Loan vs. Liquidation: A Financial Analysis Methodology

Alberto Monaco

September 4, 2025

Abstract

This document outlines the mathematical framework and methodology used in the Python script liquidation vs loan.py. The objective is to provide a formal comparison between two financial strategies for raising capital from an existing investment portfolio: securing a loan against the assets versus liquidating a portion of them. The analysis determines which strategy yields a higher net worth over a calculated time horizon, based on a set of user-defined financial parameters.

1 Introduction

An investor often faces the dilemma of needing liquidity for a significant expense, such as a mortgage down payment, while having capital invested in the market. This analysis models two common approaches to solve this problem. The core of the methodology is a fair comparison of the final net worth (P_{final}) resulting from each strategy over an identical time horizon.

2 Methodology

2.1 Common Variables and Definitions

The model is based on the following input variables:

L : The net liquidity required by the investor (e.g., the loan needed).

P : The constant monthly investment amount (PAC). This is also assumed to be the monthly repayment amount for the loan.

n_{pre} : The number of months the initial PAC has been active before the liquidity event.

r : The expected annual rate of return of the investment portfolio.

i : The nominal annual interest rate of the secured loan.

τ : The capital gains tax rate (e.g., 26% or 0.26).

2.2 Time Horizon for Comparison

To ensure a fair comparison, the analysis horizon (n_{repay}) is defined as the number of months required to fully repay the loan of amount L with monthly payments of P at an annual interest rate i. This is calculated using the standard NPER formula:

$$n_{repay} = -\frac{\ln\left(1 - \frac{L \cdot (i/12)}{P}\right)}{\ln(1 + i/12)} \tag{1}$$

2.3 Initial Capital Calculation

The starting point for both scenarios is the value of the portfolio at the moment the liquidity is needed (C_0). This is the future value of a systematic investment plan (annuity due), where payments are made at the beginning of each period.

$$g_m = (1 + r)^{1/12} \quad \text{(monthly growth factor)} \tag{2}$$

$$C_0 = P \cdot \sum_{i=1}^{n_{pre}} g_m^i = P \cdot \frac{g_m^{n_{pre}+1} - g_m}{g_m - 1} \tag{3}$$

2.4 Scenario A: The Loan (Leverage) Strategy

In this scenario, the portfolio is left untouched to grow, while a loan is taken out and repaid over n_{repay} months. The final net worth ($P_{final,A}$) is the future value of the initial capital C_0 after this period.

$$P_{final,A} = C_0 \cdot (g_m)^{n_{repay}} \tag{4}$$

2.5 Scenario B: The Liquidation Strategy

In this scenario, a portion of the portfolio is sold to obtain the net liquidity L. The remaining capital is left to grow, and the monthly amount P is reinvested into the portfolio.

2.5.1 Calculating the Gross Withdrawal Amount

To obtain a net amount L, the investor must sell a gross amount V that also covers the capital gains tax. The tax is only on the gain portion of the sale.

$$\text{Cost Basis} = n_{pre} \cdot P \tag{5}$$

$$\text{Gain Ratio} = 1 - \frac{\text{Cost Basis}}{C_0} \tag{6}$$

$$\text{Effective Tax Rate on Sale } (\tau_{eff}) = \text{Gain Ratio} \times \tau \tag{7}$$

$$V = \frac{L}{1 - \tau_{eff}} \tag{8}$$

2.5.2 Calculating Final Net Worth

The final net worth ($P_{final,B}$) is the sum of two components:

1. The future value of the residual capital after liquidation.
2. The future value of the new PAC, funded with the monthly amount P for n_{repay} months.

$$C_{residual} = C_0 - V \tag{9}$$

$$P_{final,B} = (C_{residual} \cdot g_m^{n_{repay}}) + \left(P \cdot \frac{g_m^{n_{repay}+1} - g_m}{g_m - 1} \right) \tag{10}$$

2.6 The Comparison Metric

The script visualizes the difference in final net worth between the two strategies, ΔP:

$$\Delta P = P_{final,A} - P_{final,B} \tag{11}$$

A positive ΔP indicates that the Loan strategy is superior, while a negative value indicates that Liquidation is the better choice.

3 Results and Interpretation

The script generates three interactive plots to visualize ΔP across different parameter spaces. These plots allow the user to identify break-even points and understand the sensitivity of the outcome to changes in market conditions (portfolio return r), financing costs (loan rate i), and personal savings capacity (PAC amount P). The results demonstrate that the optimal strategy is not absolute but is highly dependent on the interplay between these key financial variables.