# Finance 527Q
# Intermediate Finance
# Case 1


Team C42

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# A – MSR and GMV

**Allocation of the Maximal Sharpe Ratio (MSR) portfolio**

| Stocks | Bonds | Gold | Commodities |
|---|---|---|---|
| 31.97% | 42.82% | 10.53% | 14.69% |

**Allocation of the GMV portfolio**

| Stocks | Bonds | Gold | Commodities |
|---|---|---|---|
| 19.70% | 54.95% | 10.92% | 14.44% |

**Allocations of mean-variance investors with different risk aversions**

| | A = 1.3 | 2.8 | 6.5 | 10.5 | 16.9 |
|---|---|---|---|---|---|
| Stocks | 159.80% | 74.19% | 31.96% | 19.78% | 12.29% |
| Bonds | 214.00% | 99.36% | 42.80% | 26.49% | 16.46% |
| Gold | 52.60% | 24.42% | 10.52% | 6.51% | 4.05% |
| Commodities | 73.40% | 34.08% | 14.68% | 9.09% | 5.65% |
| Tbill | -399.81% | -132.05% | 0.04% | 38.12% | 61.55% |

# A – Correlation and VCV

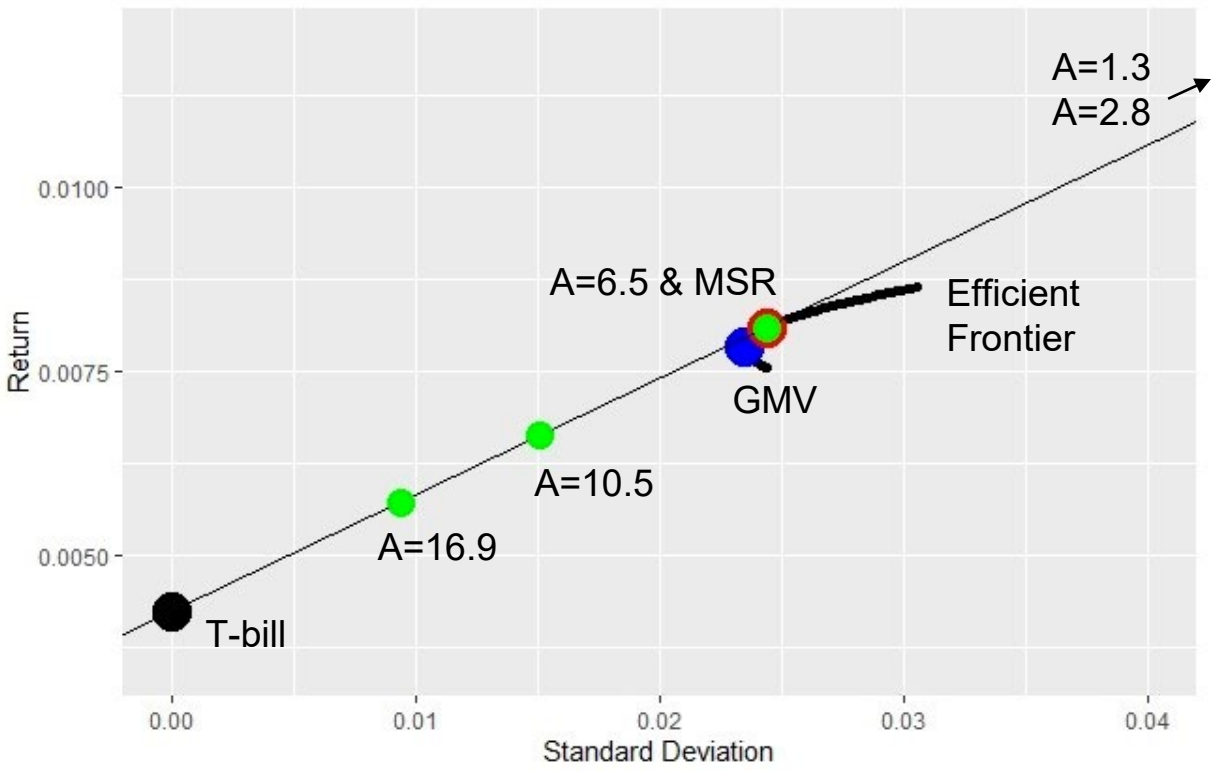
**Correlation Matrix**

| | Stocks | Bonds | Gold | Commodities |
|---|---|---|---|---|
| Stocks | 1 | 0.1111 | 0.0061 | 0.1075 |
| Bonds | 0.1111 | 1 | 0.0162 | -0.1034 |
| Gold | 0.0061 | 0.0162 | 1 | 0.2585 |
| Commodities | 0.1075 | -0.1034 | 0.2585 | 1 |

**Variance-Covariance Matrix**

| | Stocks | Bonds | Gold | Commodities |
|---|---|---|---|---|
| Stocks | 0.2128% | 0.0161% | 0.0017% | 0.0292% |
| Bonds | 0.0161% | 0.0991% | 0.0031% | -0.0191% |
| Gold | 0.0017% | 0.0031% | 0.3654% | 0.0919% |
| Commodities | 0.0292% | -0.0191% | 0.0919% | 0.3457% |

# A - Sharpe Ratio & Portfolio Plot

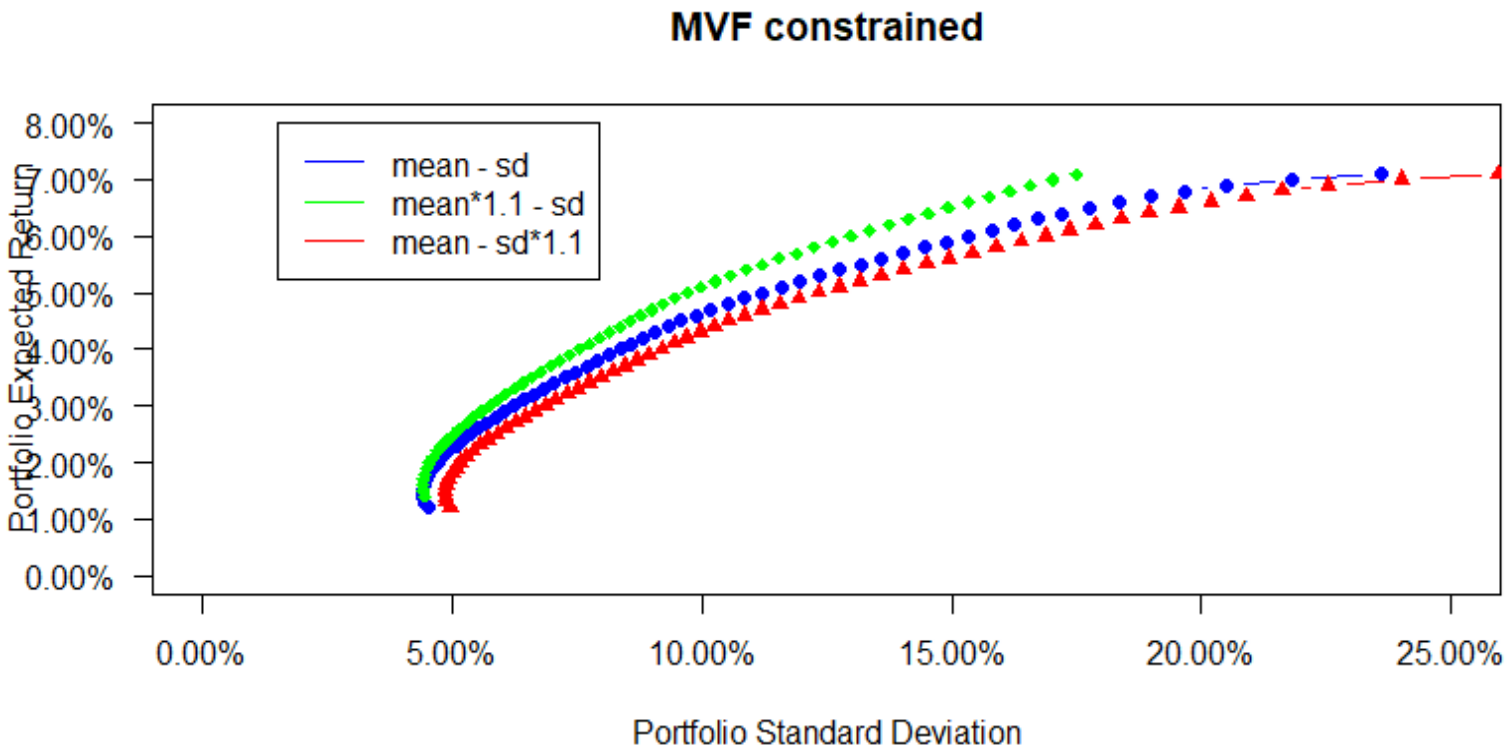



| | GMV | MSR | 1.3 | 2.8 | 6.5 | 10.5 | 16.9 |
|---|---|---|---|---|---|---|---|
| **St. Dev** | 2.35% | 2.44% | 12.18% | 5.66% | 2.44% | 1.51% | 0.94% |
| **Return** | 0.78% | 0.81% | 2.35% | 1.32% | 0.81% | 0.66% | 0.57% |

| | GMV | MSR | 1.3 | 2.8 | 6.5 | 10.5 | 16.9 |
|---|---|---|---|---|---|---|---|
| **S.R** | 15.26% | 15.84% | 15.84% | 15.84% | 15.84% | 15.84% | 15.84% |

- GMV portfolio has the lowest SR and it is the only portfolio that sits outside of the CAL
- Given that MSR (tangency portfolio) and mean-variance optimized portfolios are all sitting on the CAL, they all have the same SR. It further implies that they have the same risky asset weights
- Higher the A, more risk averse the investor, meaning that they invest less in tangency portfolio (risky assets) and more in the T-bill (A=16.9, A=10.5)
- For relatively risk-seeking investors (A=1.3, A=2.8), they could short-sell T-bill and invest more than 100% in the tangency portfolio

# B1



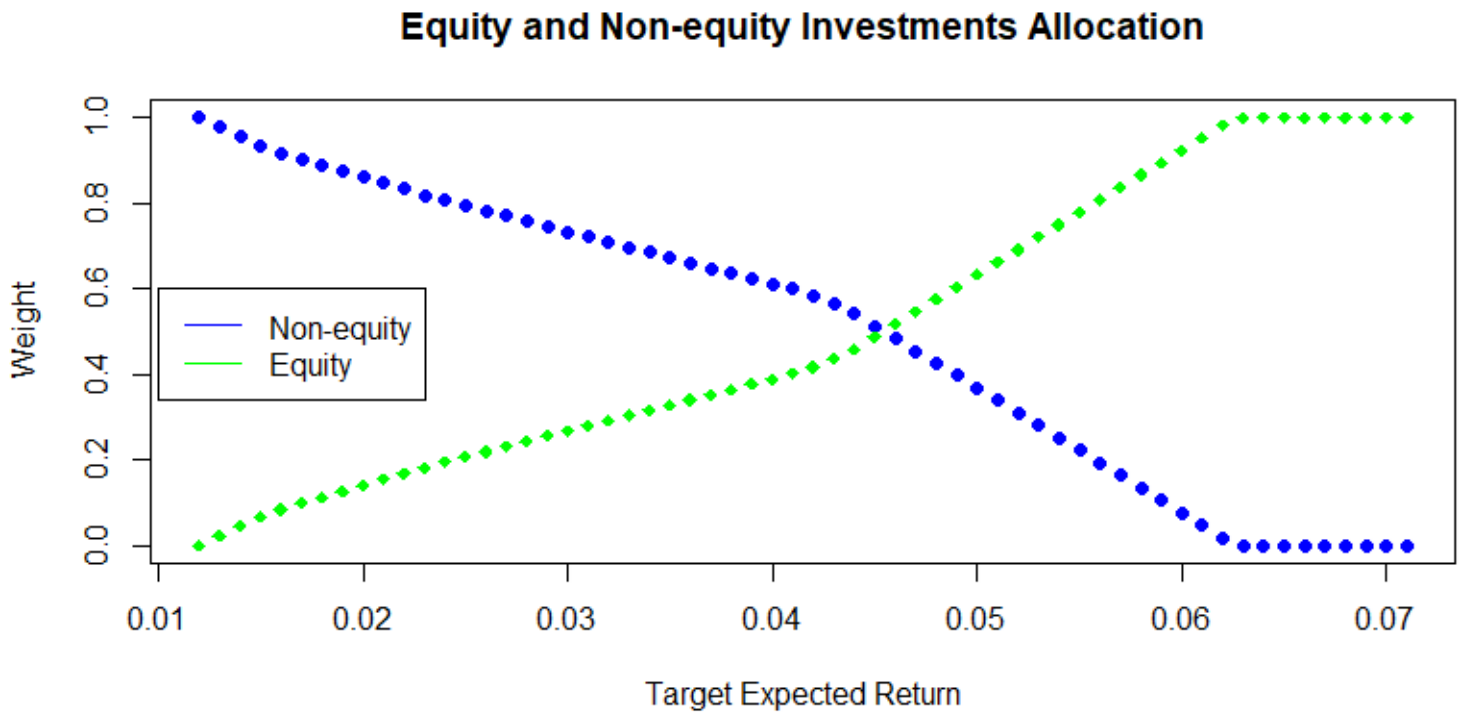

-Increasing the means:

- Higher expected return.
- Lower standard deviation.
- The ranges of portfolio expected return and sd are shrunk

-Increasing the standard deviation:

- Lower expected return.
- Higher standard deviation.
- The ranges of portfolio expected return and sd are stretched.

# B1




As E(R) increases, the weight of non-equity assets decreases and the weight of equity assets increases.

# B2 - Understanding

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **Scenario1** | 3.60% | 4.46% | 5.27% | 5.96% |
| **Scenario2** | 2.55% | 3.06% | 3.35% | 3.22% |
| **Scenario3** | 4.04% | 5.05% | 6.07% | 7.09% |

Scenario 1: Return is a little bit lower than target

Scenario 2: Return is way lower than target

Scenario 3: return has met the return target

**Understanding of OTPPB**

1. OTTPB is one kind of defined benefit plans, whose benefits are not a funtion of the investment process.
2. When the net pension assets is positive at the 85 year-old, it means that the investment of the portfolio is profitable for the company.
3. On the other hand, if the net pension assets is negative at the 85 year-old, it means that the investment does not achieve the requirement and for this fund, it should either make up the shortfall or increase the contribution rate.

# B2 - Is 7% reasonable?

Scenario 1

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | -185060 | -124704 | -88207 | -127201 |
| **64** | -357454 | -331321 | -371170 | -526726 |
| **75** | -255659 | -123616 | -107086 | -349627 |
| **85** | -271575 | -81900 | -44350 | -357729 |

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | 50% | 50% | 50% | 50% |
| **64** | 5% | 5% | 5% | 5% |
| **75** | 25% | 25% | 25% | 25% |
| **85** | 25% | 25% | 25% | 25% |

Scenario 2

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | -398620 | -427645 | -491148 | -590516 |
| **64** | -556858 | -605347 | -700620 | -824092 |
| **75** | -609941 | -658640 | -803489 | -962250 |
| **85** | -668757 | -717456 | -862304 | -1021065 |

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | 1% | 1% | 1% | 1% |
| **64** | 1% | 1% | 1% | 1% |
| **75** | 5% | 1% | 1% | 1% |
| **85** | 1% | 1% | 1% | 1% |

Scenario 3

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | -235095 | -206795 | -218714 | -314522 |
| **64** | -155947 | -55911 | -32584 | -199738 |
| **75** | 273853 | 701101 | 1015835 | 743621 |
| **85** | 347870 | 971853 | 1440599 | 965198 |

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | 25% | 25% | 25% | 25% |
| **64** | 25% | 25% | 25% | 25% |
| **75** | 50% | 50% | 50% | 50% |
| **85** | 50% | 50% | 50% | 50% |

**Not Reasonable**

1. In scenario 1 and scenario 3, a return of 6% is proper for OTPPB since it can generate most biggest net pension assets.
2. In scenario 2, a return of 4% is more proper.
3. In scenario 1 and scenario 2, the net pension assets are below zero, which means the pension fund then has no sufficient access to pay the future benefits. So this pension fund still needs to increase its contribution rate which should not be expected.

# B2 - Recommendation

Scenario 1

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | -185060 | -124704 | -88207 | -127201 |
| **64** | -357454 | -331321 | -371170 | -526726 |
| **75** | -255659 | -123616 | -107086 | -349627 |
| **85** | -271575 | -81900 | -44350 | -357729 |

Scenario 2

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | -398620 | -427645 | -491148 | -590516 |
| **64** | -556858 | -605347 | -700620 | -824092 |
| **75** | -609941 | -658640 | -803489 | -962250 |
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Scenario 3

| | 4% | 5% | 6% | 7% |
|---|---|---|---|---|
| **55** | -235095 | -206795 | -218714 | -314522 |
| **64** | -155947 | -55911 | -32584 | -199738 |
| **75** | 273853 | 701101 | 1015835 | 743621 |
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**Recommendation**

1. When the return is way lower than the target (i.e. scenario 2), with the increase of target return, the larger the loss of this pension funds. It is suggested that the company invest in 4% return or maybe lower. At the same time, this pension funds still needs to increase its contribution rate.

2. When the return is a little bit lower than the target (i.e. scenario 1), a target of 6% return is optimal. However, this pension funds still needs to increase its contribution rate to have sufficient access to pay the future benefits.

3. When the return can achieve the target, a target of 7% is reasonable, however, 6% return is better according to simulation. A return of 6% can make the net pension funds largest according to simulations.

# B2 - Evaluation of Simulation Methodology

Assumptions about teachers' demographics:

1. Non-random retirement age: We assume the teachers hold on to their positions until their retirement. In this way, their salaries and contribution rates are likely to stay constant.
2. Non-random death age: We assume the death age of teachers are constant across time. However in the real world, this is not likely the case because the average death rate grows higher across time.
3. Constant salary increasing rate: We assume that the increase rate of salary is the same no matter what position or how many experiences one teacher has.
4. Constant asset allocation: We assume that the allocation rate in different assets is the same no matter what the market is.
5. Constant inflation rate: The calculation of the benefits is indexed to inflation rate so we assume that it is constant for all times.
6. Identical starting salary: If the simulation is for multiple teachers, we assume that the starting salary for each teacher is identical. If they are not identical, the percentiles of the net pension assets will be biased.

Variation of conclusions:

1. Random retirement age: If the retirement age and thus the plan changes as time goes by, the present value of contributions and assets will change as the plan changes. This way the net plan asset does not reflect the overall return of the pension fund.
2. Non-constant salary increasing rate: If the salary increasing rate varies across time, the portfolio value is variant and the benefit calculation will be wrong. This is going to mess up the net plan asset at the end.