: 9984.62783107011

ROI: -60.061488675719566

Strategy: Harvester

Final ETH Balance: 10.776553421999981

Final TKN Balance: 0.004355620000003663

Final USD Balance: 26941.392266239953

ROI: 7.336224168286664

Strategy: Dove

Final ETH Balance: 7.0932176618064595

Final TKN Balance: 247.4047744061497

Final USD Balance: 18227.85370332845

ROI: -27.08858518668621

Strategy: Hawk

Final ETH Balance: 9.567676579434925

Final TKN Balance: 0.0

Final USD Balance: 23919.191448587313

ROI: -4.323234205650748

Final Balances DataFrame:

	Strategy	Final_ETH_Balance	Final_TKN_Balance	Final_USD_Balance	\
0	Bull	0.000000	1694.586655	3389.173309	
1	Bear	0.581497	759.010804	2971.765057	
2	DCA	0.000000	4992.313916	9984.627831	
3	Harvester	10.776553	0.004356	26941.392266	
4	Dove	7.093218	247.404774	18227.853703	
5	Hawk	9.567677	0.000000	23919.191449	

	ROI	Sharpe_Ratio
0	-86.443307	0.192201
1	-88.112940	-0.197345

2	-60.061489	0.192201
3	7.336224	-0.197342
4	-27.088585	-0.197342
5	-4.323234	-0.197342

Price History Table

	Day	Price
0	0	2500.000000
1	1	2520.266038
2	2	2515.489241
3	3	2541.899806
4	4	2604.137268

Volatility Tracking Table

	Day	Volatility
0	0	0.000000
1	1	0.000000
2	2	0.135116
3	3	0.125616
4	4	0.207762

Mean Reversion Table

	Day	Price	Deviation_from_Mean
0	0	2500.000000	-500.000000
1	1	2520.266038	-479.733962
2	2	2515.489241	-484.510759
3	3	2541.899806	-458.100194
4	4	2604.137268	-395.862732

Final Balances Table

	Strategy	Final_ETH_Balance	Final_TKN_Balance	Final_USD_Balance \
0	Bull	0.000000	1694.586655	3389.173309
1	Bear	0.581497	759.010804	2971.765057
2	DCA	0.000000	4992.313916	9984.627831
3	Harvester	10.776553	0.004356	26941.392266
4	Dove	7.093218	247.404774	18227.853703

	ROI	Sharpe_Ratio
0	-86.443307	0.192201
1	-88.112940	-0.197345
2	-60.061489	0.192201
3	7.336224	-0.197342
4	-27.088585	-0.197342

Total Volume Swapped Table

	ETH Swapped	TKN Swapped
Strategy		
Bull	9.999390	1694.586655
Bear	9.418503	759.010804

DCA	10.000000	4992.313916
Harvester	0.776553	99.995644
Dove	2.906782	247.404774

ROI per Strategy Table

	Strategy	ROI
0	Bull	-86.443307
1	Bear	-88.112940
2	DCA	-60.061489
3	Harvester	7.336224
4	Dove	-27.088585

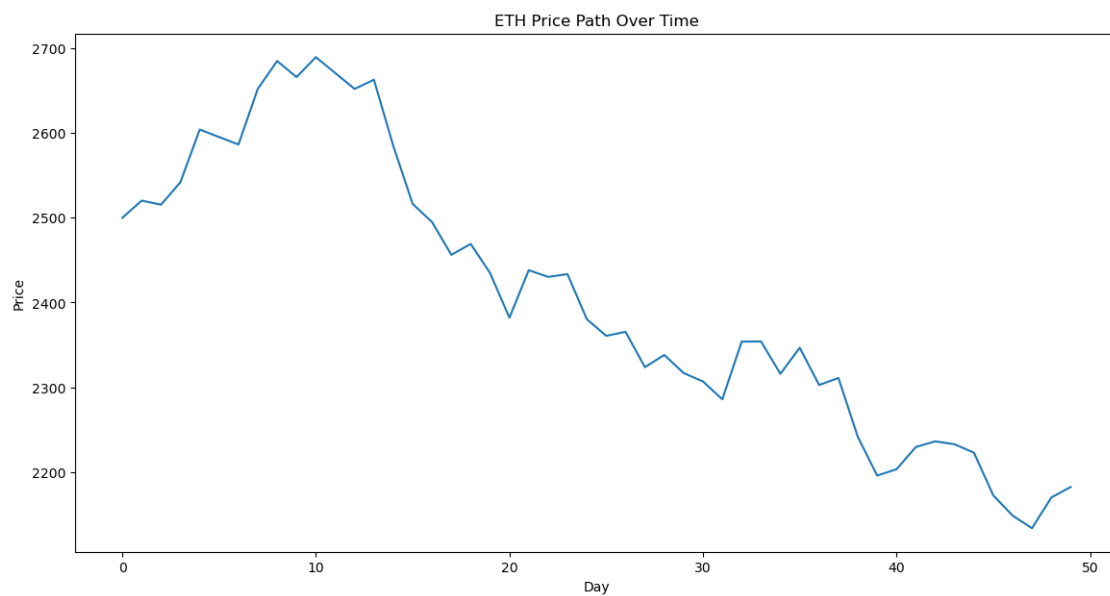
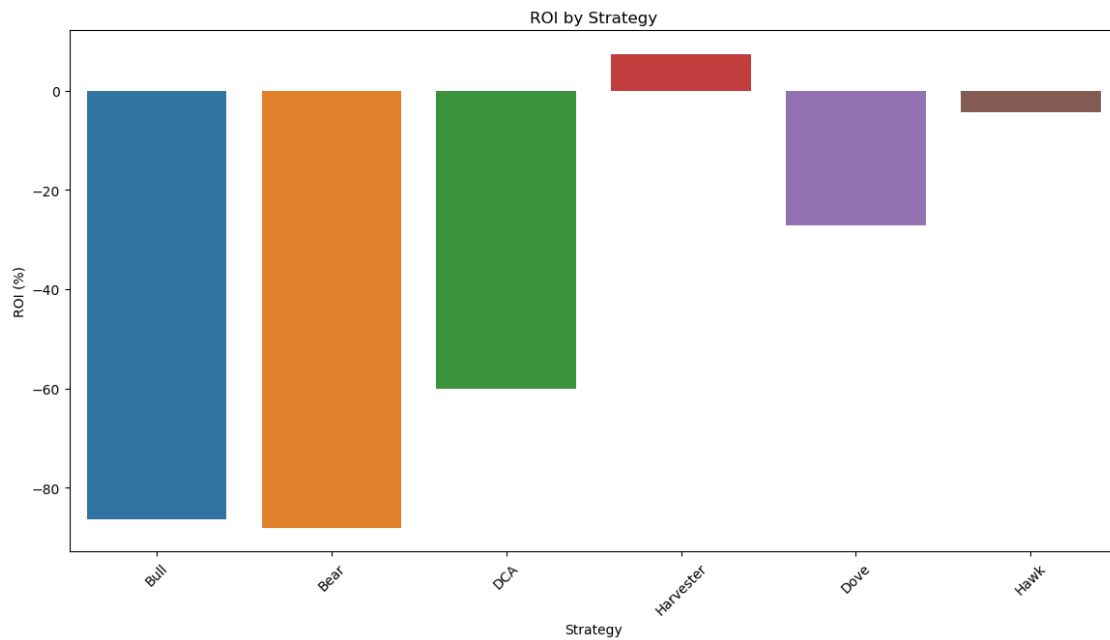
Impermanent Loss Table

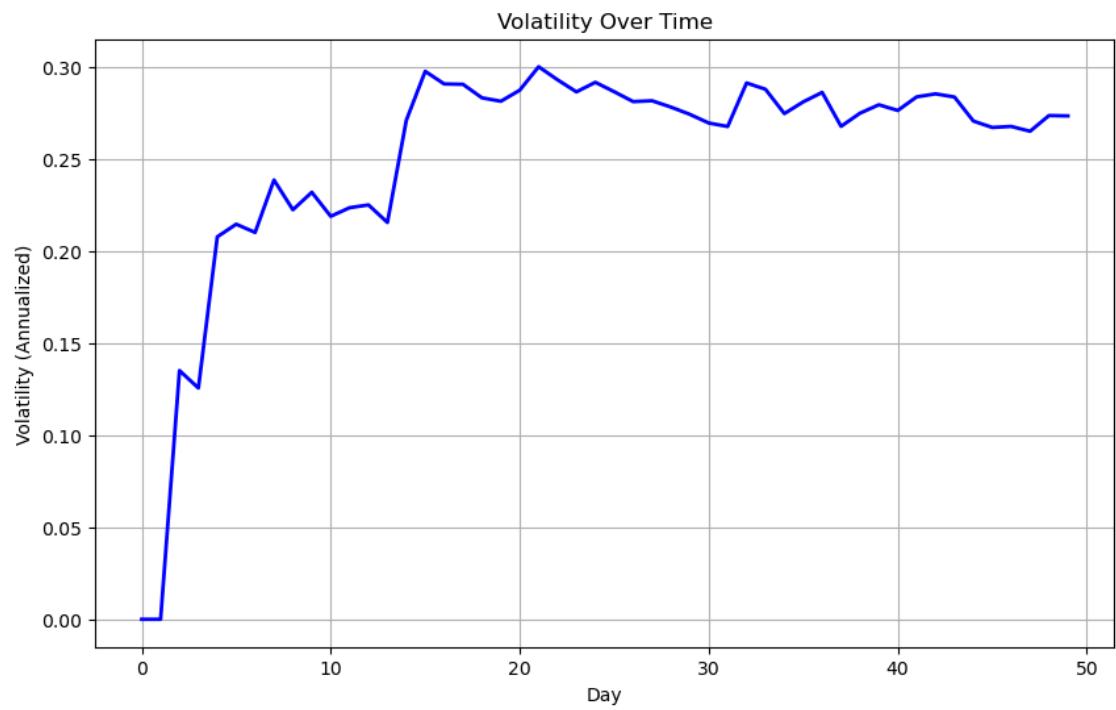
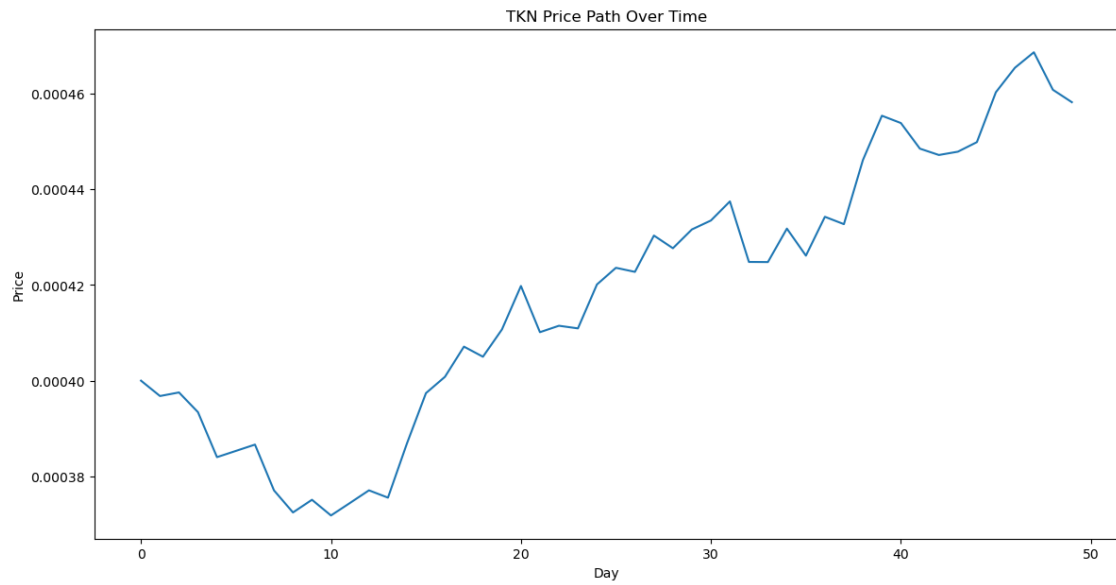
	Day	Impermanent_Loss
0	0	99.999881
1	1	99.999883
2	2	99.999883
3	3	99.999922
4	4	99.999924

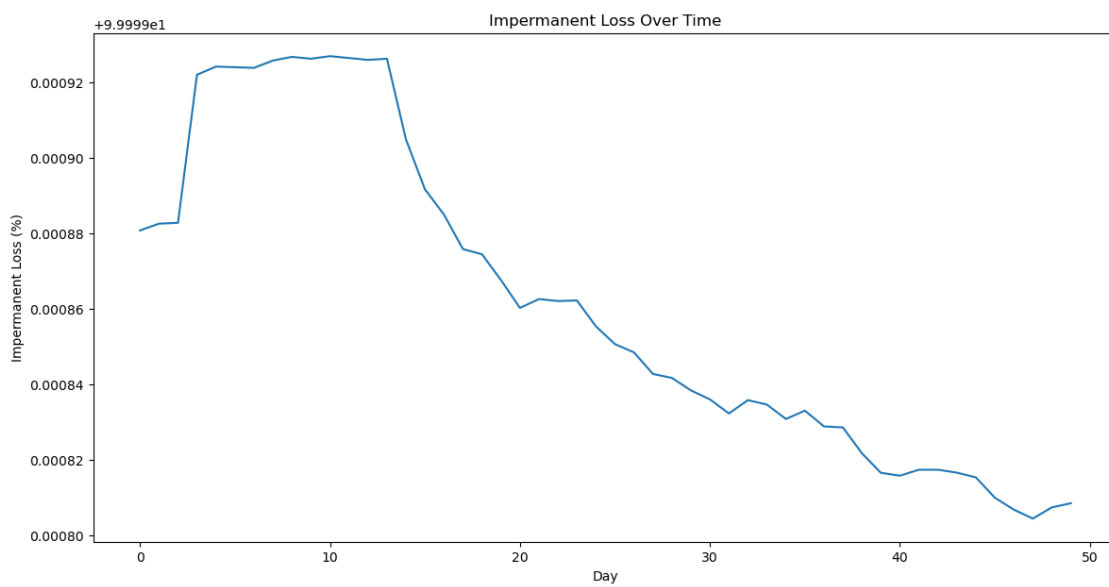
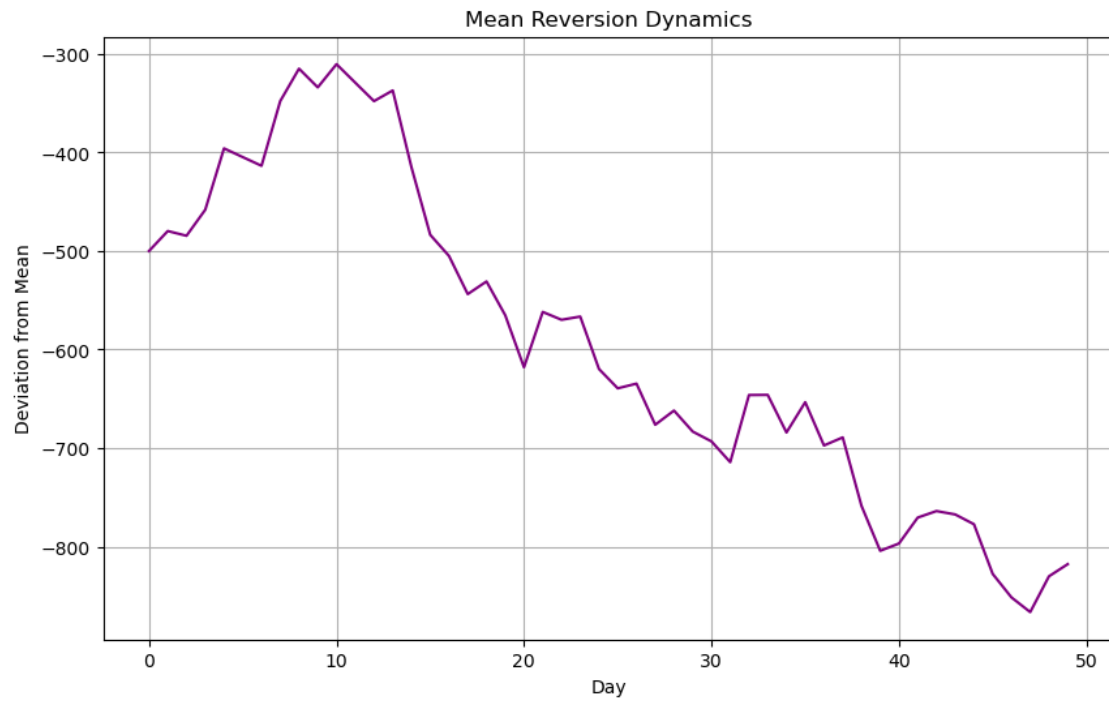
Total LP Fees Table

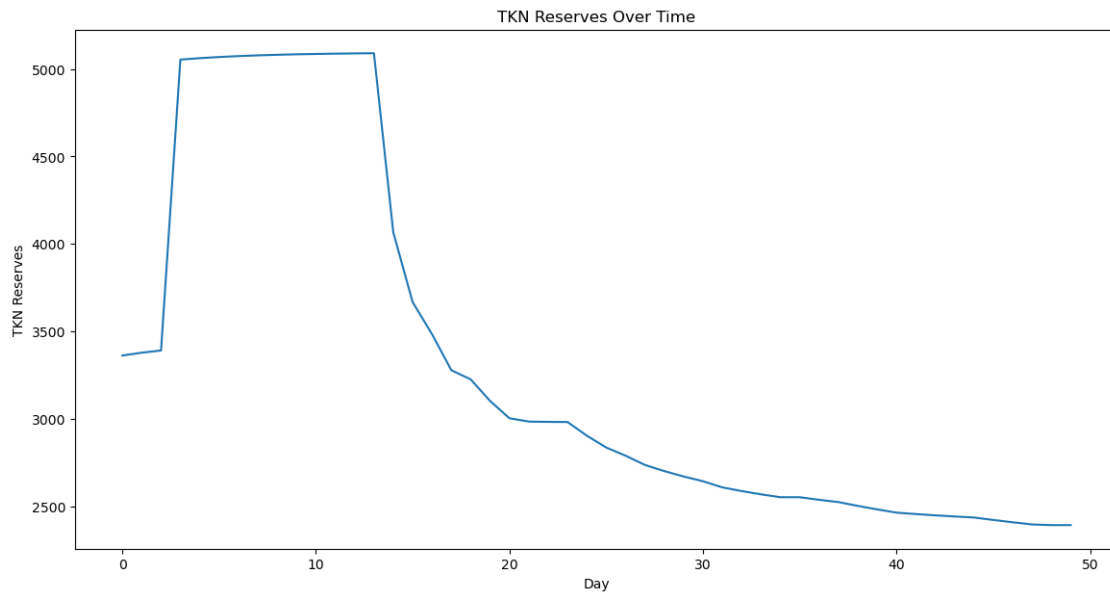
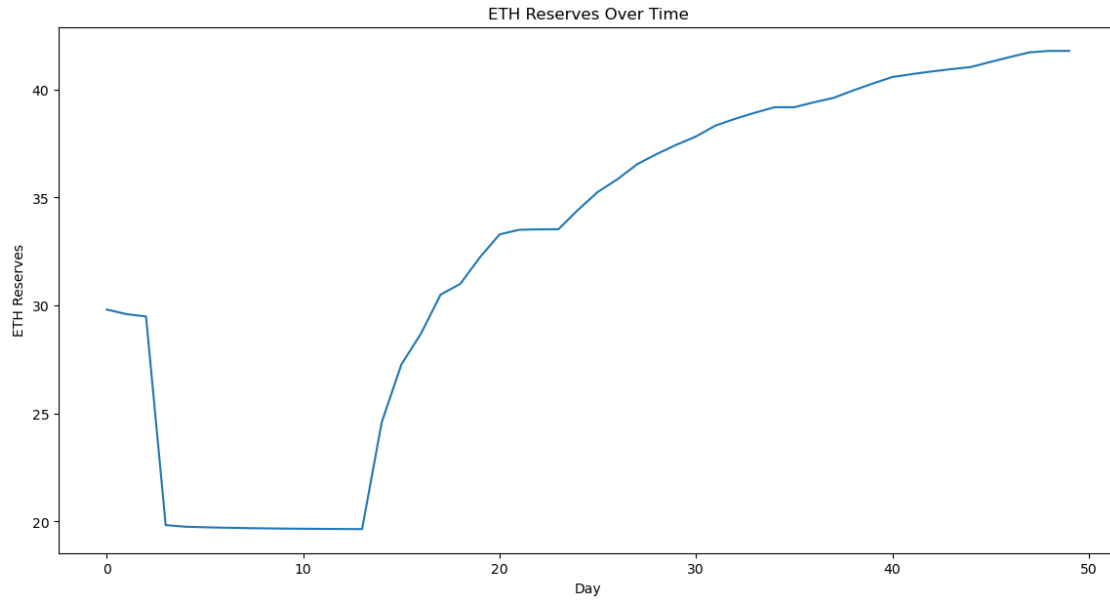
	ETH_Fees	TKN_Fees
Day		
0	0.110972	0.060799
1	0.110972	0.109560
2	0.110972	0.148445
3	0.110972	13.327804
4	0.110972	13.352513

```
C:\Users\merca\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1765:
FutureWarning: unique with argument that is not not a Series, Index,
ExtensionArray, or np.ndarray is deprecated and will raise in a future version.
order = pd.unique(vector)
```

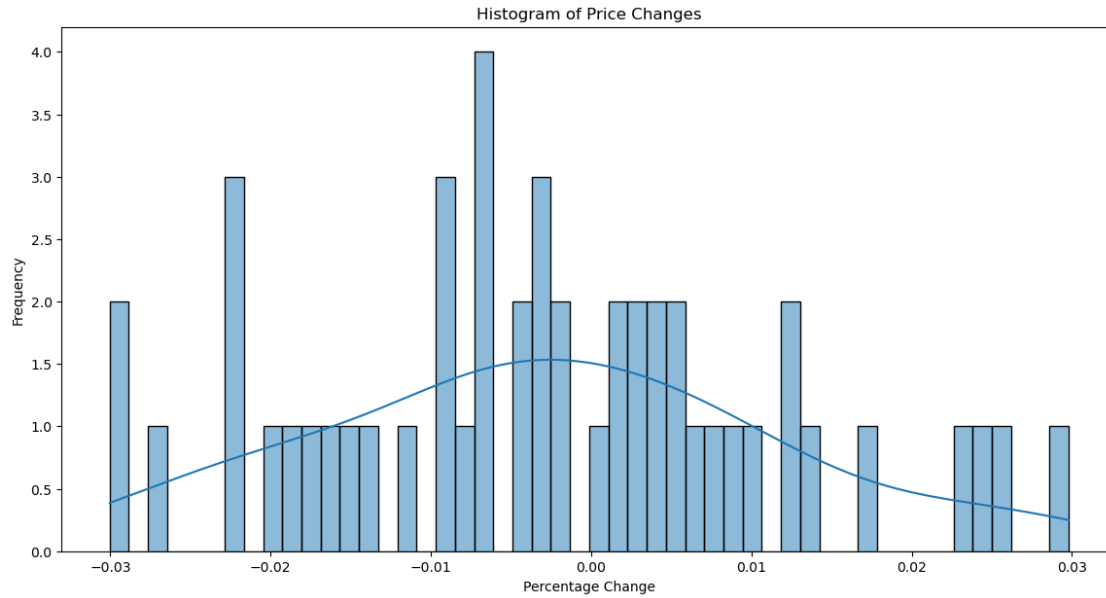




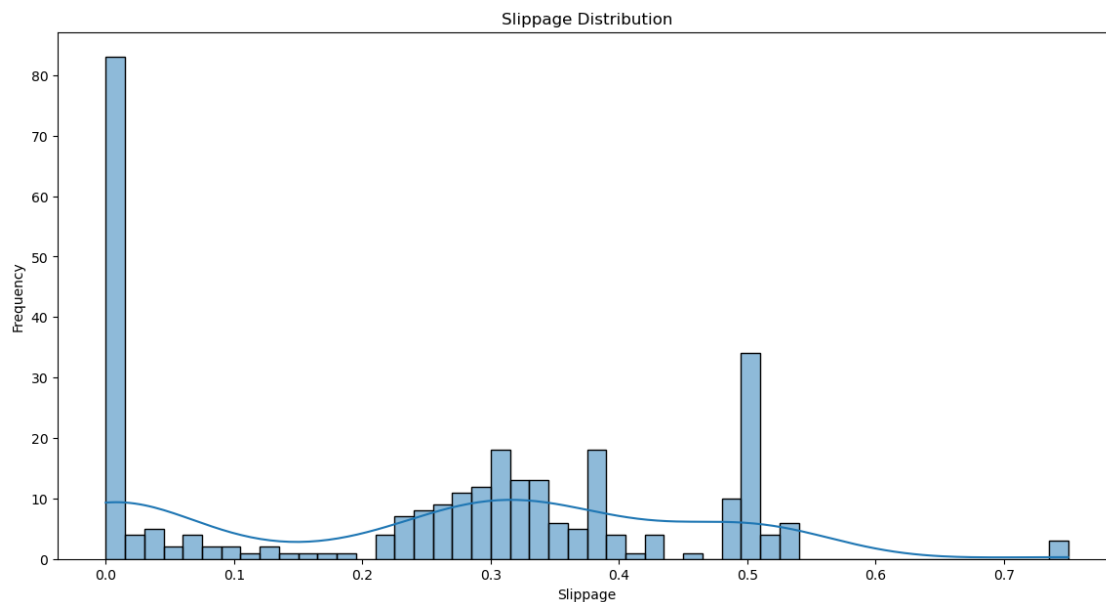




```
C:\Users\merca\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119:
FutureWarning: use_inf_as_na option is deprecated and will be removed in a
future version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
```

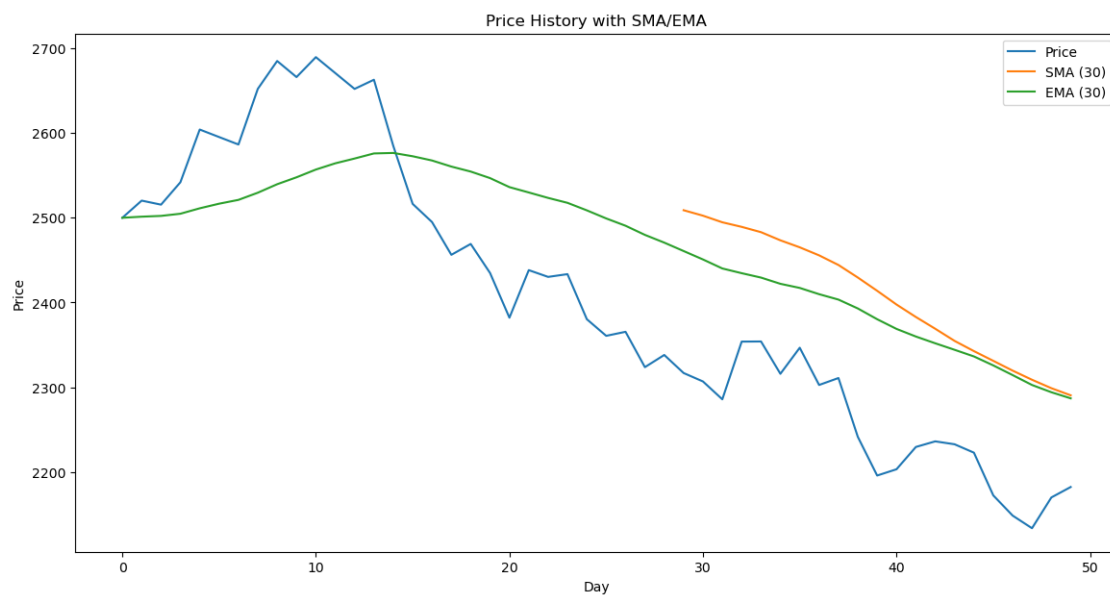
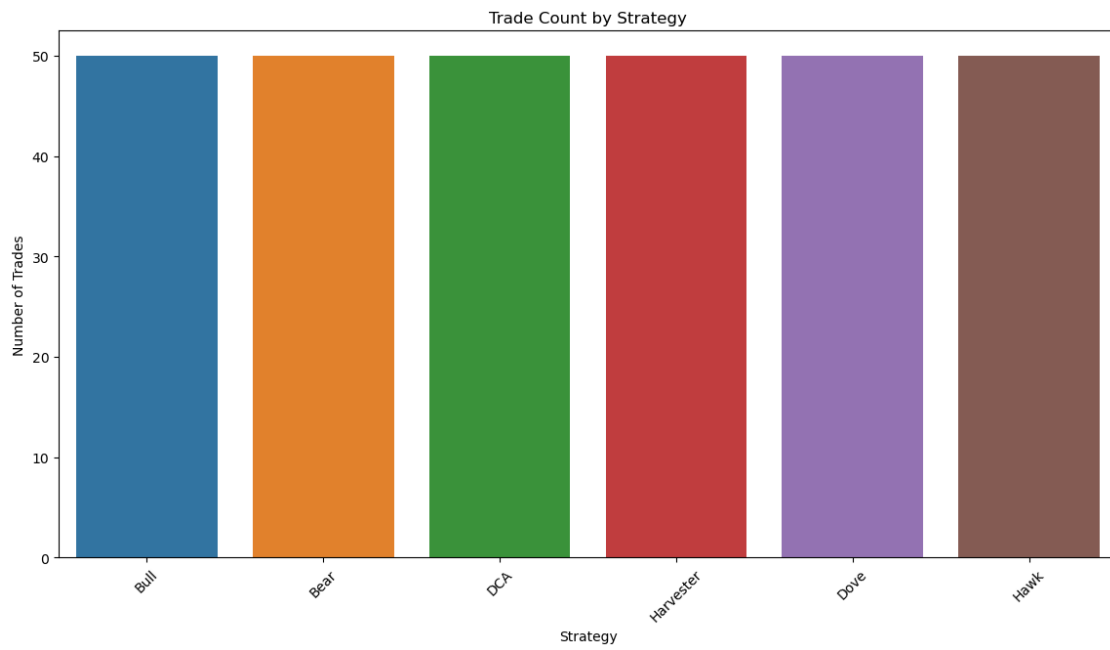


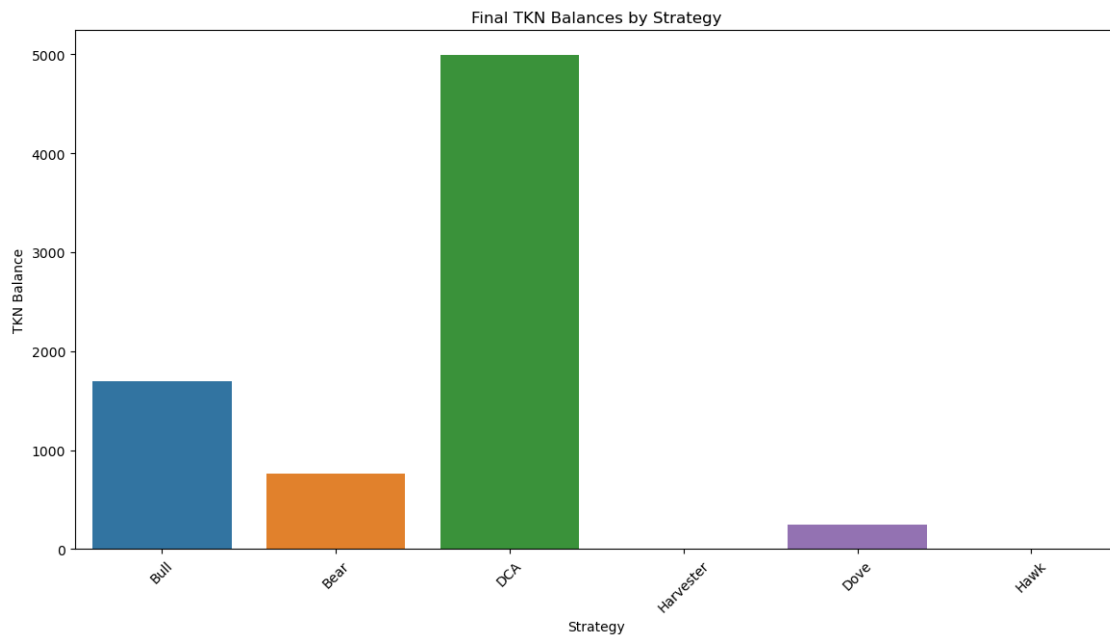
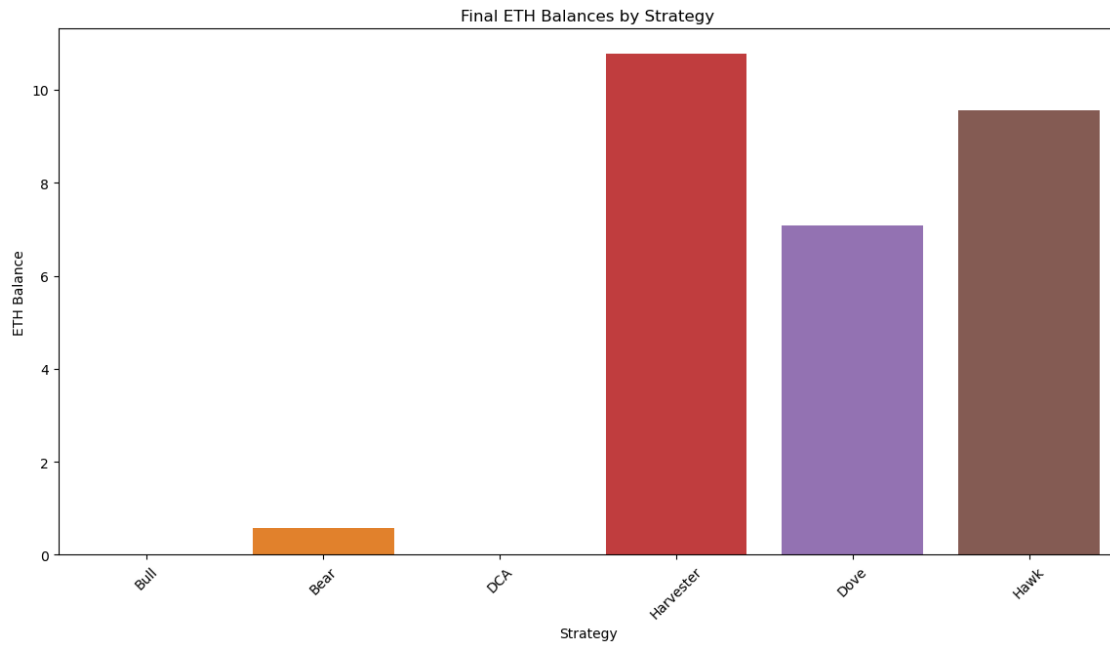
```
C:\Users\merca\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119:
FutureWarning: use_inf_as_na option is deprecated and will be removed in a
future version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
```

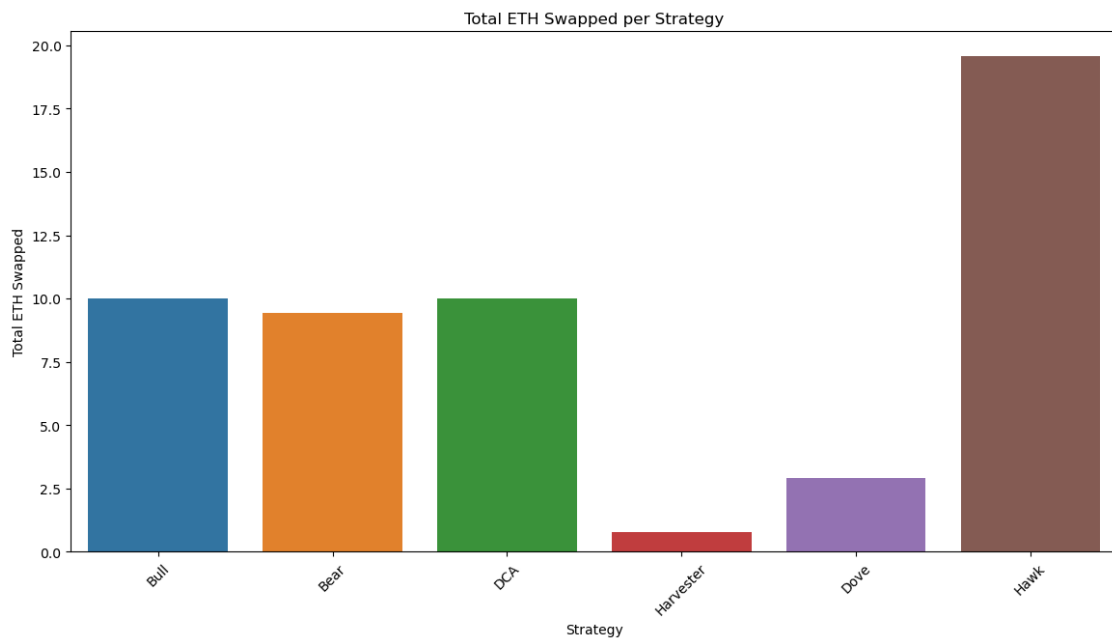
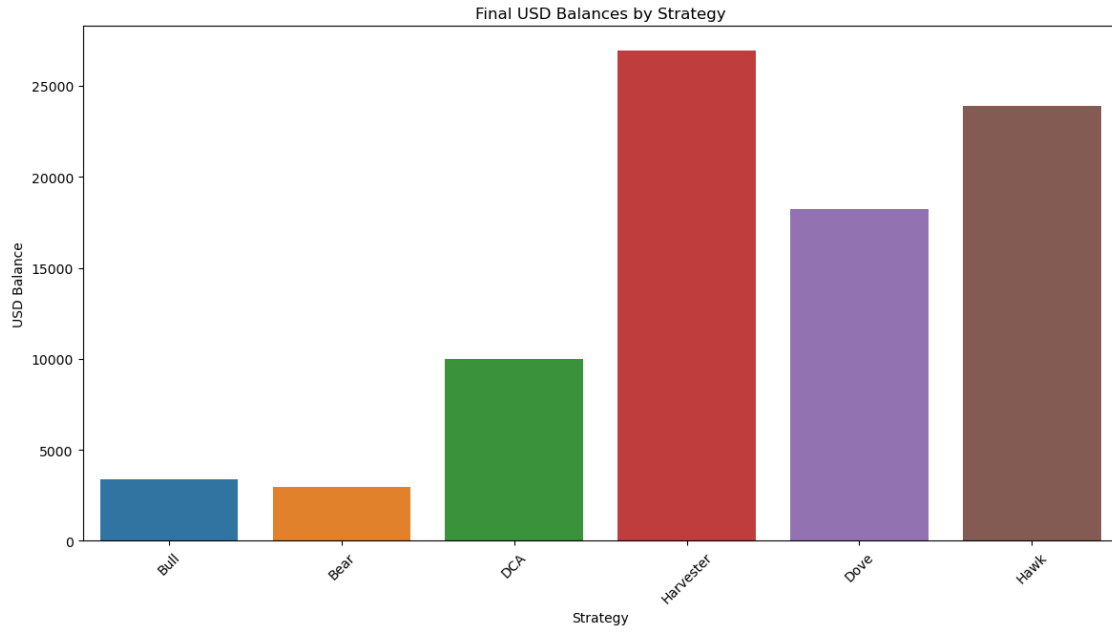


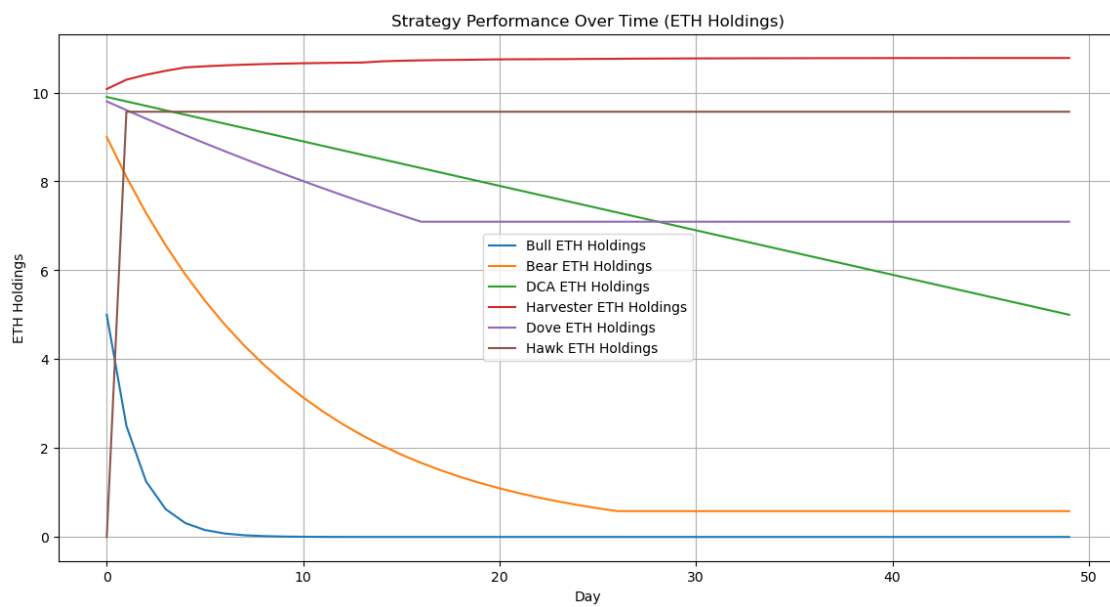
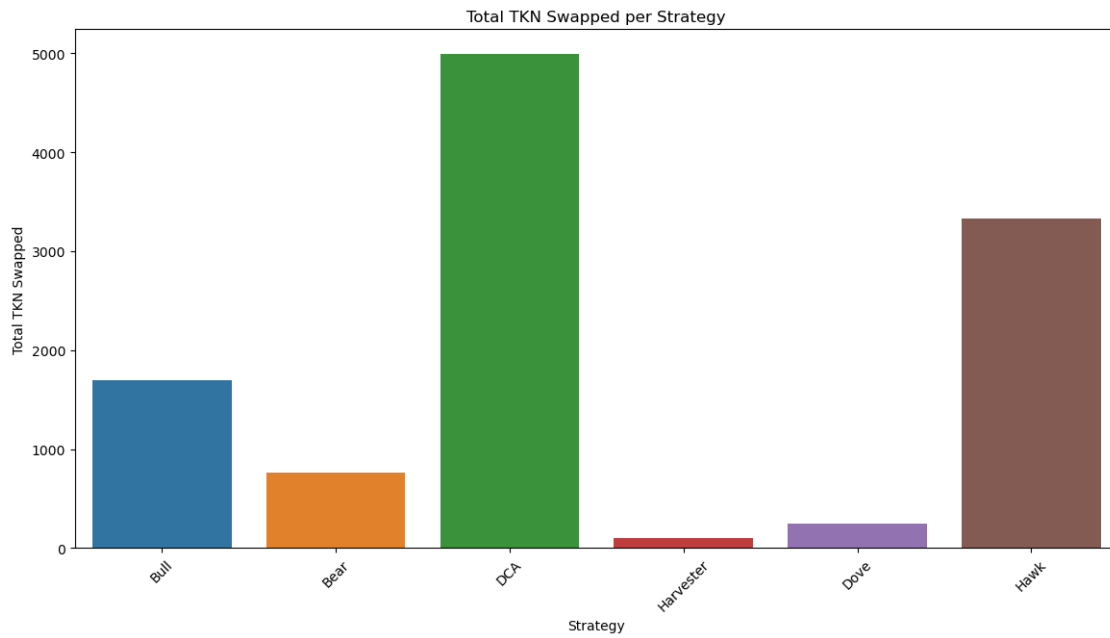
```
C:\Users\merca\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1765:
FutureWarning: unique with argument that is not not a Series, Index,
ExtensionArray, or np.ndarray is deprecated and will raise in a future version.
```

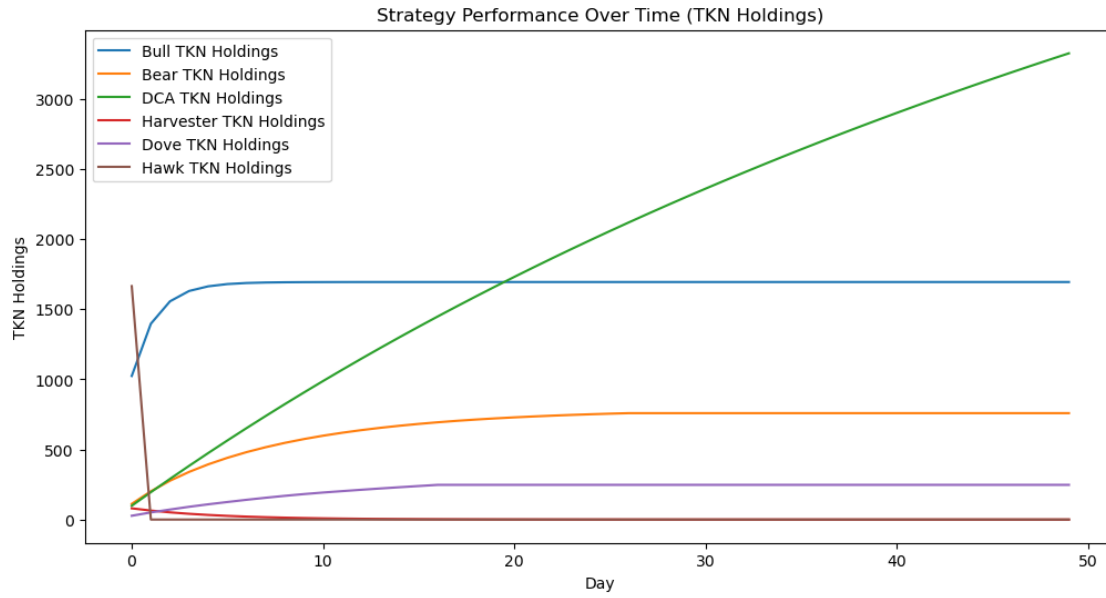
```
order = pd.unique(vector)
```











```
[53]: def run_simulation_and_prepare_data():
    market_conditions = load_json('bull_market.json')
    days = market_conditions['simulation_parameters']['days_of_simulation']
    initial_eth = market_conditions['simulation_parameters']['initial_pool_eth']
    initial_tkn = market_conditions['simulation_parameters']['initial_pool_tkn']
    initial_eth_price =
↪market_conditions['market_conditions']['initial_eth_price']
    initial_tkn_price = 1 # Assuming initial TKN price is set to 1 as it's not
↪in the JSON

    pool = TradingPool(initial_eth, initial_tkn)

    strategies = [
        BullStrategy("Bull", 10, 0, initial_eth_price, initial_tkn_price),
        BearStrategy("Bear", 10, 0, initial_eth_price, initial_tkn_price),
        DcaStrategy("DCA", 10, 0, initial_eth_price, initial_tkn_price,
↪daily_investment=0.1),
        HarvesterStrategy("Harvester", 10, 100, initial_eth_price,
↪initial_tkn_price),
        DoveStrategy("Dove", 10, 0, initial_eth_price, initial_tkn_price),
        HawkStrategy("Hawk", 10, 0, initial_eth_price, initial_tkn_price,
↪target_profit=0.05),
    ]

    # Initialize trade summary dictionary
    trade_summary = {}
```

```

# Run the simulation
eth_price_history, tkn_price_history, trade_counts, eth_reserves_over_time, \
↳ tkn_reserves_over_time, \
    lp_fees_over_time, impermanent_losses, price_impacts, detailed_logs = \
↳ run_simulation(strategies, pool, market_conditions, days)

# Evaluate the results
results = evaluate_simulation(strategies)

# Update trade summary with actual volumes
for strategy in strategies:
    update_total_volume_swapped(trade_summary, strategy.name, strategy.
↳ participant)

# Generate a summary of trades made by each strategy
trade_summary = summarize_trades(strategies)

# Create various tables to summarize the simulation results
price_history_table = create_price_history_table(eth_price_history)
volatility_table = create_volatility_tracking_table(eth_price_history)
mean_reversion_table = create_mean_reversion_table(eth_price_history, \
↳ mean_reversion_level=3000)
final_balances_table = create_corrected_final_balances_table(strategies, \
↳ eth_price_history)
total_volume_swapped_table = create_total_volume_swapped_table(trade_summary)
roi_per_strategy_table = create_roi_per_strategy_table(results)
impermanent_loss_table = create_impermanent_loss_table(impermanent_losses)
total_lp_fees_table = create_total_lp_fees_table(lp_fees_over_time)

return {
    "price_history_table": price_history_table,
    "volatility_table": volatility_table,
    "mean_reversion_table": mean_reversion_table,
    "final_balances_table": final_balances_table,
    "total_volume_swapped_table": total_volume_swapped_table,
    "roi_per_strategy_table": roi_per_strategy_table,
    "impermanent_loss_table": impermanent_loss_table,
    "total_lp_fees_table": total_lp_fees_table,
    "eth_price_history": eth_price_history, # Note this change from \
↳ 'price_history' to 'eth_price_history'
    "tkn_price_history": tkn_price_history,
    "results": results,
    "eth_reserves_over_time": eth_reserves_over_time,
    "tkn_reserves_over_time": tkn_reserves_over_time,
    "impermanent_losses": impermanent_losses,
    "price_impacts": price_impacts,

```



```

    "trade_counts": trade_counts,
    "strategies": strategies,
}

```

```

# Run the simulation and store the results
simulation_data = run_simulation_and_prepare_data()

```

```

Bull Post-Execution ETH Balance: 10, TKN Balance: 0
Bear Post-Execution ETH Balance: 10, TKN Balance: 0
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 20.0 TKN at price 2500
Harvester: Updated TKN balance is 80.0
Harvester Post-Execution ETH Balance: 10.078960121469235, TKN Balance: 80.0
Dove Post-Execution ETH Balance: 10, TKN Balance: 0
Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
Bull Post-Execution ETH Balance: 10, TKN Balance: 0
Bear: Updated TKN balance is 0
Bear Post-Execution ETH Balance: 10, TKN Balance: 0
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 16.0 TKN at price 2513.4434453823783
Harvester: Updated TKN balance is 64.0
Harvester Post-Execution ETH Balance: 10.28815025352171, TKN Balance: 64.0
Dove Post-Execution ETH Balance: 10, TKN Balance: 0
Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
Bull: Actively buying TKN with 5.0 ETH at price 2498.9754748594537
Bull: Updated ETH balance is 5.0
Bull Post-Execution ETH Balance: 5.0, TKN Balance: 484.71328448107346
Bear Post-Execution ETH Balance: 10, TKN Balance: 0
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 12.8 TKN at price 2498.9754748594537
Harvester: Updated TKN balance is 51.2
Harvester Post-Execution ETH Balance: 10.458221691340311, TKN Balance: 51.2
Dove Post-Execution ETH Balance: 10, TKN Balance: 0
Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
Bull: Actively buying TKN with 2.5 ETH at price 2473.230758545399
Bull: Updated ETH balance is 2.5
Bull Post-Execution ETH Balance: 2.5, TKN Balance: 680.3423584402412
Bear Post-Execution ETH Balance: 10, TKN Balance: 0
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
Harvester: Selling 10.24 TKN at price 2473.230758545399
Harvester: Updated TKN balance is 40.96
Harvester Post-Execution ETH Balance: 10.604334106867318, TKN Balance: 40.96
Dove Post-Execution ETH Balance: 10, TKN Balance: 0
Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
Bull Post-Execution ETH Balance: 2.5, TKN Balance: 680.3423584402412
Bear: Updated TKN balance is 0
Bear Post-Execution ETH Balance: 10, TKN Balance: 0
DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

```

Harvester: Selling 8.192 TKN at price 2497.784772445161
 Harvester: Updated TKN balance is 32.768
 Harvester Post-Execution ETH Balance: 10.714424477006188, TKN Balance: 32.768
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 2.5, TKN Balance: 680.3423584402412
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 6.5536 TKN at price 2539.2473420017877
 Harvester: Updated TKN balance is 26.2144
 Harvester Post-Execution ETH Balance: 10.80200527845215, TKN Balance: 26.2144
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Selling 340.17117922 TKN at price 2577.3592196476784 to realize profits
 Bull: Updated ETH balance is 6.515023089073749
 Bull Post-Execution ETH Balance: 6.515023089073749, TKN Balance:
 340.17117922024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 5.24288 TKN at price 2577.3592196476784
 Harvester: Updated TKN balance is 20.97152
 Harvester Post-Execution ETH Balance: 10.869644602206055, TKN Balance: 20.97152
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 6.515023089073749, TKN Balance:
 340.17117922024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 4.194304 TKN at price 2544.3145793278
 Harvester: Updated TKN balance is 16.777216000000003
 Harvester Post-Execution ETH Balance: 10.913746959762635, TKN Balance:
 16.777216000000003
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 6.515023089073749, TKN Balance:
 340.17117922024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 3.3554432 TKN at price 2532.684458951317
 Harvester: Updated TKN balance is 13.421772800000003
 Harvester Post-Execution ETH Balance: 10.948913118863986, TKN Balance:
 13.421772800000003
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683

Bull Post-Execution ETH Balance: 6.515023089073749, TKN Balance:
 340.17117922024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 2.68435456 TKN at price 2546.5907400124656
 Harvester: Updated TKN balance is 10.737418240000004
 Harvester Post-Execution ETH Balance: 10.976991139145984, TKN Balance:
 10.737418240000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Selling 170.08558961 TKN at price 2586.610114276139 to realize profits
 Bull: Updated ETH balance is 8.192918609435573
 Bull Post-Execution ETH Balance: 8.192918609435573, TKN Balance:
 170.08558961024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 2.14748365 TKN at price 2586.610114276139
 Harvester: Updated TKN balance is 8.589934590000004
 Harvester Post-Execution ETH Balance: 11.002153717757423, TKN Balance:
 8.589934590000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 8.192918609435573, TKN Balance:
 170.08558961024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 1.71798692 TKN at price 2567.9240685729974
 Harvester: Updated TKN balance is 6.871947670000004
 Harvester Post-Execution ETH Balance: 11.018274833684437, TKN Balance:
 6.871947670000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 8.192918609435573, TKN Balance:
 170.08558961024124
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 1.37438953 TKN at price 2561.150160872978
 Harvester: Updated TKN balance is 5.497558140000004
 Harvester Post-Execution ETH Balance: 11.031147563777388, TKN Balance:
 5.497558140000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Actively buying TKN with 4.0964593 ETH at price 2517.730614629694
 Bull: Updated ETH balance is 4.096459309435573

Bull Post-Execution ETH Balance: 4.096459309435573, TKN Balance: 552.4770775364897
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 1.09951163 TKN at price 2517.730614629694
 Harvester: Updated TKN balance is 4.398046510000004
 Harvester Post-Execution ETH Balance: 11.058842209116499, TKN Balance: 4.398046510000004
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Actively buying TKN with 2.04822965 ETH at price 2471.5567709338447
 Bull: Updated ETH balance is 2.0482296594355724
 Bull Post-Execution ETH Balance: 2.0482296594355724, TKN Balance: 712.2290261703824
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.8796093 TKN at price 2471.5567709338447
 Harvester: Updated TKN balance is 3.5184372100000036
 Harvester Post-Execution ETH Balance: 11.077159362799955, TKN Balance: 3.5184372100000036
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Actively buying TKN with 1.02411483 ETH at price 2503.978983252638
 Bull: Updated ETH balance is 1.0241148294355724
 Bull Post-Execution ETH Balance: 1.0241148294355724, TKN Balance: 785.7239628773423
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.70368744 TKN at price 2503.978983252638
 Harvester: Updated TKN balance is 2.8147497700000037
 Harvester Post-Execution ETH Balance: 11.090256349785703, TKN Balance: 2.8147497700000037
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 1.0241148294355724, TKN Balance: 785.7239628773423
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.56294995 TKN at price 2558.578131500563
 Harvester: Updated TKN balance is 2.2517998200000036
 Harvester Post-Execution ETH Balance: 11.09825280861014, TKN Balance: 2.2517998200000036
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 1.0241148294355724, TKN Balance: 785.7239628773423
 Bear: Updated TKN balance is 0

Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.45035996 TKN at price 2556.386926622091
 Harvester: Updated TKN balance is 1.8014398600000034
 Harvester Post-Execution ETH Balance: 11.104640103940113, TKN Balance: 1.8014398600000034
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Selling 392.86198144 TKN at price 2597.7016444486167 to realize profits
 Bull: Updated ETH balance is 5.8528435762214
 Bull Post-Execution ETH Balance: 5.8528435762214, TKN Balance: 392.86198143734225
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.36028797 TKN at price 2597.7016444486167
 Harvester: Updated TKN balance is 1.4411518900000035
 Harvester Post-Execution ETH Balance: 11.123914718363599, TKN Balance: 1.4411518900000035
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Selling 196.43099072 TKN at price 2613.21094463096 to realize profits
 Bull: Updated ETH balance is 7.831404859694724
 Bull Post-Execution ETH Balance: 7.831404859694724, TKN Balance: 196.43099071734224
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.28823038 TKN at price 2613.21094463096
 Harvester: Updated TKN balance is 1.1529215100000036
 Harvester Post-Execution ETH Balance: 11.132657223975015, TKN Balance: 1.1529215100000036
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 7.831404859694724, TKN Balance: 196.43099071734224
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.2305843 TKN at price 2587.5812302026898
 Harvester: Updated TKN balance is 0.9223372100000037
 Harvester Post-Execution ETH Balance: 11.134866613175618, TKN Balance: 0.9223372100000037
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull Post-Execution ETH Balance: 7.831404859694724, TKN Balance: 196.43099071734224
 Bear: Updated TKN balance is 0

Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.18446744 TKN at price 2603.0202804876176
 Harvester: Updated TKN balance is 0.7378697700000036
 Harvester Post-Execution ETH Balance: 11.1366195436463, TKN Balance: 0.7378697700000036
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 0, TKN Balance: 1665.2261139495683
 Bull: Selling 98.21549536 TKN at price 2667.382738130305 to realize profits
 Bull: Updated ETH balance is 8.733591944542892
 Bull Post-Execution ETH Balance: 8.733591944542892, TKN Balance: 98.21549535734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.14757395 TKN at price 2667.382738130305
 Harvester: Updated TKN balance is 0.5902958200000037
 Harvester Post-Execution ETH Balance: 11.140650329300877, TKN Balance: 0.5902958200000037
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2667.382738130305 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Selling 49.10774768 TKN at price 2666.6130596777134 to realize profits
 Bull: Updated ETH balance is 8.973700831639889
 Bull Post-Execution ETH Balance: 8.973700831639889, TKN Balance: 49.10774767734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.11805916 TKN at price 2666.6130596777134
 Harvester: Updated TKN balance is 0.4722366600000037
 Harvester Post-Execution ETH Balance: 11.1418374734447, TKN Balance: 0.4722366600000037
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2666.6130596777134 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Selling 24.55387384 TKN at price 2733.689823651925 to realize profits
 Bull: Updated ETH balance is 9.069337725013353
 Bull Post-Execution ETH Balance: 9.069337725013353, TKN Balance: 24.55387383734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.09444733 TKN at price 2733.689823651925
 Harvester: Updated TKN balance is 0.3777893300000037
 Harvester Post-Execution ETH Balance: 11.142490496677222, TKN Balance: 0.3777893300000037
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0

Hawk: Selling all TKN at price 2733.689823651925 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 9.069337725013353, TKN Balance:
 24.55387383734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.07555787 TKN at price 2624.2342395809787
 Harvester: Updated TKN balance is 0.30223146000000367
 Harvester Post-Execution ETH Balance: 11.142785317903607, TKN Balance:
 0.30223146000000367
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 9.069337725013353, TKN Balance:
 24.55387383734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.06044629 TKN at price 2659.0507835489007
 Harvester: Updated TKN balance is 0.24178517000000366
 Harvester Post-Execution ETH Balance: 11.143020485760683, TKN Balance:
 0.24178517000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2659.0507835489007 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 9.069337725013353, TKN Balance:
 24.55387383734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.04835703 TKN at price 2663.4174636308485
 Harvester: Updated TKN balance is 0.19342814000000366
 Harvester Post-Execution ETH Balance: 11.1432086139609, TKN Balance:
 0.19342814000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2663.4174636308485 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 9.069337725013353, TKN Balance:
 24.55387383734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.03868563 TKN at price 2651.6678080273728
 Harvester: Updated TKN balance is 0.15474251000000366
 Harvester Post-Execution ETH Balance: 11.143359113959605, TKN Balance:
 0.15474251000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2651.6678080273728 after reaching profit target

Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 9.069337725013353, TKN Balance:
 24.55387383734223
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0309485 TKN at price 2656.2189646438674
 Harvester: Updated TKN balance is 0.12379401000000366
 Harvester Post-Execution ETH Balance: 11.14347951229288, TKN Balance:
 0.12379401000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2656.2189646438674 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 4.53466886 ETH at price 2575.3035451898427
 Bull: Updated ETH balance is 4.534668865013353
 Bull Post-Execution ETH Balance: 4.534668865013353, TKN Balance:
 963.0659320300429
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0247588 TKN at price 2575.3035451898427
 Harvester: Updated TKN balance is 0.09903521000000366
 Harvester Post-Execution ETH Balance: 11.162546139901538, TKN Balance:
 0.09903521000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 2.26733443 ETH at price 2567.1387086984787
 Bull: Updated ETH balance is 2.2673344350133533
 Bull Post-Execution ETH Balance: 2.2673344350133533, TKN Balance:
 1313.6623619219138
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.01980704 TKN at price 2567.1387086984787
 Harvester: Updated TKN balance is 0.07922817000000366
 Harvester Post-Execution ETH Balance: 11.170263124200286, TKN Balance:
 0.07922817000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 1.13366722 ETH at price 2582.282108798289
 Bull: Updated ETH balance is 1.1336672150133533
 Bull Post-Execution ETH Balance: 1.1336672150133533, TKN Balance:
 1467.635749863661
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.01584563 TKN at price 2582.282108798289
 Harvester: Updated TKN balance is 0.06338254000000366
 Harvester Post-Execution ETH Balance: 11.173926736602874, TKN Balance:
 0.06338254000000366

Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 1.1336672150133533, TKN Balance: 1467.635749863661
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.01267651 TKN at price 2643.633963035625
 Harvester: Updated TKN balance is 0.05070603000000366
 Harvester Post-Execution ETH Balance: 11.174033813085863, TKN Balance: 0.05070603000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2643.633963035625 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.56683361 ETH at price 2622.9252261517922
 Bull: Updated ETH balance is 0.5668336050133533
 Bull Post-Execution ETH Balance: 0.5668336050133533, TKN Balance: 1540.0280215840705
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.01014121 TKN at price 2622.9252261517922
 Harvester: Updated TKN balance is 0.040564820000003665
 Harvester Post-Execution ETH Balance: 11.175840653863945, TKN Balance: 0.040564820000003665
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.2834168 ETH at price 2590.5458834015403
 Bull: Updated ETH balance is 0.2834168050133533
 Bull Post-Execution ETH Balance: 0.2834168050133533, TKN Balance: 1575.1552260094702
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00811296 TKN at price 2590.5458834015403
 Harvester: Updated TKN balance is 0.03245186000000366
 Harvester Post-Execution ETH Balance: 11.176759789187663, TKN Balance: 0.03245186000000366
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.1417084 ETH at price 2570.9195660226196
 Bull: Updated ETH balance is 0.1417084050133533
 Bull Post-Execution ETH Balance: 0.1417084050133533, TKN Balance: 1592.4605840994516
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00649037 TKN at price 2570.9195660226196
 Harvester: Updated TKN balance is 0.025961490000003664
 Harvester Post-Execution ETH Balance: 11.177237251181921, TKN Balance:

0.025961490000003664
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.0708542 ETH at price 2608.856274577046
 Bull: Updated ETH balance is 0.0708542050133533
 Bull Post-Execution ETH Balance: 0.0708542050133533, TKN Balance:
 1601.0498182354256
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0051923 TKN at price 2608.856274577046
 Harvester: Updated TKN balance is 0.020769190000003664
 Harvester Post-Execution ETH Balance: 11.177491488238779, TKN Balance:
 0.020769190000003664
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 0.0708542050133533, TKN Balance:
 1601.0498182354256
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00415384 TKN at price 2623.0773111735193
 Harvester: Updated TKN balance is 0.016615350000003665
 Harvester Post-Execution ETH Balance: 11.177526190239133, TKN Balance:
 0.016615350000003665
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.0354271 ETH at price 2602.0600870624376
 Bull: Updated ETH balance is 0.03542710501335329
 Bull Post-Execution ETH Balance: 0.03542710501335329, TKN Balance:
 1605.32864792767
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00332307 TKN at price 2602.0600870624376
 Harvester: Updated TKN balance is 0.013292280000003664
 Harvester Post-Execution ETH Balance: 11.177659182197718, TKN Balance:
 0.013292280000003664
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 0.03542710501335329, TKN Balance:
 1605.32864792767
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00265846 TKN at price 2623.835395306057
 Harvester: Updated TKN balance is 0.010633820000003664
 Harvester Post-Execution ETH Balance: 11.177681355644625, TKN Balance:

0.010633820000003664
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 0.03542710501335329, TKN Balance:
 1605.32864792767
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00212676 TKN at price 2628.5582254485107
 Harvester: Updated TKN balance is 0.008507060000003664
 Harvester Post-Execution ETH Balance: 11.17769884165163, TKN Balance:
 0.008507060000003664
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2628.5582254485107 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Selling 802.66432396 TKN at price 2669.576442442426 to realize profits
 Bull: Updated ETH balance is 5.369276356017967
 Bull Post-Execution ETH Balance: 5.369276356017967, TKN Balance: 802.66432396767
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00170141 TKN at price 2669.576442442426
 Harvester: Updated TKN balance is 0.006805650000003664
 Harvester Post-Execution ETH Balance: 11.1960132679459, TKN Balance:
 0.006805650000003664
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2669.576442442426 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 5.369276356017967, TKN Balance: 802.66432396767
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.00136113 TKN at price 2641.031749761066
 Harvester: Updated TKN balance is 0.005444520000003663
 Harvester Post-Execution ETH Balance: 11.196075590012956, TKN Balance:
 0.005444520000003663
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk: Selling all TKN at price 2641.031749761066 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull Post-Execution ETH Balance: 5.369276356017967, TKN Balance: 802.66432396767
 Bear: Updated TKN balance is 0
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester: Selling 0.0010889 TKN at price 2628.1980033763607
 Harvester: Updated TKN balance is 0.004355620000003663
 Harvester Post-Execution ETH Balance: 11.1960816799266, TKN Balance:
 0.004355620000003663
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0

Hawk: Selling all TKN at price 2628.1980033763607 after reaching profit target
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 2.68463818 ETH at price 2612.781206917272
 Bull: Updated ETH balance is 2.6846381760179674
 Bull Post-Execution ETH Balance: 2.6846381760179674, TKN Balance:
 1241.1548993283498
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 11.1960816799266, TKN Balance:
 0.004355620000003663
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 1.34231909 ETH at price 2554.1208158801037
 Bull: Updated ETH balance is 1.3423190860179675
 Bull Post-Execution ETH Balance: 1.3423190860179675, TKN Balance:
 1429.7661388815077
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 11.1960816799266, TKN Balance:
 0.004355620000003663
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.67115954 ETH at price 2566.7279763013807
 Bull: Updated ETH balance is 0.6711595460179675
 Bull Post-Execution ETH Balance: 0.6711595460179675, TKN Balance:
 1517.2834396358837
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 11.1960816799266, TKN Balance:
 0.004355620000003663
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.33557977 ETH at price 2577.9774995719167
 Bull: Updated ETH balance is 0.33557977601796746
 Bull Post-Execution ETH Balance: 0.33557977601796746, TKN Balance:
 1559.4872938401868
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055
 Harvester Post-Execution ETH Balance: 11.1960816799266, TKN Balance:
 0.004355620000003663
 Dove Post-Execution ETH Balance: 10, TKN Balance: 0
 Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0
 Bull: Actively buying TKN with 0.16778989 ETH at price 2578.890955703066
 Bull: Updated ETH balance is 0.16778988601796746
 Bull Post-Execution ETH Balance: 0.16778988601796746, TKN Balance:
 1580.21682554204
 Bear Post-Execution ETH Balance: 10, TKN Balance: 0
 DCA Post-Execution ETH Balance: 0.0, TKN Balance: 4992.313915535055

Harvester Post-Execution ETH Balance: 11.1960816799266, TKN Balance: 0.004355620000003663

Dove Post-Execution ETH Balance: 10, TKN Balance: 0

Hawk Post-Execution ETH Balance: 9.869014294035463, TKN Balance: 0.0

Strategy: Bull

Final ETH Balance: 0.16778988601796746

Final TKN Balance: 1580.21682554204

Final USD Balance: 3579.9083661289988

ROI: -85.68036653548401

Strategy: Bear

Final ETH Balance: 10

Final TKN Balance: 0

Final USD Balance: 25000

ROI: 0.0

Strategy: DCA

Final ETH Balance: 0.0

Final TKN Balance: 4992.313915535055

Final USD Balance: 9984.62783107011

ROI: -60.061488675719566

Strategy: Harvester

Final ETH Balance: 11.1960816799266

Final TKN Balance: 0.004355620000003663

Final USD Balance: 27990.2129110565

ROI: 11.514792474328686

Strategy: Dove

Final ETH Balance: 10

Final TKN Balance: 0

Final USD Balance: 25000

ROI: 0.0

Strategy: Hawk

Final ETH Balance: 9.869014294035463

Final TKN Balance: 0.0

Final USD Balance: 24672.535735088655

ROI: -1.3098570596453791

Final Balances DataFrame:

	Strategy	Final_ETH_Balance	Final_TKN_Balance	Final_USD_Balance \
0	Bull	0.167790	1580.216826	3579.908366
1	Bear	10.000000	0.000000	25000.000000
2	DCA	0.000000	4992.313916	9984.627831
3	Harvester	11.196082	0.004356	27990.212911
4	Dove	10.000000	0.000000	25000.000000
5	Hawk	9.869014	0.000000	24672.535735

	ROI	Sharpe_Ratio
0	-85.680367	0.043164
1	0.000000	0.043218
2	-60.061489	-0.049172
3	11.514792	0.043218

```
4  0.000000      0.043218
5 -1.309857      0.043218
```

```
[54]: # Display the Price History Table
display(simulation_data['price_history_table'].head())
```

```
      Day      Price
0      0  2500.000000
1      1  2513.443445
2      2  2498.975475
3      3  2473.230759
4      4  2497.784772
```

```
[55]: # Display the Volatility Tracking Table
display(simulation_data['volatility_table'].head())
```

```
      Day  Volatility
0      0   0.000000
1      1   0.000000
2      2   0.150407
3      3   0.154122
4      4   0.180103
```

```
[56]: # Display the Mean Reversion Table
display(simulation_data['mean_reversion_table'].head())
```

```
      Day      Price  Deviation_from_Mean
0      0  2500.000000          -500.000000
1      1  2513.443445          -486.556555
2      2  2498.975475          -501.024525
3      3  2473.230759          -526.769241
4      4  2497.784772          -502.215228
```

```
[57]: # Display the Final Balances Table
display(simulation_data['final_balances_table'].head())
```

```
      Strategy  Final_ETH_Balance  Final_TKN_Balance  Final_USD_Balance  \
0      Bull          0.167790          1580.216826          3579.908366
1      Bear          10.000000           0.000000          25000.000000
2      DCA           0.000000          4992.313916          9984.627831
3  Harvester          11.196082           0.004356          27990.212911
4      Dove          10.000000           0.000000          25000.000000
```

```
      ROI  Sharpe_Ratio
0 -85.680367      0.043164
1   0.000000      0.043218
2 -60.061489     -0.049172
3  11.514792      0.043218
4   0.000000      0.043218
```

```
[58]: # Display the Total Volume Swapped Table
display(simulation_data['total_volume_swapped_table'].head())
```

	ETH Swapped	TKN Swapped
Strategy		
Bull	47.976192	5728.399189
Bear	0.000000	0.000000
DCA	10.000000	4992.313916
Harvester	1.196082	99.995644
Dove	0.000000	0.000000

```
[59]: # Display the ROI per Strategy Table
display(simulation_data['roi_per_strategy_table'].head())
```

	Strategy	ROI
0	Bull	-85.680367
1	Bear	0.000000
2	DCA	-60.061489
3	Harvester	11.514792
4	Dove	0.000000

```
[60]: # Display the Impermanent Loss Table
display(simulation_data['impermanent_loss_table'].head())
```

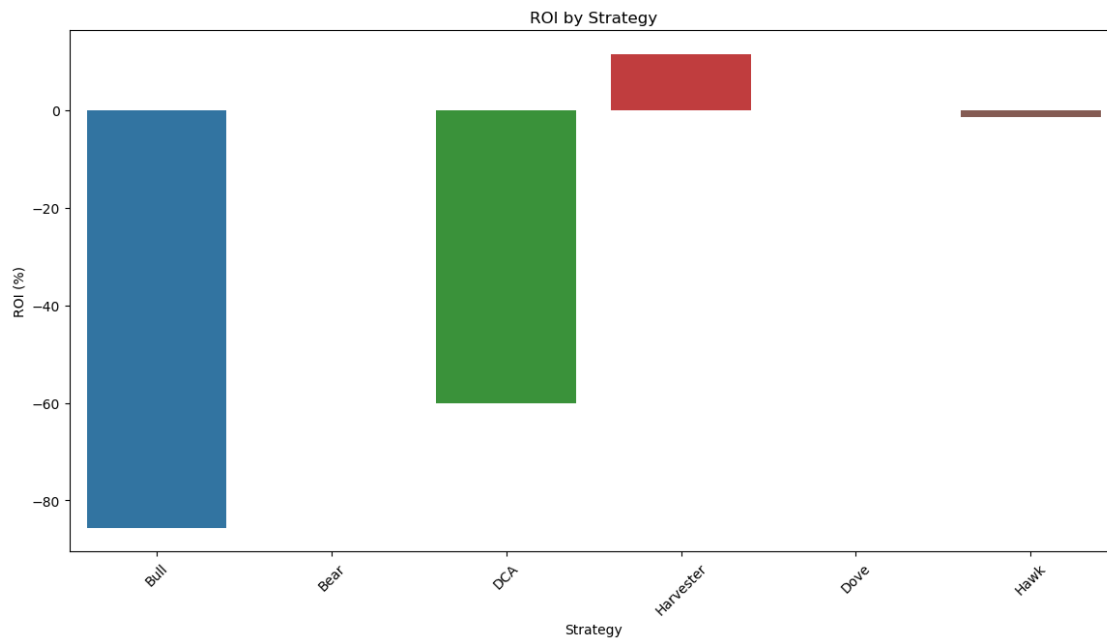
	Day	Impermanent_Loss
0	0	99.999881
1	1	99.999882
2	2	99.999862
3	3	99.999851
4	4	99.999853

```
[61]: # Display the Total LP Fees Table
display(simulation_data['total_lp_fees_table'].head())
```

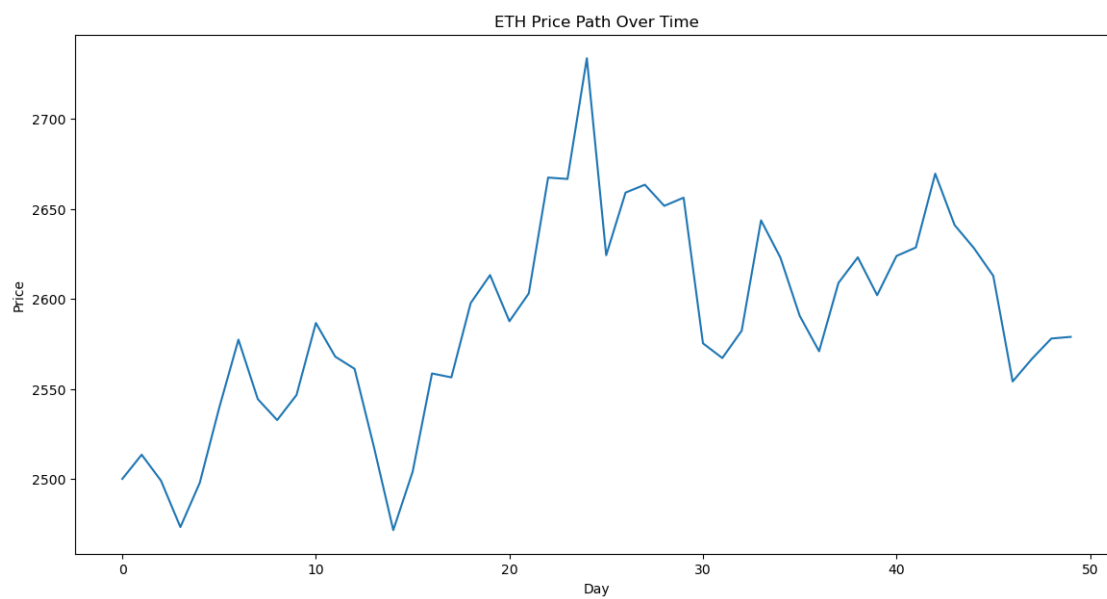
	ETH_Fees	TKN_Fees
Day		
0	0.110972	0.060799
1	0.110972	0.109560
2	0.134418	0.148526
3	0.143734	0.179633
4	0.143734	0.204456

```
[62]: # Plot ROI by Strategy
plot_roi_by_strategy(simulation_data['results'])
```

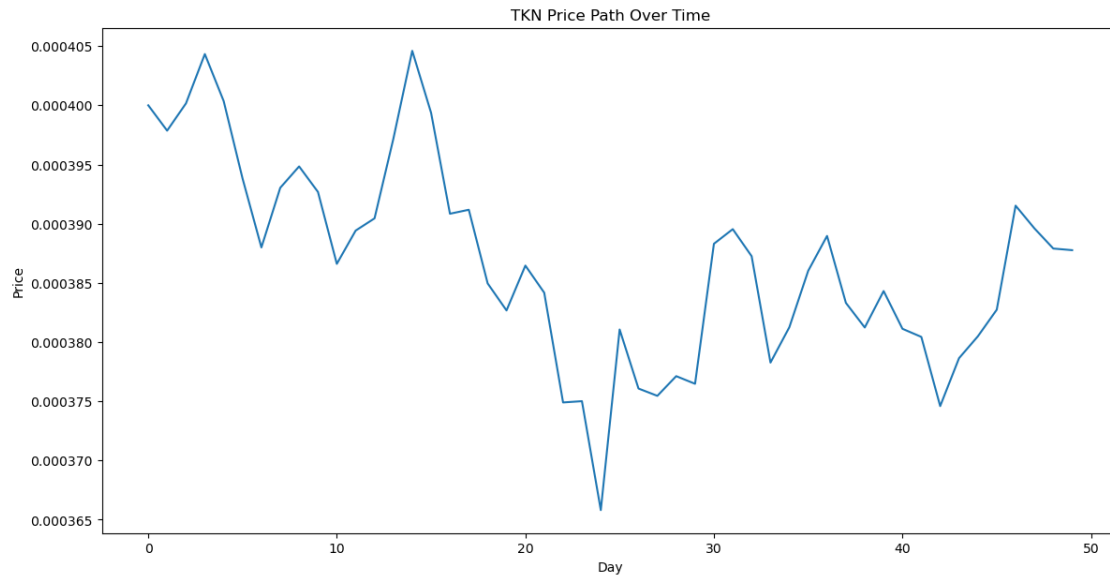
```
C:\Users\merca\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1765:
FutureWarning: unique with argument that is not not a Series, Index,
ExtensionArray, or np.ndarray is deprecated and will raise in a future version.
order = pd.unique(vector)
```



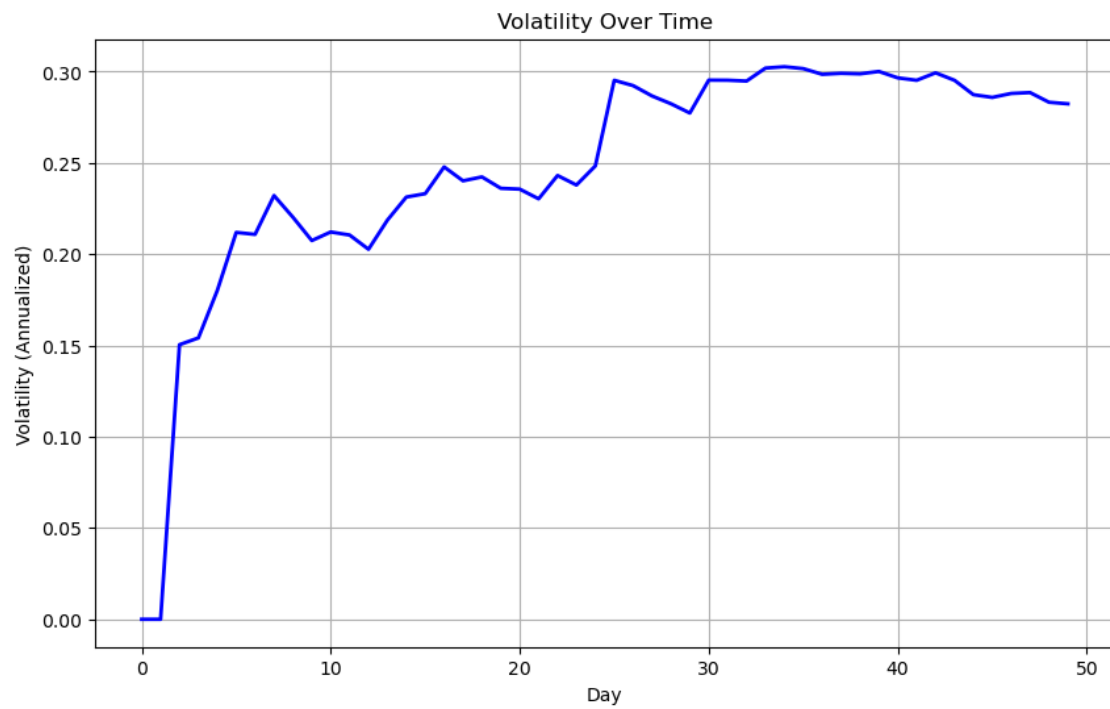
```
[63]: plot_price_path(simulation_data['eth_price_history'])
```



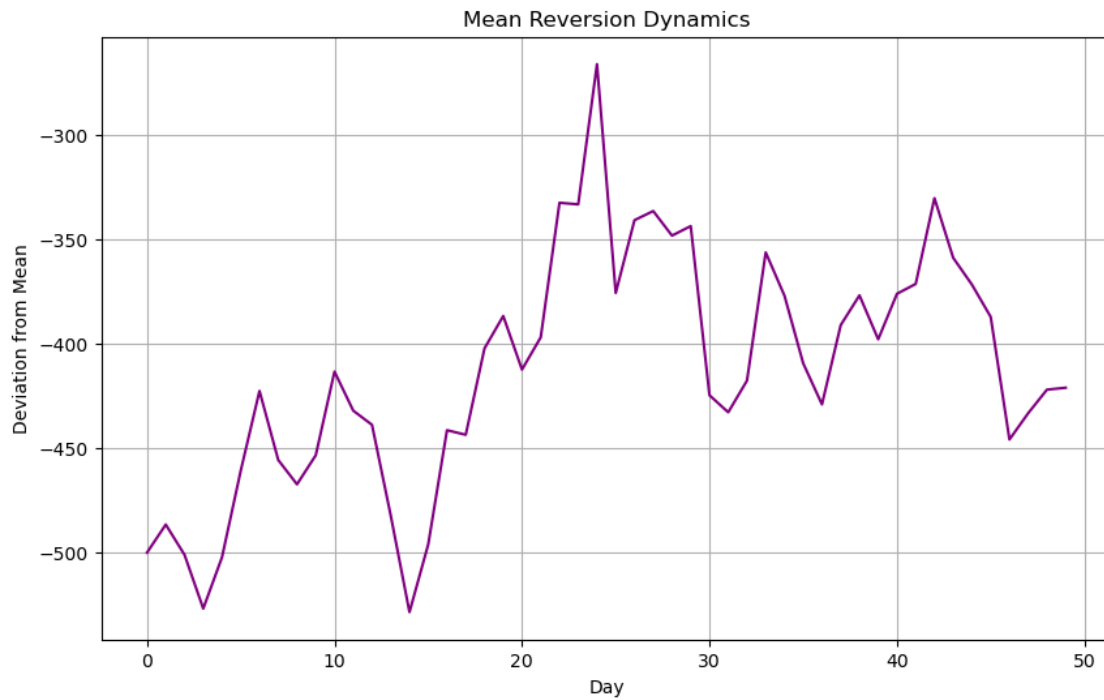
```
[64]: plot_tkn_price_path(simulation_data['tkn_price_history'])
```

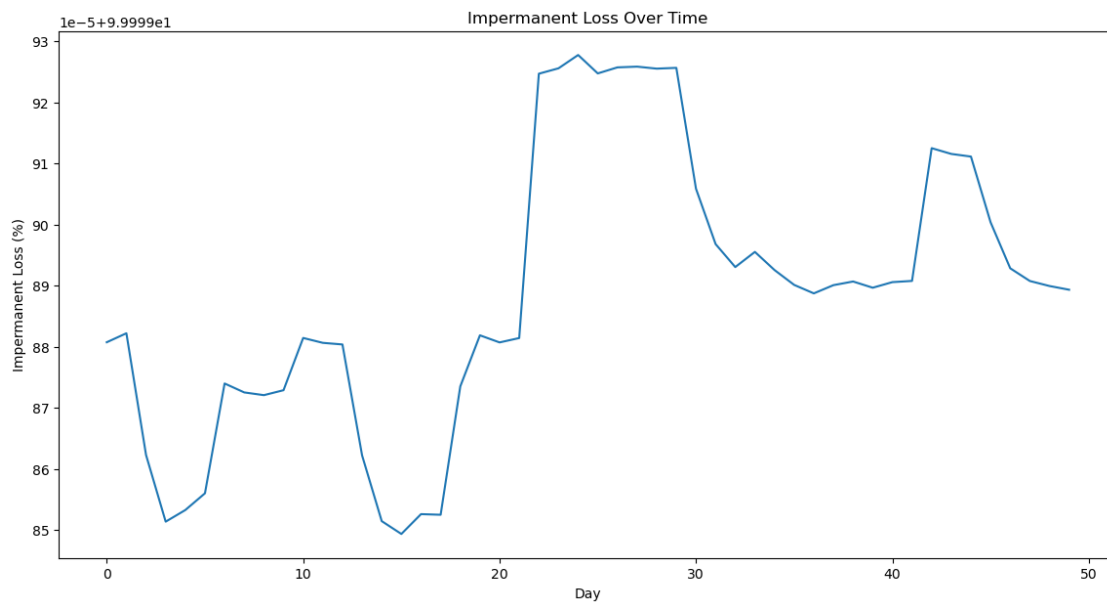
```
[65]: # Plot Volatility Over Time
      plot_volatility_over_time(simulation_data['volatility_table'])
```



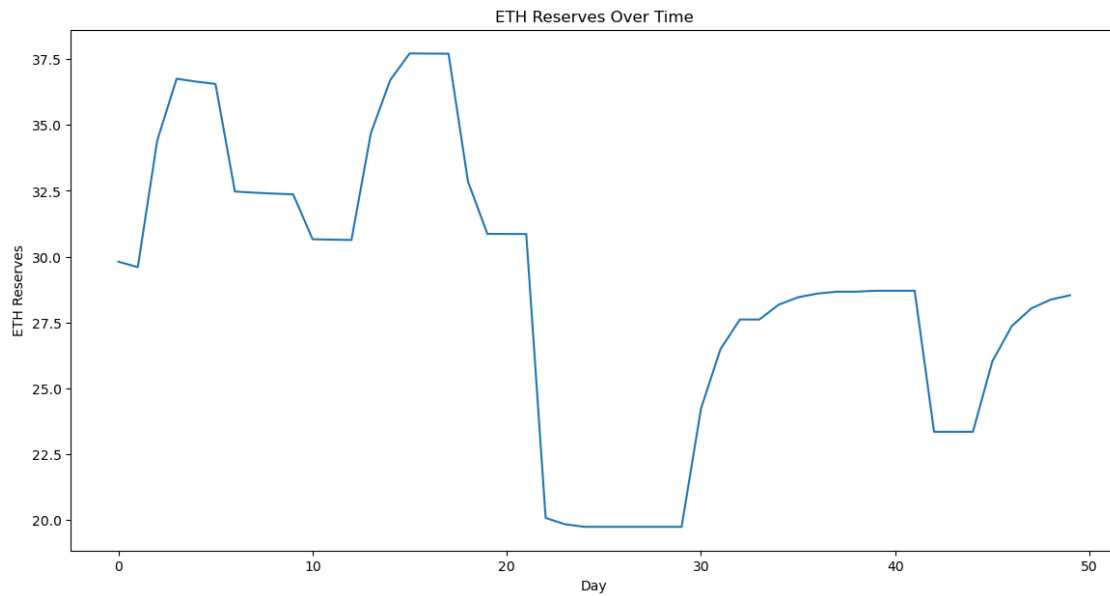
```
[66]: # Plot Mean Reversion Dynamics
plot_mean_reversion(simulation_data['eth_price_history'],
                    mean_reversion_level=3000)
```



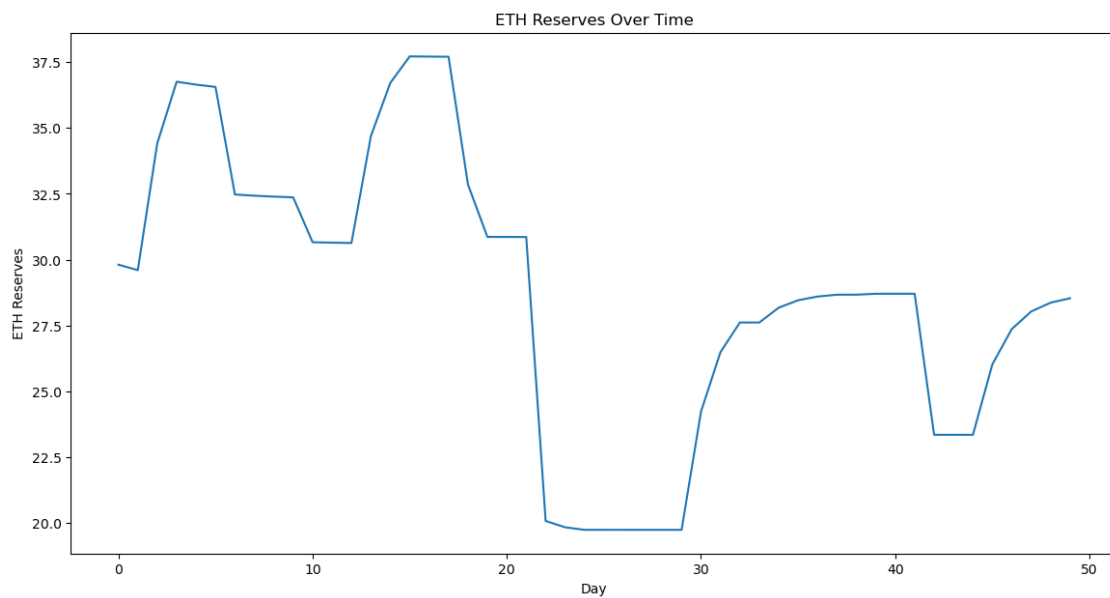
```
[67]: # Plot Impermanent Loss Over Time
plot_impermanent_loss_over_time(simulation_data['impermanent_losses'])
```



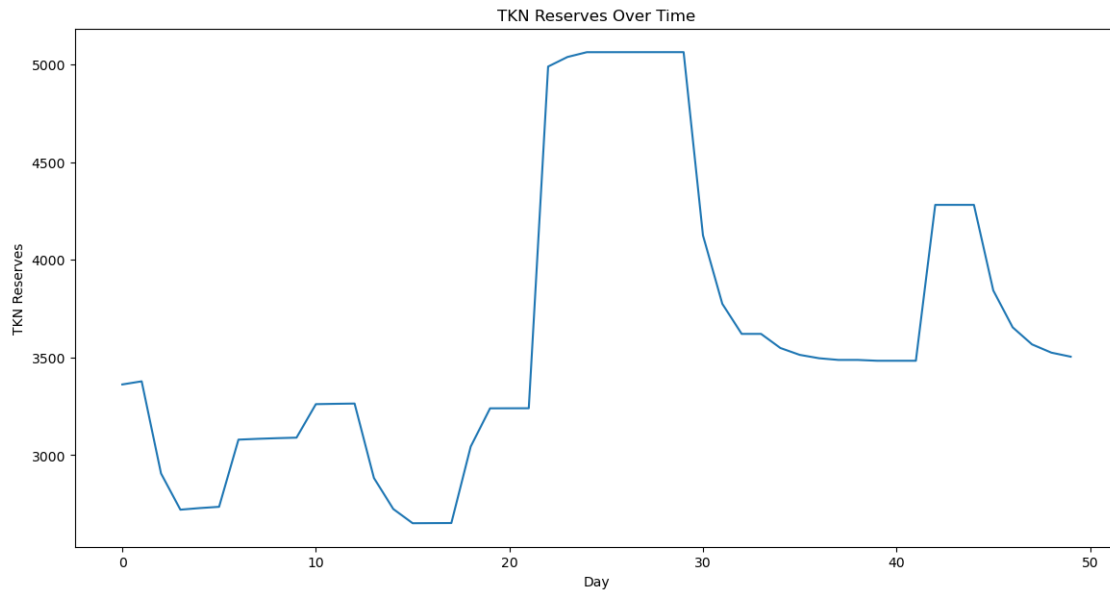
```
[68]: # Plot ETH Reserves Over Time
plot_eth_reserves_over_time(simulation_data['eth_reserves_over_time'])
```



```
[69]: # Plot ETH Reserves Over Time
plot_eth_reserves_over_time(simulation_data['eth_reserves_over_time'])
```

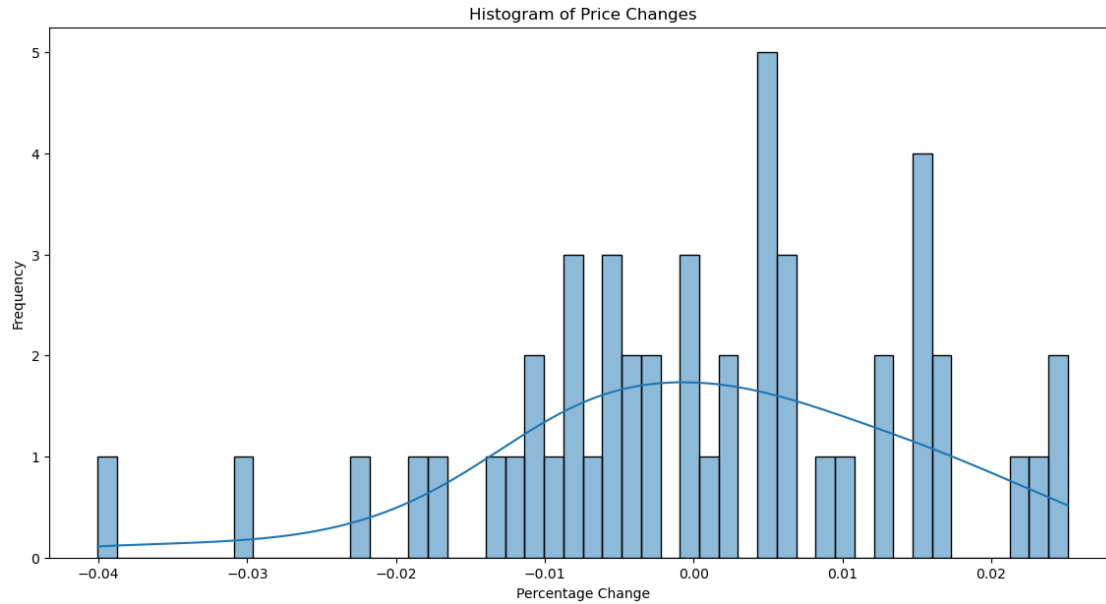


```
[70]: # Plot TKN Reserves Over Time
plot_tkn_reserves_over_time(simulation_data['tkn_reserves_over_time'])
```



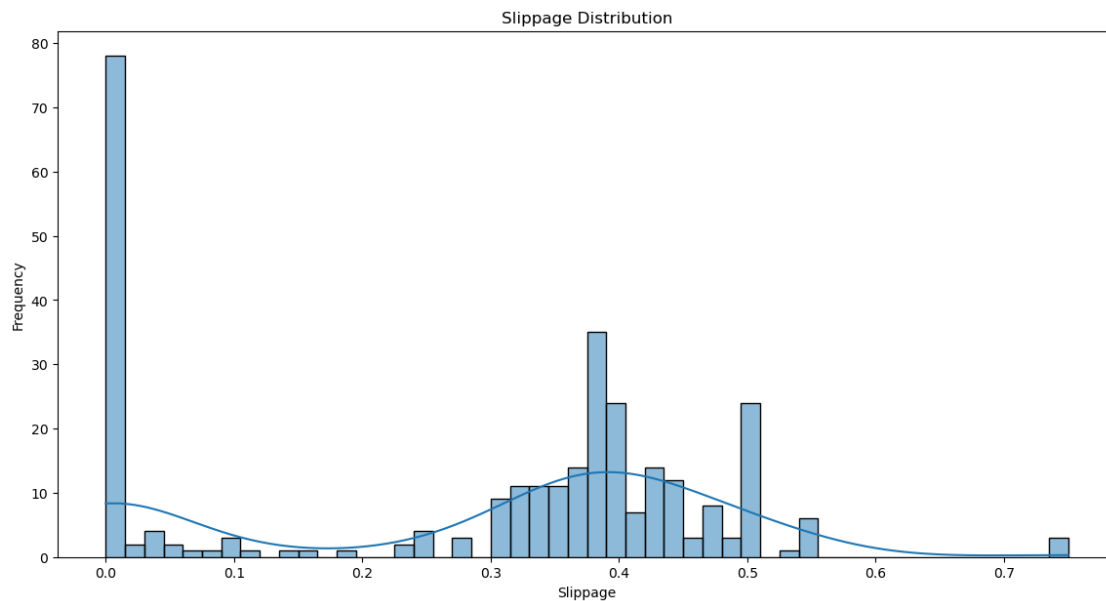
```
[71]: # Additional Visualizations
# Additional Visualizations
plot_histogram_of_price_changes(simulation_data['eth_price_history'])
```

C:\Users\merca\anaconda3\Lib\site-packages\seaborn_oldcore.py:1119:
FutureWarning: use_inf_as_na option is deprecated and will be removed in a
future version. Convert inf values to NaN before operating instead.
with pd.option_context('mode.use_inf_as_na', True):



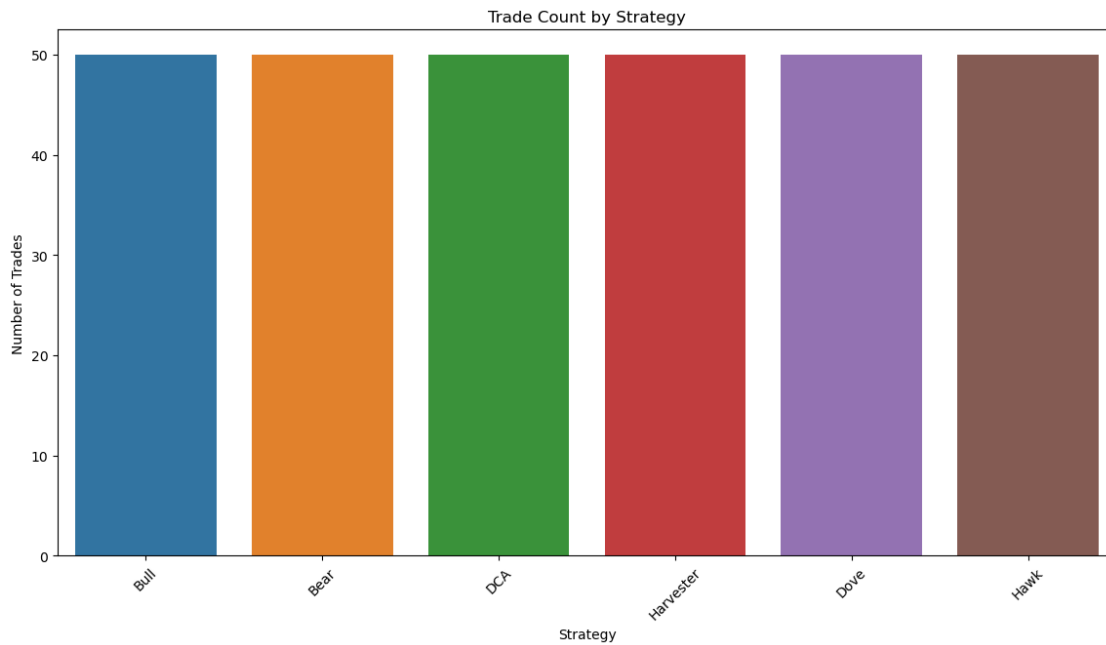
```
[72]: plot_slippage_distribution(simulation_data['price_impacts'])
```

C:\Users\merca\anaconda3\Lib\site-packages\seaborn_oldcore.py:1119:
FutureWarning: use_inf_as_na option is deprecated and will be removed in a
future version. Convert inf values to NaN before operating instead.
with pd.option_context('mode.use_inf_as_na', True):

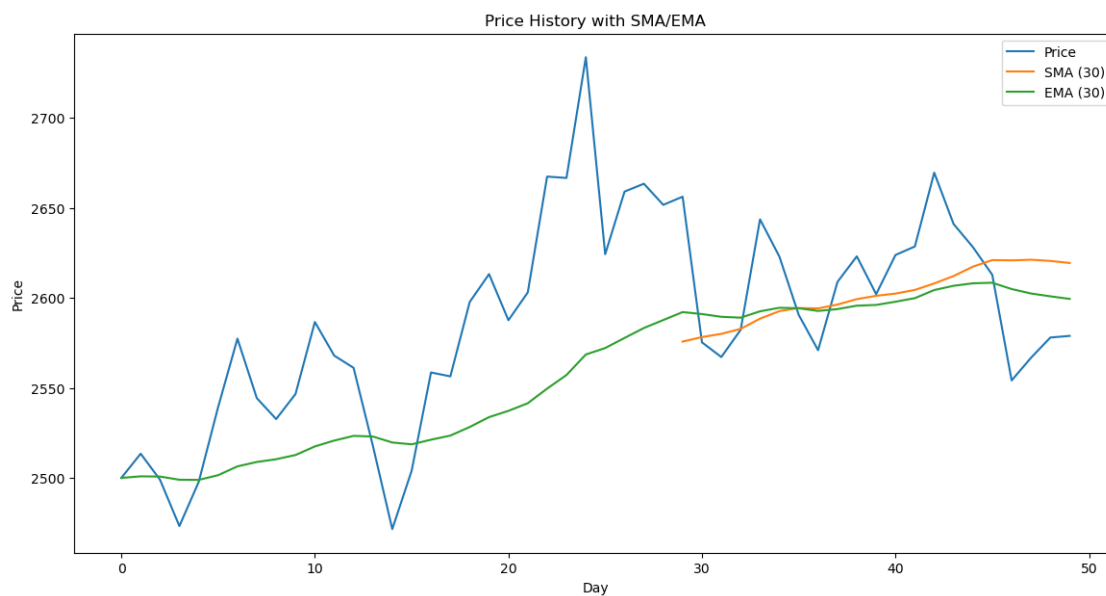


```
[73]: plot_trade_count_by_strategy(simulation_data['trade_counts'])
```

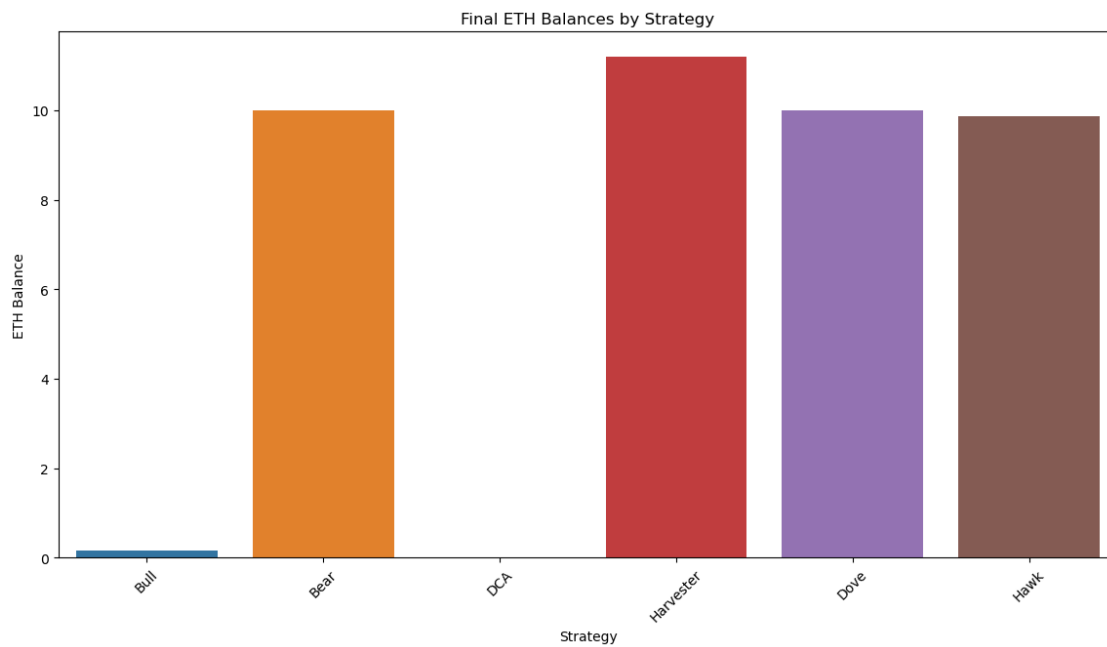
C:\Users\merca\anaconda3\Lib\site-packages\seaborn_oldcore.py:1765:
FutureWarning: unique with argument that is not not a Series, Index,
ExtensionArray, or np.ndarray is deprecated and will raise in a future version.
order = pd.unique(vector)



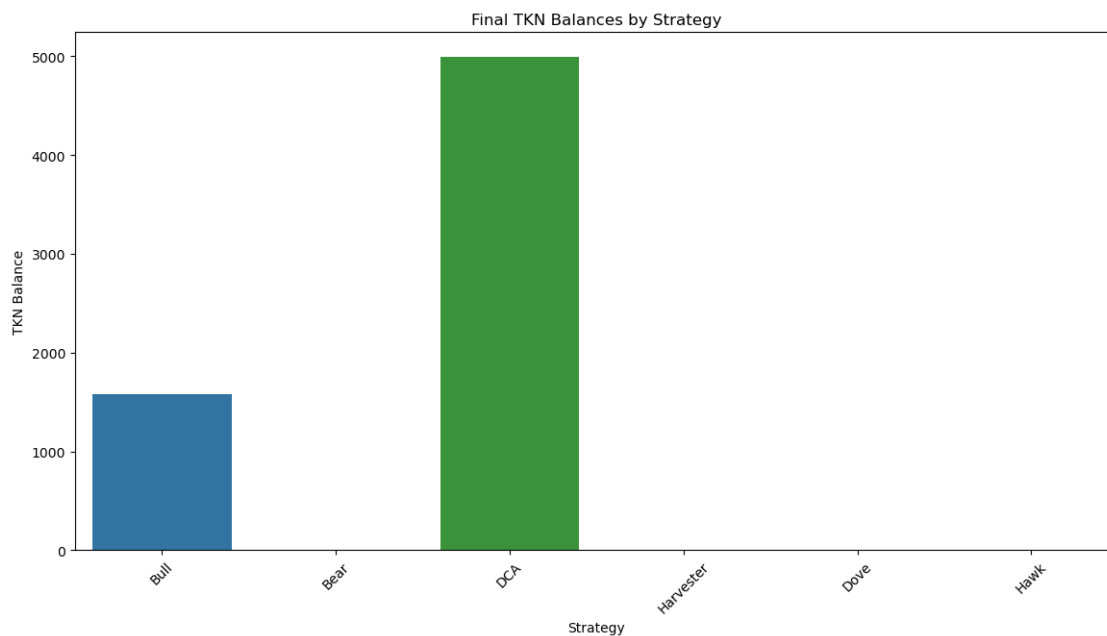
```
[74]: # Plot Price History with SMA and EMA
plot_price_history_with_sma_ema(simulation_data['eth_price_history'])
```



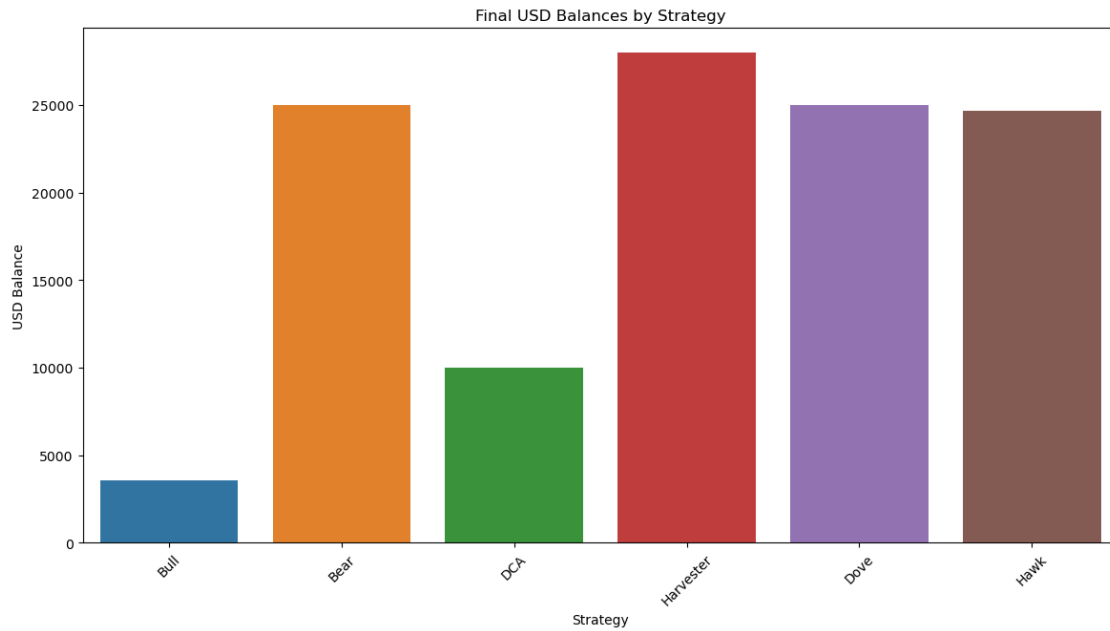
```
[75]: # Added Visualizations
plot_final_eth_balances_by_strategy(simulation_data['final_balances_table'])
```



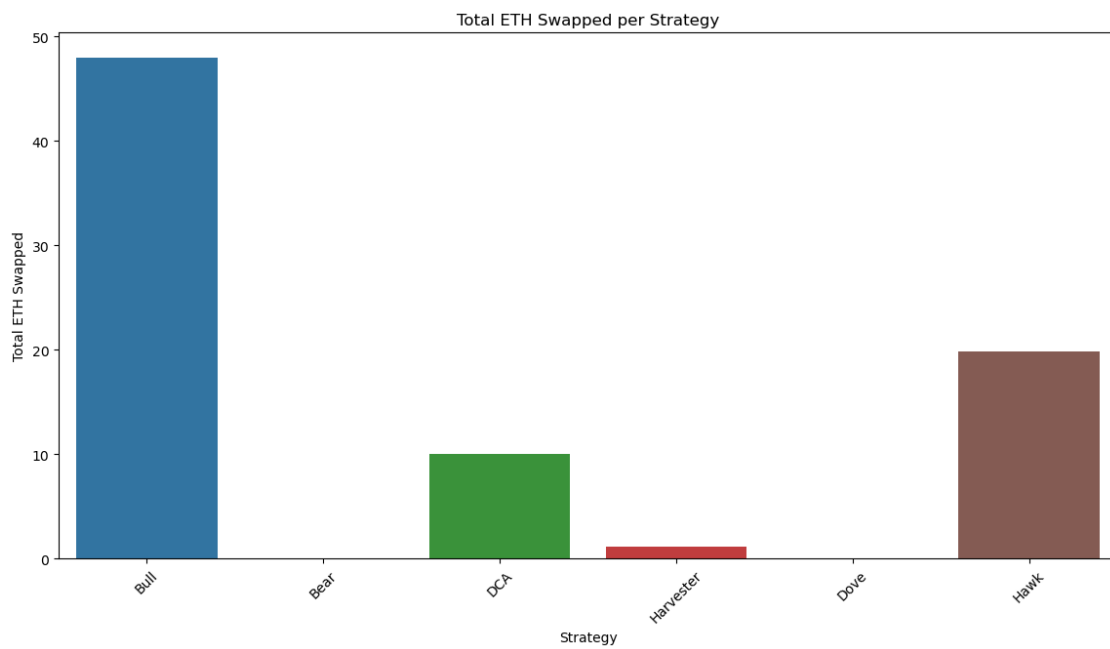
```
[76]: plot_final_tkn_balances_by_strategy(simulation_data['final_balances_table'])
```



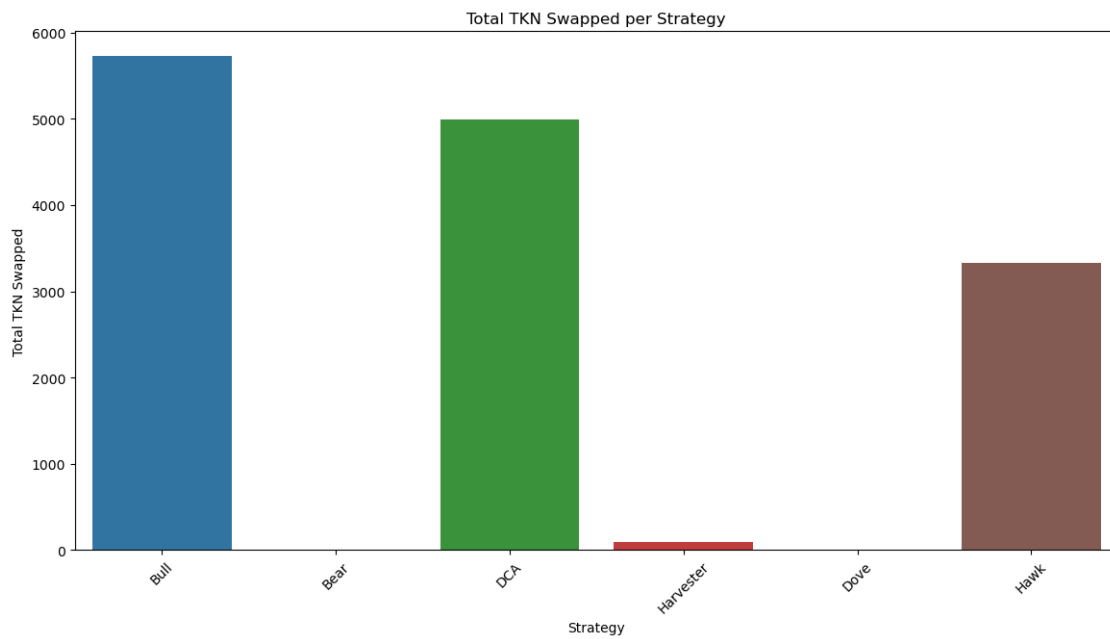
```
[77]: plot_final_usd_balances_by_strategy(simulation_data['final_balances_table'])
```



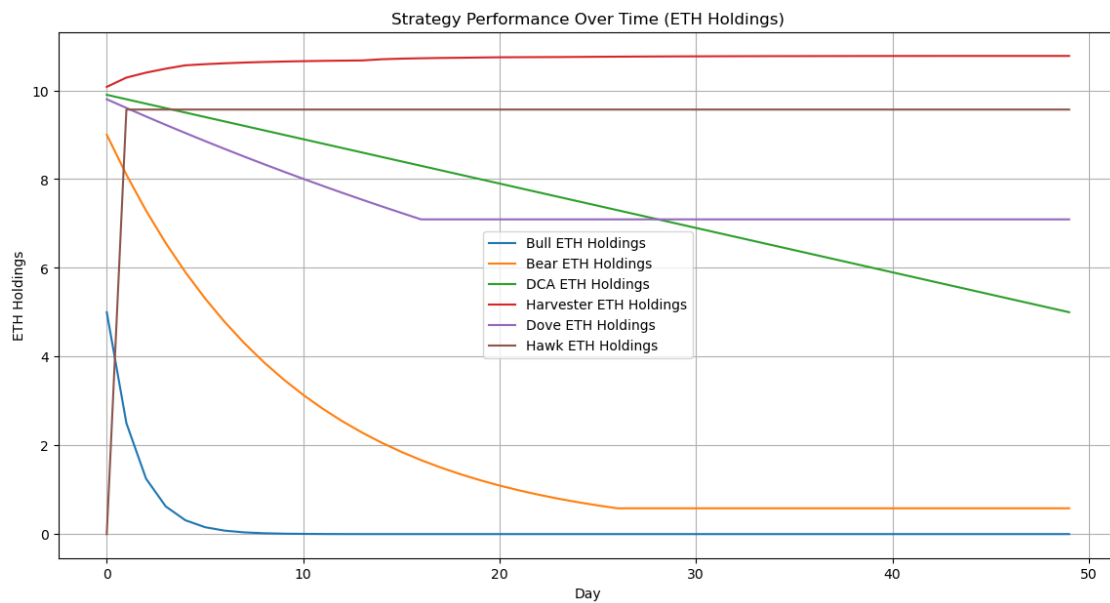
```
[78]: plot_total_eth_swapped_per_strategy(simulation_data['total_volume_swapped_table'])
```

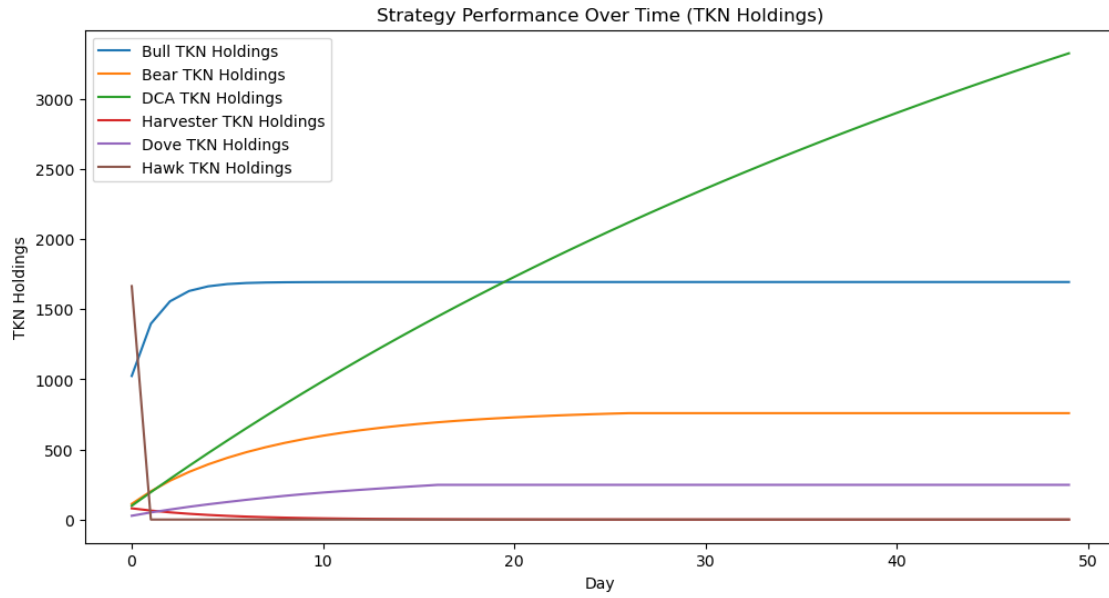



```
[79]: plot_total_tkn_swapped_per_strategy(simulation_data['total_volume_swapped_table'])
```

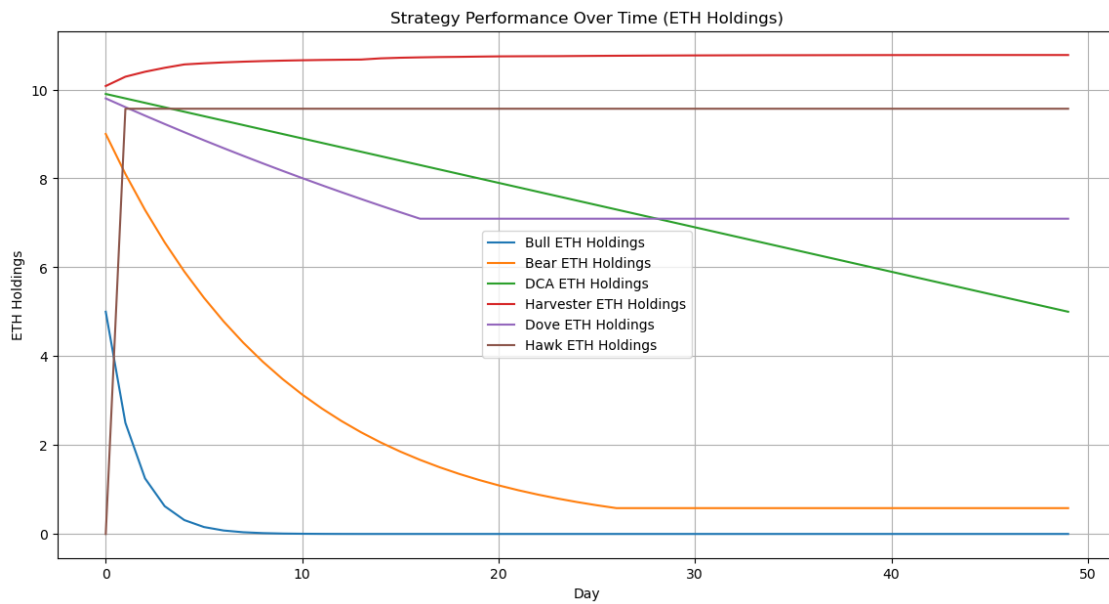


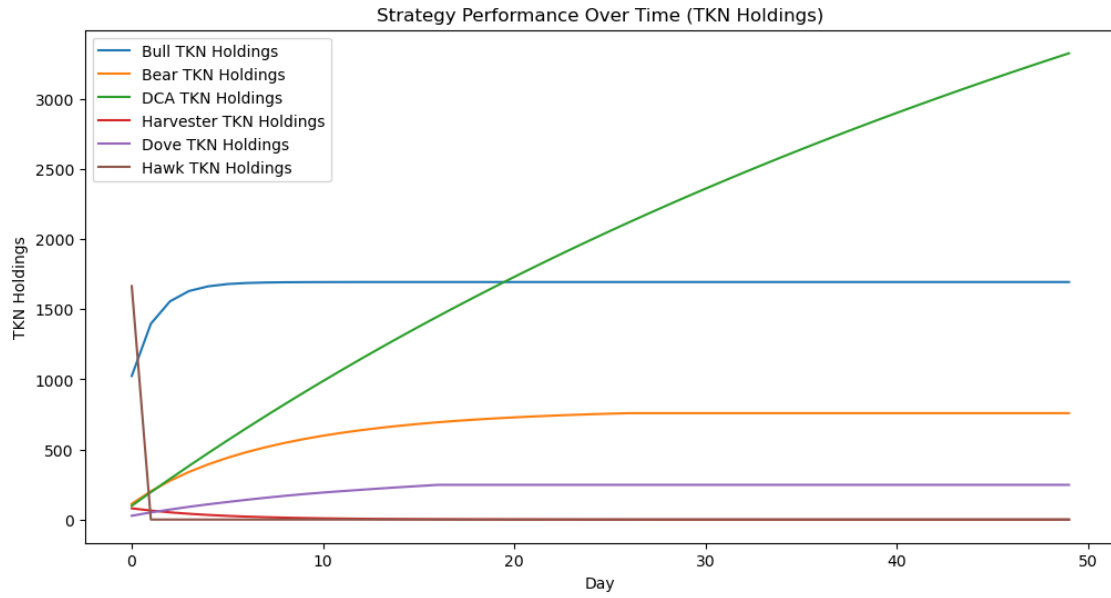
```
[81]: plot_strategy_performance_over_time(strategies, eth_price_history)
```





```
[82]: plot_strategy_performance_over_time(strategies, tkn_price_history)
```





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