

# Practice Final Exam

Started: Jun 5 at 8:57pm

## Quiz Instructions

Please note that Canvas will auto-submit your responses to this Final Exam at exactly the time the exam ends, unless you have manually submitted your Final Exam before that time.

### Final Letter Grade Determination

Your final letter grade will be based on a curve that reflects how your performance compares to other students in the class. The final letter grade is not known until the curve is determined after the final exam has been graded and all your scores for the quarter are reviewed carefully. In this class we will not drop the lowest homework or quiz score; all of your work contributes to your final grade as outlined in this syllabus.

#### Question 1

5 pts

A cutting-edge pharmaceutical company has developed a new vaccine for the Coronavirus disease 2019 (COVID-19) . Production of the vaccine would require \$10 million in initial capital expenditure. It is anticipated that 1 million units would be sold each year for 5 years, and then herd immunity would be achieved and the mass production of the vaccine would cease. Each year's production would require 10,000 hours of labor and 100 tons of raw material.

In the first year, the average wage rate is \$30 per hour, the cost of the raw material is \$100 per ton and the vaccine will sell for \$3.30 per unit. All three of these unit prices (wage rate per hour, cost of raw material per ton, and vaccine revenue per unit) will increase each year after the first year by the inflation rate which is assumed to be 10% per year. All cash flows (revenues and costs) are assumed to come at the end of each year.

The interest rate is 3% and corporate tax rate is 34% on profit. The initial capital expenditure can be depreciated in a straight line fashion over 5 years (\$2 million per year).

What is the (after-tax) present value of the new vaccine? Please round your numerical answer to the nearest integer number of dollars.

**Question 2****5 pts**

In lecture we defined quasi-modified duration as the extension of the concept of duration to the term structure framework.

It is possible to extend the process of immunization to the term structure framework. A portfolio of bonds designed to fund a stream of obligations can be immunized against a parallel shift in the spot rate curve by matching both the present values and the quasi-modified durations of the bonds and the obligations.

Consider the following stream of future obligations, in dollars, corresponding to college tuition payments for 2 children, Jay and Rio, as shown in the table below:

Year	1	2	3	4	5
<b>JAY</b>	50,000	51,000	52,000	53,000	0
<b>RIO</b>		51,000	52,000	53,000	54,000

You are given the spot rate curve is as follows:

YEAR	SPOT RATE %
1	2.25
2	2.50
3	2.75
4	3.00
5	3.25

Find a portfolio, consisting of the two bonds below, that has the same present value as the obligation stream (including tuition payments for both Jay and Rio) and is immunized against an additive shift in the spot rate curve:

- Bond 1 is a 5-year 6% annual coupon bond with a price of \$112.78
- Bond 2 is a 4-year 10% annual coupon bond with a price of \$126.25

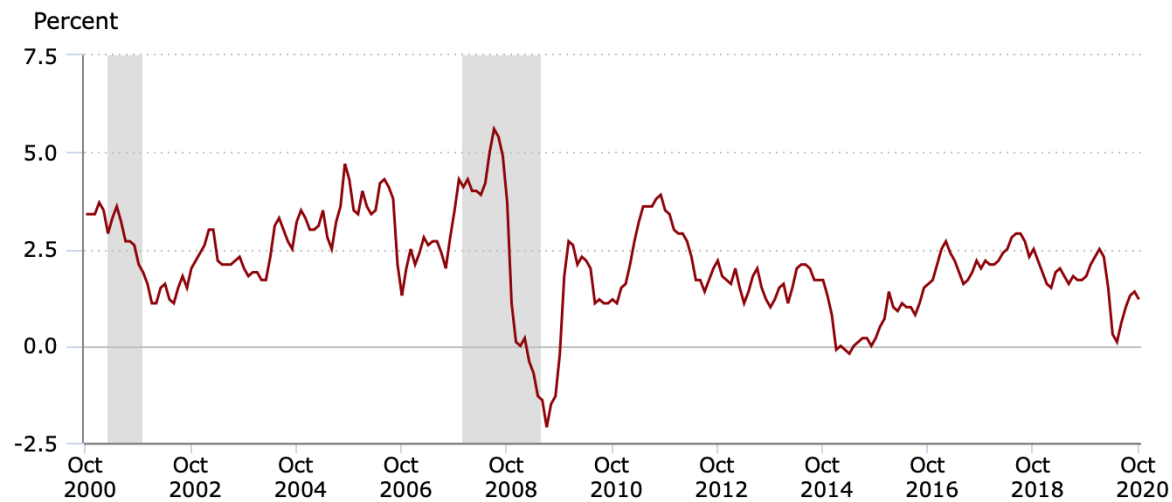
Both bonds have a face value of \$100. How many units of Bond 2 should be held in the immunized portfolio?

Please round your numerical answer to the nearest integer number of units.

### Question 3

5 pts

In 1997, the U.S. Treasury issued "Treasury inflation-protected securities" (**TIPS**). These are fixed-income securities that are inflation indexed to protect their value against inflation. Like conventional bonds, they have a fixed coupon rate and maturity date, but the face value is periodically adjusted for inflation by multiplying the original face value by the ratio of the Consumer Price Index (CPI) at the current date to the CPI at the original issue date. At maturity, the bondholder receives the maximum of the inflation-adjusted face value or the original face value. Hence, if deflation occurs, the bondholder is guaranteed not to lose on the face value. A chart of the historical CPI annual percent changes over the past 20 years, for illustrative purposes only, is provided below.



Hover over chart to view data.

Note: Shaded area represents recession, as determined by the National Bureau of Economic Research.

Source: U.S. Bureau of Labor Statistics.



In October, 2010, you observe the following prices of two 10-year Treasury inflation-protected securities (**TIPS**):

- TIPS 1:  $P_1 = 79.66$        $C_1 = 3\%$        $F_1 = 100$
- TIPS 2:  $P_2 = 100.00$        $C_2 = 6\%$        $F_2 = 100$

where  $P$  is the price,  $C$  is the coupon rate, and  $F$  is the original face value.

Compute the price of a theoretical 10-year inflation-adjusted zero coupon bond with original face value of 100. Please round your numerical answer to 2 decimal places.

**Hint:** you do not need to know the precise numerical values for the CPI annual percent changes in order to solve this problem.

#### Question 4

5 pts

Upon graduation from UCI you decide to buy a home and take out a variable-rate mortgage. The mortgage value is \$1,000,000, the term is 30 years with monthly compounding, and initially the nominal annual interest rate is 2%. This nominal annual interest rate is guaranteed to be fixed at 2% for 5 years, after which time the rate will be adjusted according to prevailing rates. The new rate can be applied to the loan either by changing the monthly payment amount, or by keeping the monthly payment amount the same and extending the length of the mortgage.

If the interest rate on the mortgage changes to 5% after 5 years, what will be the new monthly payment that keeps the termination time the same? Please round your numerical answer to the nearest integer number of dollars.

**Question 5****5 pts**

Upon graduation from UCI you decide to buy a home and take out a variable-rate mortgage. The mortgage value is \$1,000,000, the term is 30 years with monthly compounding, and initially the nominal annual interest rate is 2%. This nominal annual interest rate is guaranteed to be fixed at 2% for 5 years, after which time the rate will be adjusted according to prevailing rates. The new rate can be applied to the loan either by changing the monthly payment amount, or by keeping the monthly payment amount the same and extending the length of the mortgage.

If the interest rate on the mortgage changes to 5% after 5 years, how many months beyond the original term of 30 years does the mortgage need to be extended if the monthly payments are to remain the same? Please round your numerical answer to an integer number of months.

**Question 6****5 pts**

A specialized machine essential for a company's operations costs \$16,000 and has operating costs of \$2,000 the first year. The operating costs increase by \$1,000 each year thereafter. We assume that the operating costs occur at the end of each year. The annual interest rate is 6% and the company plans to stay in operation forever.

You have an option to replace the machine periodically after a period of  $n$  years, where  $n$  must be an integer. The replacement cost is \$16,000. Your objective is to select the replacement period  $n$  such that the present value of the total cost is

minimized. Assume that due to its specialized nature, the machine has no salvage value.

What is the optimal replacement period,  $n$ ? Note  $n$  must be an integer.

### Question 7

2 pts

Assume  $\sigma_M^2$  is the variance of the returns of the total stock market and  $\sigma_{Mi}$  is the covariance between the returns of risky asset  $i$  and the returns of the total stock market.

If the total market includes  $n$  risky assets and the weight  $w_i$  is the weight of the risky asset  $i$  corresponding to the market portfolio, then

$$\sum_{i=1}^n w_i \sigma_{Mi} = \sigma_M^2$$

☐ True

☐ False

### Question 8

5 pts

In this problem we assume that the annual expected rate of return of the market portfolio is 12% and the annual risk-free rate is 2%. The standard deviation of the market portfolio returns is 24%. Assume the market is in equilibrium such that the Capital Asset Pricing Model (**CAPM**) holds: the market portfolio is efficient.

If you have \$1,000 to invest, how should you allocate it to achieve an annual expected return of 18%?

☐ Borrow \$260 at the risk-free rate and invest \$1,260 in the market portfolio

- ☐ Invest \$600 in the risk-free asset and \$400 in the market portfolio
- ☐ Invest \$260 in the risk-free asset and \$740 in the market portfolio
- ☐ Borrow \$600 at the risk-free rate and invest \$1,600 in the market portfolio
- ☐ Invest \$800 in the risk-free asset and \$200 in the market portfolio
- ☐ Invest \$600 in the risk-free asset and sell short \$1600 in the market portfolio

**Question 9****5 pts**

The top 5 stocks in the S&P 500 index, when ranked by market capitalization, make up 22% of the total market capitalization of the S&P 500 index.

Numerical estimates of the mean (or expected) rates of return values of these top five stocks, expressed in decimal (not percentage) form, are listed in the table below.

STOCK	TICKER	MEAN RETURN
Apple, Inc.	<b>AAPL</b>	0.69
Amazon.com Inc.	<b>AMZN</b>	0.65
Microsoft Corp.	<b>MSFT</b>	0.44
Alphabet, Inc.	<b>GOOG</b>	0.36
Facebook, Inc.	<b>FB</b>	0.41

The variance of returns (entries on the main diagonal) and covariances between returns of these top five stocks, expressed in decimal (not percentage) form, are as follows:

	<b>AAPL</b>	<b>AMZN</b>	<b>MSFT</b>	<b>GOOG</b>	<b>FB</b>
<b>AAPL</b>	0.21	0.12	0.17	0.13	0.16
<b>AMZN</b>	0.12	0.15	0.12	0.10	0.12
<b>MSFT</b>	0.17	0.12	0.19	0.14	0.15

<b>GOOG</b>	0.13	0.10	0.14	0.15	0.14
<b>FB</b>	0.16	0.12	0.15	0.14	0.21

You would like to invest \$10,000 and seek an expected return of 80% annually. A friend tells you that this is impossible since the stock with the highest annual expected return, from the table above, is **AAPL** with an expected annual return of 69%. Your friend advises you to invest all the \$10,000 in **AAPL**.

**Assuming there is no risk-free asset available and short selling is allowed**, is it possible to allocate your \$10,000 amongst the 5 stocks in the table to achieve an expected return of 80%?

- If so, what is the optimal number of dollars to invest in **AAPL** such that the expected portfolio return is 80% while minimizing the portfolio variance?
- If not, then enter an answer of 10,000.

Please round your numerical answer to the nearest integer number of dollars.

### Question 10

5 pts

The top 5 stocks in the S&P 500 index, when ranked by market capitalization, make up 22% of the total market capitalization of the S&P 500 index.

Numerical estimates of the mean (or expected) rates of return values of these top five stocks, expressed in decimal (not percentage) form, are listed in the table below.

<b>STOCK</b>	<b>TICKER</b>	<b>MEAN RETURN</b>
Apple, Inc.	<b>AAPL</b>	0.69
Amazon.com Inc.	<b>AMZN</b>	0.65
Microsoft Corp.	<b>MSFT</b>	0.44
Alphabet, Inc.	<b>GOOG</b>	0.36



Facebook, Inc.	<b>FB</b>	0.41
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<b>AMZN</b>	0.12	0.15	0.12	0.10	0.12
<b>MSFT</b>	0.17	0.12	0.19	0.14	0.15
<b>GOOG</b>	0.13	0.10	0.14	0.15	0.14
<b>FB</b>	0.16	0.12	0.15	0.14	0.21

**Assuming there is no risk-free asset available**, suppose you desire to invest in a portfolio of these 5 stocks by minimizing the variance of your portfolio of 5 stocks, subject to the constraint that the weightings of each stock position sum to 1. Note that short positions are permissible.

You are risk-averse and hope that a portfolio with variance less than or equal to 0.14 is attainable. A friend tells you that this is impossible since the stocks with the lowest variance from the table above, **AMZN** or **GOOG**, have a variance of 0.15.

Using mean-variance portfolio optimization, determine the absolute minimum possible portfolio variance.

Please express your numerical answer in decimal (not percentage) form and round your numerical answer to two decimal places.

## Question 11

5 pts

The top 5 stocks in the S&P 500 index, when ranked by market capitalization, make up 22% of the total market capitalization of the S&P 500 index.

Numerical estimates of the mean (or expected) rates of return values of these top five stocks, expressed in decimal (not percentage) form, are listed in the table below.

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Apple, Inc.	<b>AAPL</b>	0.69
Amazon.com Inc.	<b>AMZN</b>	0.65
Microsoft Corp.	<b>MSFT</b>	0.44
Alphabet, Inc.	<b>GOOG</b>	0.36
Facebook, Inc.	<b>FB</b>	0.41

The variance of returns (entries on the main diagonal) and covariances between returns of these top five stocks, expressed in decimal (not percentage) form, are as follows:

	<b>AAPL</b>	<b>AMZN</b>	<b>MSFT</b>	<b>GOOG</b>	<b>FB</b>
<b>AAPL</b>	0.21	0.12	0.17	0.13	0.16
<b>AMZN</b>	0.12	0.15	0.12	0.10	0.12
<b>MSFT</b>	0.17	0.12	0.19	0.14	0.15
<b>GOOG</b>	0.13	0.10	0.14	0.15	0.14
<b>FB</b>	0.16	0.12	0.15	0.14	0.21

**Assuming there is a risk-free asset available** in addition to these 5 risky assets, determine the portfolio weightings for each of these stocks of the unique fund **F** as defined in the One-fund theorem of Modern Portfolio Theory. Note that short positions (negative weights) are permissible and the sum of all the weights must be equal to one. The annual risk-free rate is 4%.

What is the optimal portfolio weight for Alphabet Inc. (ticker: **GOOG**)?

Please express your answer in decimal (not percentage) form and round your numerical answer to two decimal places.

## Question 12

10 pts

In this problem we assume the market portfolio is the S&P 500 index.

The top 5 stocks in the S&P 500 index, when ranked by market capitalization, make up 22% of the total market capitalization of the S&P 500 index.

Numerical estimates of the beta values of these top five stocks are listed in the table below.

STOCK	TICKER	BETA
Apple, Inc.	<b>AAPL</b>	1.16
Amazon.com Inc.	<b>AMZN</b>	0.70
Microsoft Corp.	<b>MSFT</b>	1.15
Alphabet, Inc.	<b>GOOG</b>	0.98
Facebook, Inc.	<b>FB</b>	1.01

Furthermore, the variance of returns (entries on the main diagonal) and covariances between returns of these top five stocks are as follows:

	<b>AAPL</b>	<b>AMZN</b>	<b>MSFT</b>	<b>GOOG</b>	<b>FB</b>
<b>AAPL</b>	0.21	0.12	0.17	0.13	0.16
<b>AMZN</b>	0.12	0.15	0.12	0.10	0.12
<b>MSFT</b>	0.17	0.12	0.19	0.14	0.15
<b>GOOG</b>	0.13	0.10	0.14	0.15	0.14

<b>FB</b>	0.16	0.12	0.15	0.14	0.21
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The variance of the S&P 500 index returns is known to be 0.04.

Suppose we desire to invest in the S&P 500 index portfolio, but find that it is impractical to invest in all 500 stocks. Instead we choose to invest in the five stocks in the table in a way that replicates or tracks the S&P 500 index portfolio most closely--- in the sense of minimizing the variance of the difference in returns between our portfolio of 5 stocks and the S&P 500 index portfolio. Note that short positions (negative weights) are permissible and the sum of all the weights must be equal to one.

What is the optimal portfolio weight for Apple, Inc. (ticker: **AAPL**)?

Please express your answer in decimal (not percentage) form and round your numerical answer to two decimal places.

### Question 13

10 pts

In this problem we assume the market portfolio is the S&P 500 index.

The top 5 stocks in the S&P 500 index, when ranked by market capitalization, make up 22% of the total market capitalization of the S&P 500 index.

Numerical estimates of the mean (or expected) rates of return values of these top five stocks, expressed in decimal (not percentage) form, are listed in the table below.

STOCK	TICKER	MEAN RETURN
Apple, Inc.	<b>AAPL</b>	0.69
Amazon.com Inc.	<b>AMZN</b>	0.65
Microsoft Corp.	<b>MSFT</b>	0.44
Alphabet, Inc.	<b>GOOG</b>	0.36
Facebook, Inc.	<b>FB</b>	0.41

Numerical estimates of the beta values of these top five stocks are listed in the table below.

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Apple, Inc.	<b>AAPL</b>	1.16
Amazon.com Inc.	<b>AMZN</b>	0.70
Microsoft Corp.	<b>MSFT</b>	1.15
Alphabet, Inc.	<b>GOOG</b>	0.98
Facebook, Inc.	<b>FB</b>	1.01

Furthermore, the variance of returns (entries on the main diagonal) and covariances between returns of these top five stocks are as follows:

	<b>AAPL</b>	<b>AMZN</b>	<b>MSFT</b>	<b>GOOG</b>	<b>FB</b>
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<b>AMZN</b>	0.12	0.15	0.12	0.10	0.12
<b>MSFT</b>	0.17	0.12	0.19	0.14	0.15
<b>GOOG</b>	0.13	0.10	0.14	0.15	0.14
<b>FB</b>	0.16	0.12	0.15	0.14	0.21

The variance of the S&P 500 index returns is known to be 0.04.

Suppose we desire to invest in the S&P 500 index portfolio, but find that it is impractical to invest in all 500 stocks. Instead we choose to invest in the five stocks in the table in a way that replicates or tracks the S&P 500 index portfolio most closely---in the sense of minimizing the variance of the difference in returns between our portfolio of 5 stocks and the S&P 500 index portfolio. Simultaneously, we desire to choose the portfolio weights so that the portfolio mean return is equal to 0.10.

Note that short positions (negative weights) are permissible and the sum of all the weights must be equal to one.

What is the optimal portfolio weight for Alphabet, Inc. (ticker: **GOOG**)?

Please express your answer in decimal (not percentage) form and round your numerical answer to two decimal places.

**Question 14****3 pts**

At what price is the yield of a 10-year, 10% bond equal to the yield of a 5-year, 4% bond whose price is \$102?

Both bonds pay coupons every 6 months and have a face value of \$100.

Please round your numerical answer to two decimal places.

**Question 15****5 pts**

Upon graduation from UCI you receive a generous gift of \$500,000 from a wealthy relative to buy a house in Irvine. Instead of using the gift to buy a house, you decide to invest the \$500,000 in the S&P 500 index and take out a mortgage loan for an additional \$500,000 to buy the house.

Assume the mortgage has an original principal balance of \$500,000 and has a term of 30 years. The mortgage has an annual interest rate of 3%, or 0.25% per month. The mortgage compounds monthly. The downpayment on the house is zero.

Assume your investment in the S&P 500 index grows at 1% per month and also compounds monthly, for 30 years.

In order to make the fixed monthly mortgage payments that occur at the end of each month, you sell a portion of your investment in the S&P 500 index at the end of each month to exactly make the required mortgage payment.

Assume there are zero transactions costs and zero taxes.

After 30 years, your mortgage loan is completely paid off and you own the house. How much is your investment in the S&P 500 index worth at that time?

- ☐ Between \$9 million and \$11 million
- ☐ Between \$11 million and \$13 million
- ☐ Between \$7 million and \$9 million
- ☐ Less than \$5 million
- ☐ More than \$15 million
- ☐ Between \$5 million and \$7 million
- ☐ Between \$13 million and \$15 million

### Question 16

5 pts

Consider a market with 100 **mutually uncorrelated** risky assets that all have the same identical variance  $\sigma^2$  but whose Sharpe ratios  $S_k$  are all different, ranging according to the formula:

$$S_k = \frac{k}{100\sigma}, \quad 1 \leq k \leq 100$$

Using Markowitz mean-variance optimization, determine the optimal portfolio weights, assuming a risk-free asset exists. Note the risk-free rate  $r_f$  and variance  $\sigma^2$  are unknown.

What is the optimal portfolio weight for the risky asset with the maximum Sharpe ratio?

Please express your answer in percentage and round your numerical answer to two decimal places.

**Question 17****10 pts**

Consider a popular portfolio management strategy called **constant-proportion rebalancing**.

Assume a risky stock price doubles or halves every day, with equal probability.

You start off with \$100 and invest 50% in the risky stock and 50% in cash which earns zero interest.

At the end of every day, no matter how the stock price changes, you rebalance your portfolio to be exactly 50% invested in the risky stock and 50% invested in cash.

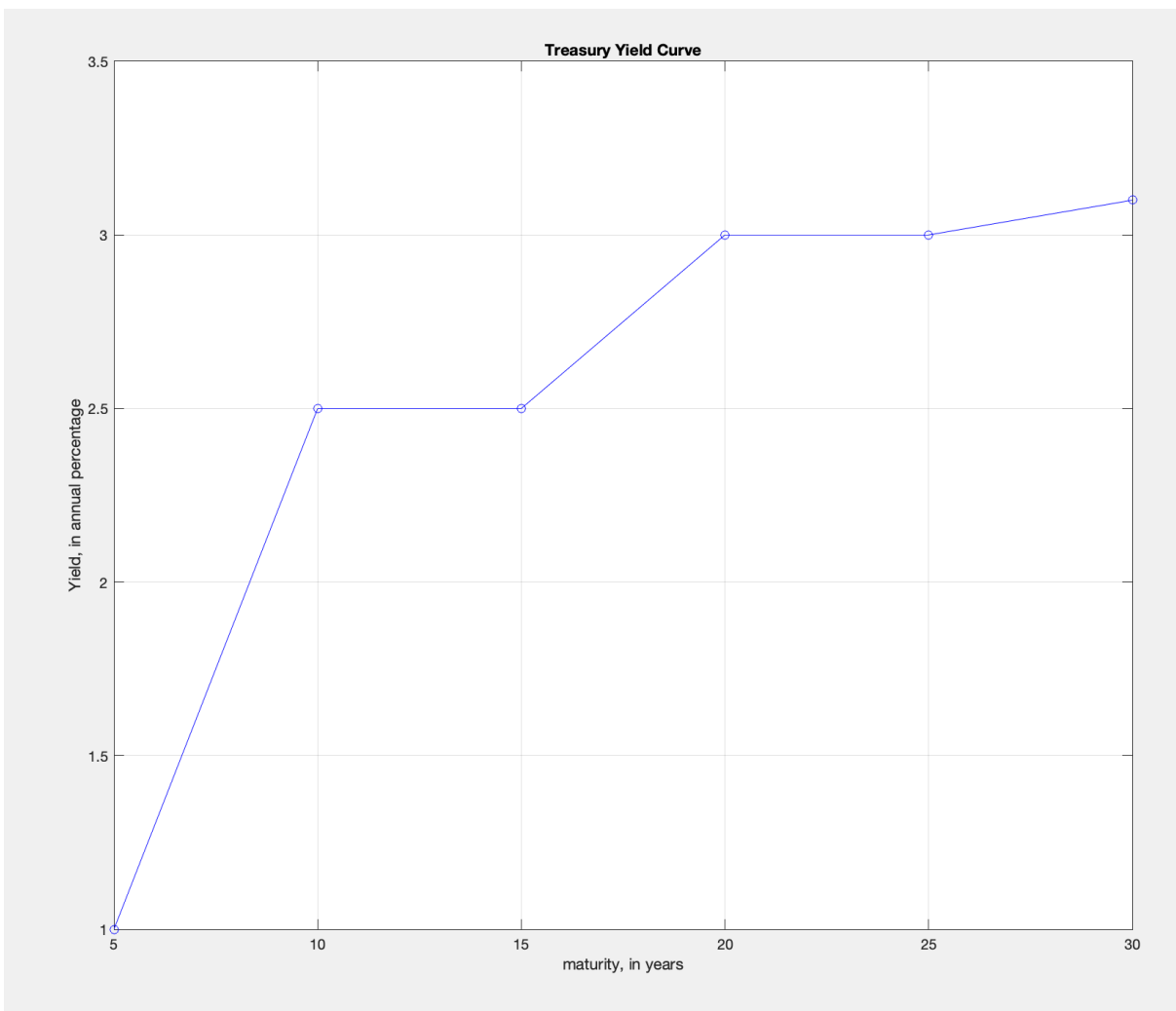
What is the expected value of this constant-proportion rebalanced portfolio after 10 days?

Please round your numerical answer to the nearest integer number of dollars.

**Question 18****5 pts****Bond Trading**

Consider the United States Treasury Yield Curve today:





The precise yield-to-maturities for 6 tradable zero-coupon U.S. treasuries are listed here:

30-year Bond	3.1%
25-year Bond	3.0%
20-year Bond	3.0%
15-year Bond	2.5%
10-year Note	2.5%
5-year Note	1.0%

As a bond trader, you are given \$100,000 to invest and seek to maximize the value of your investment in 10 years. You are free to invest in any of the 6 U.S. zero-coupon treasuries listed in the table above today, and may rebalance your portfolio once

again in exactly 5 years. After this rebalancing, you must hold the portfolio for the remaining 5 years.

**You may assume the yield curve does not change over the entire 10 year investment period.** Note this implies **that in 5 years**, the 30-year zero-coupon bond will be a 25-year zero-coupon bond with 3.0% yield-to-maturity, the 25-year zero-coupon bond will be a 20-year zero-coupon bond with 3.0% yield-to-maturity, the 20-year zero-coupon bond will be a 15-year bond with 2.5% yield-to-maturity, etc.

What is the maximum possible value of your investment after 10 years? Please round your numerical answer to the nearest dollar.

Quiz saved at 8:57pm

Submit Quiz