

# RISK PARITY WITH ASSET ALLOCATION

PYTHON PROJECT FOR FINANCE CLUB UNIPI

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- Introduction

This project implements a Risk Parity portfolio allocation strategy using Python. The objective is to construct a diversified portfolio in which each asset contributes equally to the total portfolio risk, rather than allocating capital based solely on expected returns or market capitalization.

- Data

We use historical monthly data for 15 years from three major asset classes:

1. S&P 500 Index (Equities)
2. U.S. Long-Term Government Bonds
3. Gold

The goal is to determine the optimal portfolio weights  $w_i$  such that the risk contribution (RC) of each asset is equal.

- Code

def portfolio\_vol : the first function finds the volatility of the portfolio, based on each individual asset's weight ( $w_i$ )

def rc\_calculator : this function computes the risk contribution (rc) and the marginal risk contribution (MRC)

def sum\_calculator : the third function of the program sets our target rc as the average rc and find the squared error (difference between them)

def weight\_calculator : our last function is responsible for determining the optimal portfolio weights that satisfy the Risk Parity objective, performing a numerical optimization that minimizes the error produced by the previous function. We use the Sequential Least Programming algorithm from the SciPy library, which also allows us to set our constraints (long only selling). The optimization process requires an initial guess of equal weights for all the assets. Then the optimizer adjusts the weights to minimize the error, driving it to as close to zero as possible, with the help of a tight tolerance level for the precision of the solution.

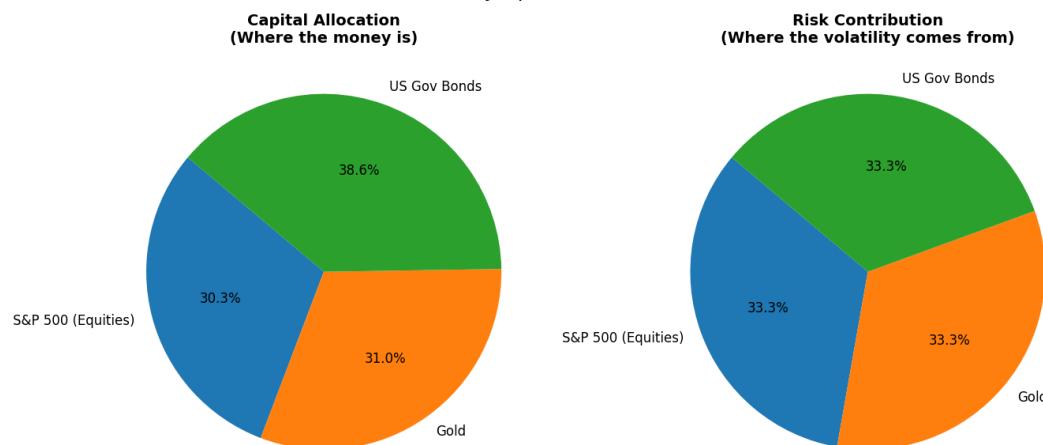
- Results and Analysis

The Risk Parity results are:

	Asset	Weight	Risk Contribution	% of Total Risk
0	^GSPC	0.3032	0.0310	0.3333
1	GLD	0.3104	0.0310	0.3333
2	BLGBX	0.3864	0.0310	0.3333

Total Portfolio Volatility: 0.0929

Risk Parity Optimization Results



The results of the program show a successful Risk Parity optimization. Generally we have created a pretty safe and diverse defensive portfolio with low volatility (9.29%), where each asset contributes about 1/3 of the total risk. The weights are pretty similar with small differences, the largest one being between the Bonds and the SP500 (about 0.0828). This is completely normal due to the general nature of Bonds having lower volatility compared to Stocks, so in order to equalize the risk contribution the model assigns the higher weight to the lower risk asset.