

Hedging Against Turkish Inflation

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Introduction

The ongoing economic crisis in Türkiye has been characterized by high inflation, the depreciation of the Turkish Lira (TRY), rising borrowing costs, and increasing loan defaults. The underlying causes of the crisis can be attributed to several factors, including political instability, global economic pressures, and the implementation of unconventional economic policies. Since 2018, inflation has been a persistent issue, partly due to fluctuations in global oil prices and exchange rates, with Turkey's inflation rate ranking among the highest in emerging markets Yilmazkuday [2022]. The effectiveness of inflation-targeting policies has been limited by both internal shocks, such as political events and the COVID-19 pandemic, and external factors, such as rising global inflation [Nazlioglu et al., 2024]. Furthermore, the Turkish government's policy of maintaining low interest rates to stimulate growth, despite the conventional theory that raising interest rates should reduce inflation, has contributed significantly to the current economic challenges [Kantur and Özcan, 2021]. Nevertheless, interest rates have been raised significantly. As of November 2024, the most recent rate hike was in March 2024, when the central bank increased the policy rate by 5 percentage points to 50% as the year-on-year inflation reached 75% [Bloomberg, 2024]. Since then, the rate has remained unchanged as the central bank has been committed to fighting high inflation and stabilising the Turkish lira. As of October 2024, year-on-year inflation stands at 48% [Bloomberg, 2024]. This study aims to analyze which assets, as well as which portfolio of assets, would have been the most effective in hedging against Turkish inflation.

Methodology

This study examines the effectiveness of various assets as hedges against Turkish inflation, using monthly data from January 2018 to September 2024. The monthly frequency was selected for the following reasons:

1. The use of monthly data allows for the smoothing of short-term fluctuations. This facilitates the identification of more coherent relationships between inflation and asset returns.
2. Key economic indicators, including inflation rates, are typically reported on a monthly basis. By aligning asset data with this frequency, the analysis maintains consistency and relevance in relation to reported inflation rates.
3. The influence of short-term trading anomalies, seasonal effects and temporary market shocks on weekly data must be acknowledged. Monthly data minimizes the impact of these irregularities, thereby providing a more stable basis for the analysis of assets as potential inflation hedges.

Data Collection

This study includes a range of assets to capture different potential hedging mechanisms against inflation.

Following indices were sourced from Bloomberg:

- **TUCXEFYY Index:** This index tracks the Turkish CPI (Consumer Price Index) excluding categories such as food, energy, alcohol, and tobacco. This represents the core inflation rate and excludes the most volatile components of the CPI, given that the aforementioned categories are often subject to short-term price fluctuations due to external factors. In the context of hedging against inflation, it is more meaningful to focus on core inflation, as short-term fluctuations in volatile categories can distort the true underlying inflation rate. Therefore, this index serves as the benchmark and allows for direct comparison of the other assets against inflation.
- **XU100 Index (BIST 100):** This index comprises the 100 largest companies traded at the Borsa Istanbul and provides insight into the response of Turkish stocks to inflation.
- **GTRY10YR (10-Year Turkish Government Bond):** Long-term government bonds, such as the 10-year Turkish government bond, are traditionally considered low-risk investments. Including this bond in the analysis allows for an assessment of the inflation risk premium embedded in Turkish government debt.

- **XAU:** This index represents the price of one ounce of gold quoted in US Dollars (USD). Gold is often seen as a traditional hedge against inflation due to its historical retention of value. Analyzing gold prices in USD allows for an assessment of gold's ability to preserve purchasing power during periods of high inflation in Türkiye, while avoiding the potential distortions caused by exchange rate volatility.
- **XBT BGN:** Bitcoin is included in the analysis as an alternative inflation hedge, with prices analyzed in USD. Analyzing Bitcoin in USD focuses on its performance as a global inflation hedge, independent of potential distortions caused by exchange rate volatility. This approach provides insights into Bitcoin's ability to preserve purchasing power and its relevance in the context of Turkish inflation.
- **USGG10YR Index:** The 10-year US Government bond yield was used as the risk-free rate in the Markowitz Optimization. This rate serves as a benchmark for risk-free returns and provides a baseline to evaluate the performance of other assets and calculate excess returns in the portfolio construction.

Furthermore, the house price index data was obtained from the Turkish Central Bank's EVDS database (<https://evds2.tcmb.gov.tr/index.php?/evds/portlet/KSAktmjeowo%3D/en>). Specifically, the **TP KFE TR-1** series was used, which tracks nationwide residential property price change in Türkiye. Real estate is often considered a strong inflation hedge, as property values and rental income tend to rise with inflation. This index allows an analysis of the effectiveness of the real estate sector in preserving purchasing power during inflationary periods.

Analysis Techniques

The analysis consists of two main steps. First, the effectiveness of each individual asset in providing a hedge is evaluated. Subsequently, an optimal hedging portfolio is determined.

The first step is to calculate the **real return** for each asset relative to the Turkish inflation rate. This ensures a consistent measure of an asset's effectiveness in preserving purchasing power in Türkiye's inflationary environment.

$$\text{Real Return} = \frac{1 + \text{Nominal Return}}{1 + \text{Inflation Rate}} - 1$$

This formula adjusts the nominal return of each asset to account for the impact of Turkish inflation. By expressing returns in real terms, it provides a clearer picture of an asset's ability to act as an inflation hedge, irrespective of whether it is denominated in TRY or USD.

This first step evaluates each asset's ability to preserve purchasing power. Assets with consistently positive excess returns are considered to have stronger hedging characteristics, as they maintain or increase purchasing power above inflation. This initial analysis provides a basis for assessing each asset's stand-alone ability to serve as an inflation hedge.

Building on the individual asset analysis, the next step applies **Markowitz portfolio optimization** to construct an optimal portfolio that maximizes the hedging effectiveness against Turkish inflation. Markowitz optimization, also referred to as **Mean-Variance Optimization**, determines the portfolio composition that achieves the highest return for a given level of risk / the lowest risk for a given return. In the context of this study, the aim is to construct a portfolio that minimizes inflation risk while providing stable excess returns. By balancing a range of assets, this optimization creates a portfolio that preserves purchasing power against inflation more effectively than any individual asset alone.

The process involves the following calculations:

1. Portfolio Return:

$$\text{Portfolio Return} = R_p = \sum_{i=1}^n w_i R_i$$

where:

- R_p : Portfolio return

- w_i : Weight of asset i in the portfolio
- R_i : Return of asset i
- n : Number of assets in the portfolio

2. Portfolio Variance:

$$\text{Portfolio Variance} = \sigma_p^2 = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \sigma_{ij}$$

where:

- σ_p^2 : Portfolio variance (measure of risk)
- w_i, w_j : Weights of assets i and j in the portfolio
- σ_{ij} : Covariance between the returns of assets i and j
- σ_{ii} or σ_i^2 : Variance of asset i (case when $i = j$)

3. Minimizing Portfolio Risk:

$$\min_w \sigma_p^2 \quad \text{subject to:} \quad \sum_{i=1}^n w_i R_i = R_{\text{target}}, \quad \sum_{i=1}^n w_i = 1, \quad w_i \geq 0$$

where:

- $\min_w \sigma_p^2$: The objective is to minimize the portfolio variance
- $\sum_{i=1}^n w_i R_i = R_{\text{target}}$: The portfolio must achieve a specified target return (R_{target})
- $\sum_{i=1}^n w_i = 1$: The sum of portfolio weights must equal 1, this ensures that the portfolio is fully invested
- $w_i \geq 0$: Weights must be non-negative, assuming no short-selling

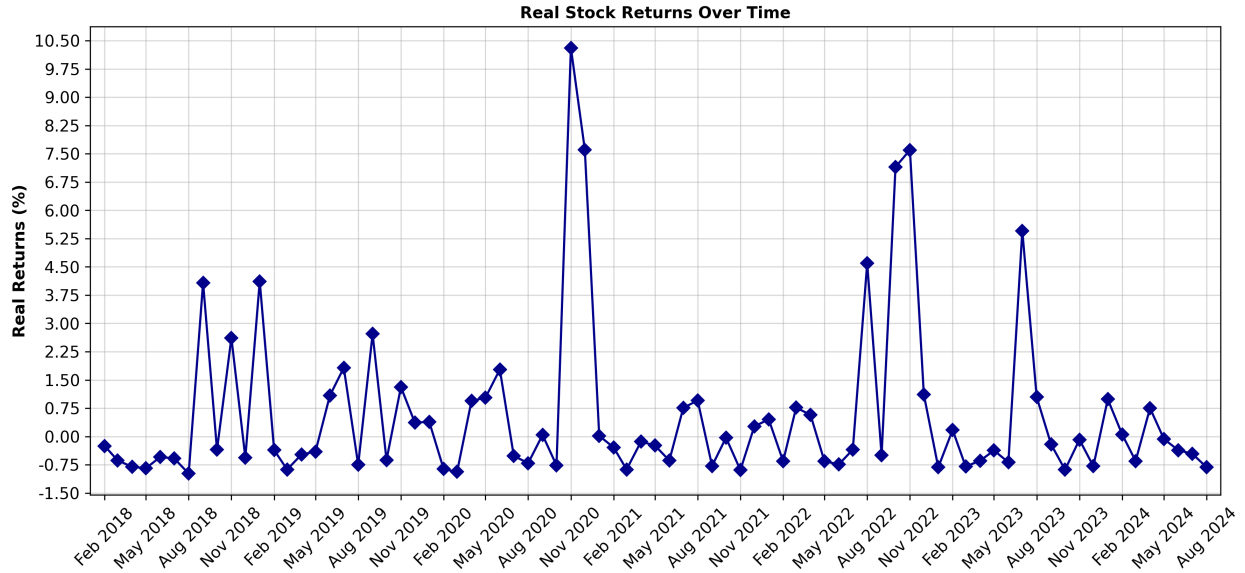
Solving the optimization problem generates the efficient frontier, which represents the set of optimal portfolios that offer the highest return for a given level of risk. The efficient frontier is derived by varying R_{target} and solving the optimization problem for each level of return.

To ensure the robustness of the results, the Markowitz portfolio optimization is presented using both the median and mean real risk-free rate adjusted for Turkish inflation. This approach allows the assessment of portfolio outcomes under different assumptions about the risk-free rate in a highly volatile inflation environment. While US government bonds provide positive nominal yields, the much higher inflation in Turkey results in negative real returns when adjusted to the local inflation rate. Despite this, using the real return is appropriate as it ensures consistency with the inflation-adjusted returns of other assets, reflecting the actual economic conditions faced by investors in terms of purchasing power.

Results

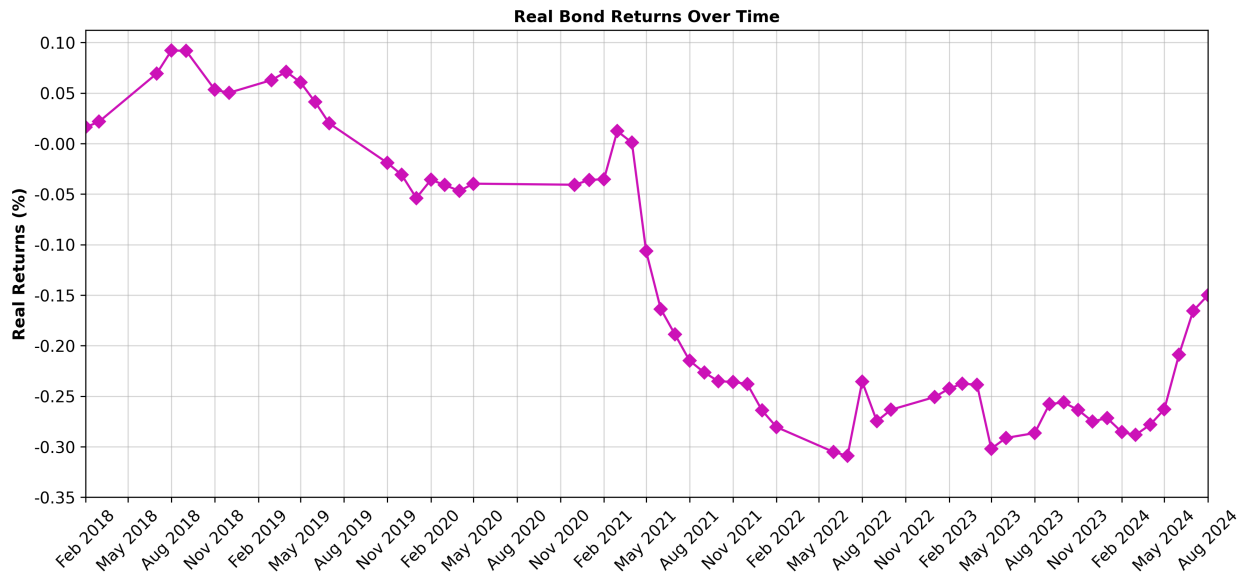
Real Return of Individual Assets

a) Turkish Stocks



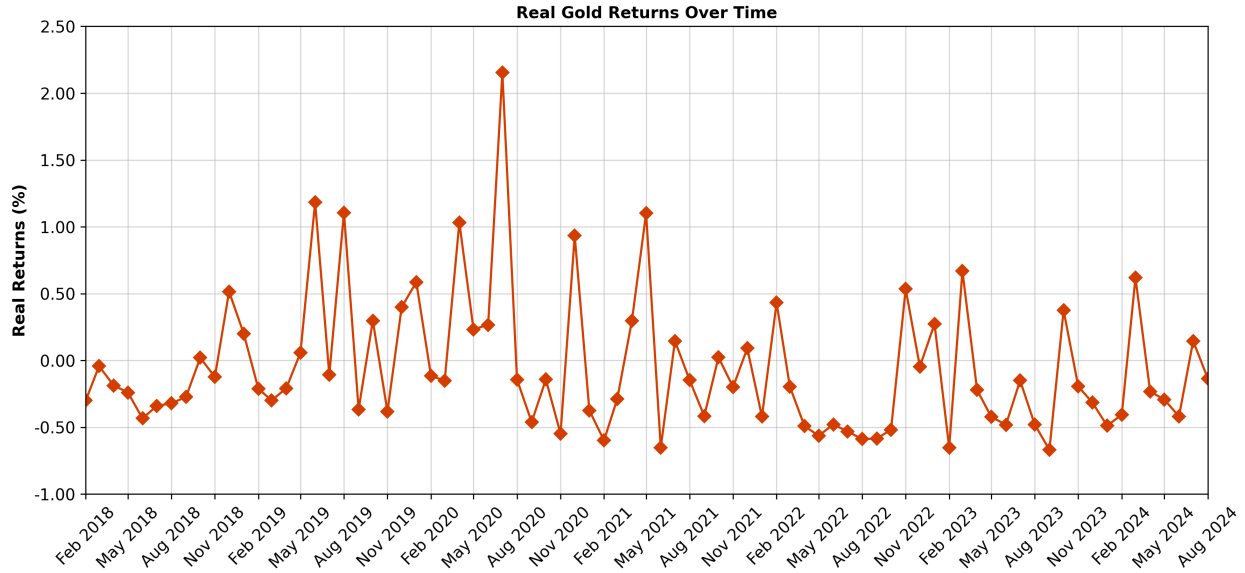
Turkish stocks are highly volatile, with several sharp peaks and periods of low or negative returns. For instance, there are noticeable spikes in returns, especially around mid/late 2020 and mid-2022. Therefore, Turkish equities appear to offer opportunities for inflation hedging during certain periods, but are inconsistent as a hedge. While they may reflect market optimism during inflationary periods, they still carry significant risks, as shown by the high volatility.

b) Turkish Government Bond



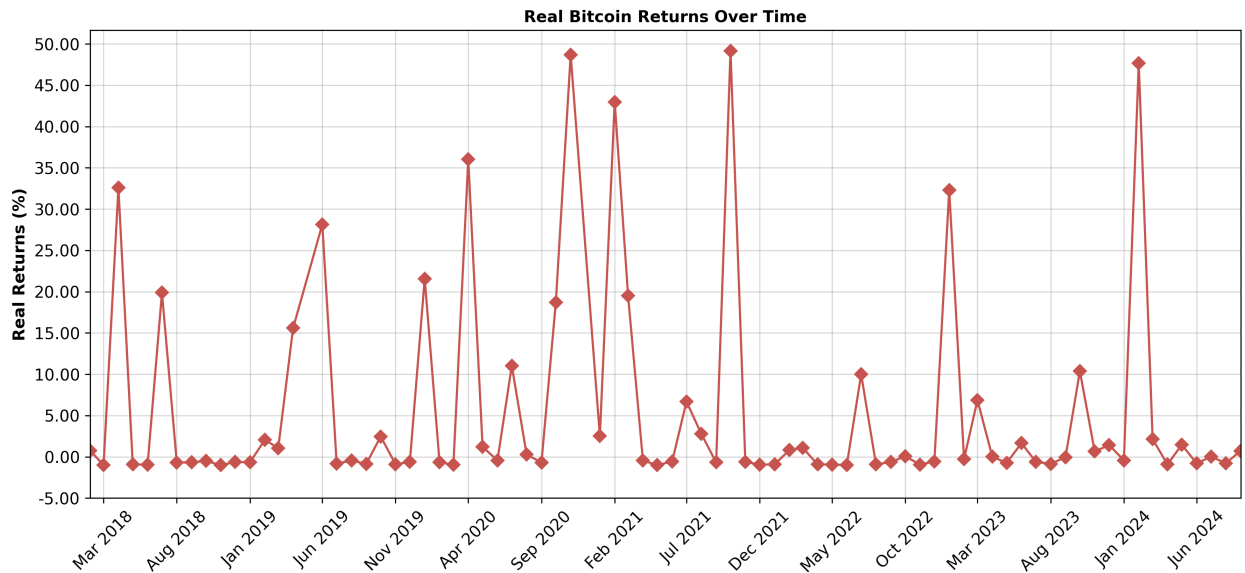
10 year Turkish government bonds show prolonged periods of negative real returns, especially as inflation rises. Recent improvements in real returns may reflect monetary tightening, but the overall trend suggests that they struggle to keep up with inflation. Therefore, Turkish bonds are not a good hedge against inflation due to their sensitivity to high inflation and credit risk.

c) Gold



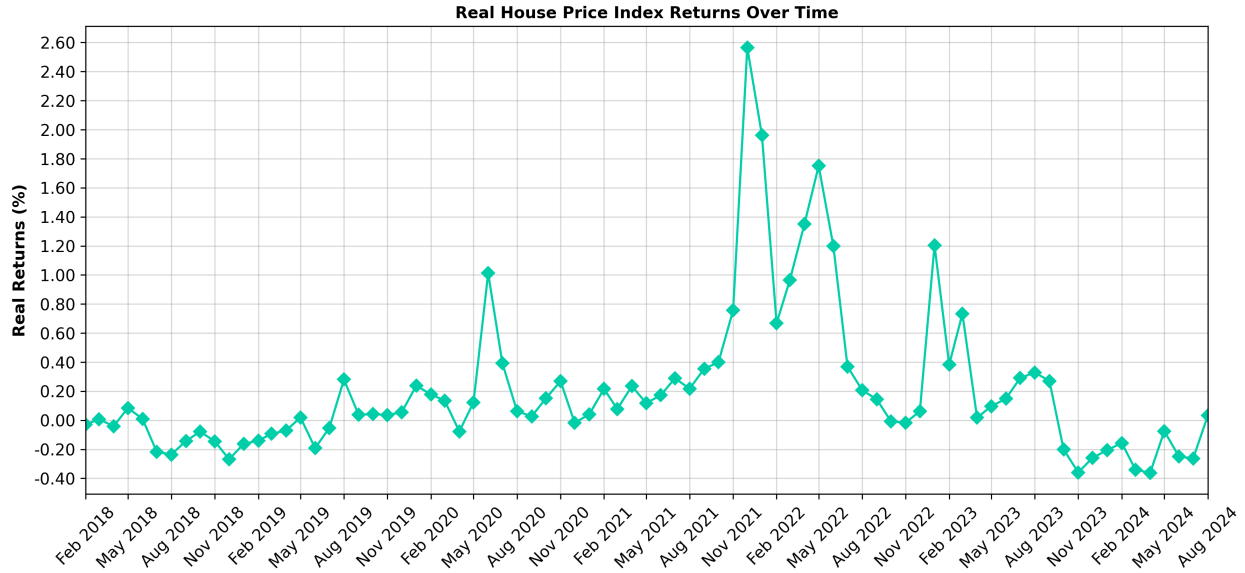
Gold has traditionally been seen as an inflation hedge. Despite some negative returns, gold maintains a consistent performance compared to other assets. This makes gold a modest hedge against Turkish inflation, as it tends to hold its value during inflationary spikes.

d) Bitcoin



Bitcoin's real returns are highly volatile. It occasionally generates high positive real returns but also shows frequent periods of near-zero or negative returns. Therefore, it is not a consistent hedge against Turkish inflation due to its high volatility. While it offers occasional large positive returns, it also carries significant downside risk. This makes it speculative rather than a stable store of value in the context of inflation hedging.

e) Turkish Real Estate



Real returns on Turkish real estate show occasional spikes, but generally remain close to zero, with also a few periods of slightly negative returns. The peak in real returns occurred in late 2021, likely driven by a spike in inflation, with real estate acting as a safe haven. Consequently, real estate appears to be a viable hedge against inflation during periods of high inflation in Türkiye. The sharp increase in real returns suggests strong investor demand for real assets to preserve wealth amid economic uncertainty.

Comparing the assets, one can conclude for the period from January 2018 to September 2024:

- **Least Effective Hedges:**
 - **Turkish Bonds:** Struggle to generate positive real returns under high inflation.
 - **Bitcoin:** High volatility reduces reliability as a consistent inflation hedge.
- **Balanced Hedge:**
 - **Stocks:** Provide a mix of potential growth and inflation protection but require careful risk management due to volatility.
- **Best Inflation Hedges:**
 - **Gold:** Offers steady value preservation, especially during high inflation periods.
 - **House Price Index:** Reasonable alignment with inflation but lacks significant outperformance.

Markowitz Portfolio Optimization

Portfolio allocation using the mean real return of the US 10y Gov Bond (-20.87%):

- **Turkish Stocks:** 3.48%
- **Turkish Government Bond:** 57.76%
- **Gold:** 8.40%
- **Bitcoin:** 0.15%
- **Turkish Real Estate:** 30.21%

Resulting in:

- **Expected Portfolio Return:** 1.34%
- **Expected Portfolio Volatility:** 19.77%

Portfolio allocation using the median real return of the US 10y Gov Bond (-13.71%):

- **Turkish Stocks:** 7.71%
- **Turkish Government Bond:** 0.00%
- **Gold:** 24.67%
- **Bitcoin:** 0.47%
- **Turkish Real Estate:** 67.15%

Resulting in:

- **Expected Portfolio Return:** 22.05%
- **Expected Portfolio Volatility:** 41.25%

The results highlight the sensitivity of portfolio allocation and expected outcomes to the chosen risk-free rate. It also emphasizes the importance of robust assumptions in the Markowitz optimization framework.

Using the average real return of the 10-year US Treasury (-20.87%), the portfolio is heavily allocated to Turkish government bonds (57.76%) and Turkish real estate (30.21%), with minimal allocations to gold (8.40%) and bitcoin (0.15%). This allocation reflects a strategy to minimize risk while achieving a modest expected portfolio return (1.34%) and relatively low volatility (19.77%).

In contrast, using the median real return (-13.71%) shifts the allocation dramatically, with a complete exclusion of Turkish government bonds (0.00%) and a heavier weighting in gold (24.67%) and Turkish real estate (67.15%). This allocation results in a much higher expected return (22.05%), but at the cost of much higher volatility (41.25%).

The differences in portfolio allocations and outcomes illustrate that the choice between the mean and median real risk-free rate can profoundly affect optimization results, particularly in environments with volatile inflation and significant outliers. The mean risk-free rate, which is more sensitive to extreme values, drives a conservative allocation with lower returns and risk. The median risk-free rate, which is robust to outliers, leads to a more aggressive allocation that prioritizes higher expected returns at the expense of greater volatility. These results show the importance of conducting robustness checks, especially when inflation or other economic conditions vary significantly, as assumptions about the risk-free rate directly impact the portfolio's risk-return profile.

It is also worth noting that the Markowitz optimization is purely mathematical and does not take into account behavioral factors or practical constraints such as aversion to extreme volatility or liquidity needs.

Conclusion and Future Research

This study highlights the sensitivity of portfolio allocation to the choice of the real risk-free rate in inflation-adjusted Markowitz optimization. Turkish real estate emerges as a key portfolio component due to its relatively high real returns and alignment with inflationary trends. However, the resulting portfolio achieves high expected returns at the cost of significant volatility, particularly when the median real risk-free rate is applied.

Future research could look into areas such as:

- Expand the asset universe to include more complex financial products, such as derivatives (e.g., inflation-linked swaps or options), exchange-traded funds (ETFs), or foreign-denominated assets. These products could provide more effective and flexible hedging mechanisms against inflation.
- Explore dynamic portfolio strategies that adapt to changing inflationary environments.
- Assess the role of alternative risk measures, such as downside risk or drawdown, to create portfolios that better address practical investor concerns.

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