

Econ 252 - Financial Markets

Spring 2011

Professor Robert Shiller

Midterm Exam #2

Suggested Solution

Part I.

1. Fabozzi et al., pp. 465-468; Lecture 10 on “Real Estate”.

Fannie Mae is the Federal National Mortgage Association, created by Congress in 1938 to create a secondary market for FHA approved mortgages. It borrows money, buys and holds mortgages. It also securitizes mortgages.

- 1944: Allowed to buy VA (Veteran Administration Loans).
- 1954: Congress makes Fannie Mae a “mixed ownership corporation”, with private owners.
- 1968: President Johnson signs bill making Fannie a fully private corporation.
- 1976: Conventional loans outnumber FHA & VA.
- 2008: Failed, put into conservatorship 2008.

2. Shiller manuscript, chapter 9; Lecture 10 on “Real Estate.”

Most loans to buy a house before the 1930s in the United States were simple 3- to 5-year loans, carrying the requirement to pay the interest monthly, and the entire term at

the end of the period. After the housing crisis of the 1930s, the US switched to long-term amortizing mortgages.

3. Lecture 11 on “Behavioral Finance and the Role of Psychology”.

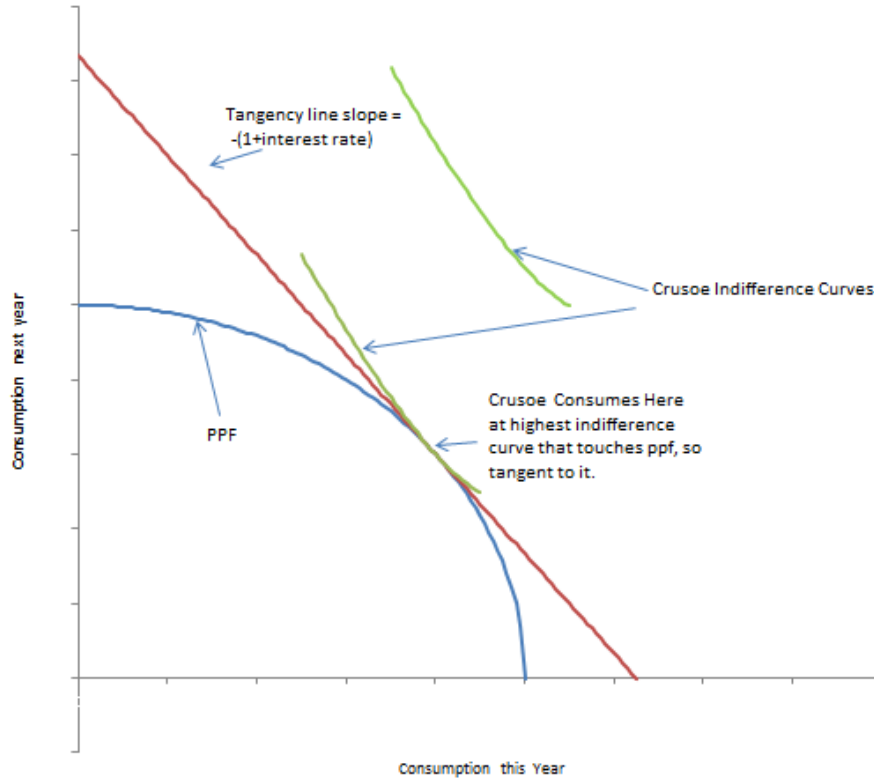
Cognitive dissonance is the mental conflict that occurs when one learns one’s beliefs are wrong, leading to avoidance behavior.

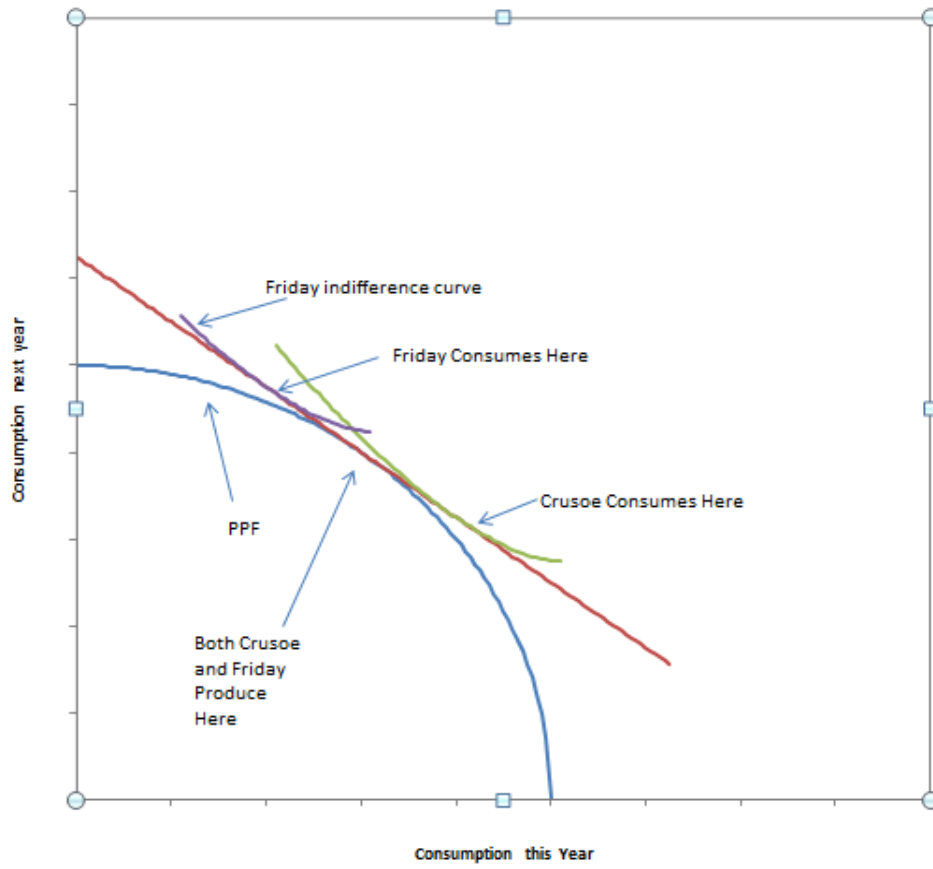
As an example, Sendhil Mullainathan and his co-authors sent hired actors to financial advisers. Each actor presented to the advisor one of several made-up portfolios. Some were risk oriented, others conservative. The advisers suggested they continue with whatever investment strategy they had started out with, apparently not wanting to stir up cognitive dissonance feelings.

4. Lecture 8 on “Theory of Debt, Its Proper Role, Leverage Cycles”.

Pre-Friday, equilibrium has Crusoe finding the point on the PPF that touches his highest indifference curve, and both produces and consumes there.

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In the post-Friday equilibrium, Crusoe borrows part of Friday's output, consumes more this period, Friday consumes less. This is reversed next year. Interest rate declines, since a more patient individual enters the economy, forcing the production point to the left, where the PPF has a less negative slope.

5. Guest lecture by Maurice “Hank” Greenberg.

Hank Greenberg, in his lecture, emphasized building the right corporate culture, an innovative culture that attracted smart people. They then looked for major risks that were not managed, and got together a group of underwriters, who could really figure out these risks. For example, AIG was the first to offer directors and officers insurance. That met a need. Also, kidnapping insurance for executives. He could insure such things by keeping diversified, not too much of any one kind of risk. He got good at hedging risks, with smart people. He went to Lloyd's of London and got them to reinsure, convinced them. He also was very strong about getting into foreign markets, he was politically active about opening trade. He lobbied in this country to block Japanese financial services from the US until Japan allowed US financial services into Japan. This eventually worked. The trade negotiators never got much involved in financial services, they were focused on manufacturing, but he used his personal suasion to get these things going. These things took years. He visited China for 15 years or so, before he got them to allow him to start selling life insurance there. It was all based on personal relationships, and diplomacy. It is a big world, but to deal with it you have to work with the people and press for basic principles. (AIG never once gave bribes, long before the Foreign Corrupt Practices Act of 1977 forbade US corporations from giving bribes abroad.)

6. Fabozzi et al., p. 426.

Trade Reporting and Compliance Engine, introduced in 2002 by the National Association of Securities Dealers, reports trades in corporate bonds, over-the-counter secondary market transactoins, publishes aggregate statistics at the end of each day.

7. Fabozzi et al., p. 351.

A circuit breaker is a temporary halting of trading during a sharp market drop.

8. Lecture 12 on “Misbehavior, Crises, Regulation, and Self-Regulation.”

Traditional financial regulation is microprudential: It seeks to reduce risks to individual firms’ fulfilling their obligations to their clients, to prevent instabilities internal to the firm. Macroprudential regulation has become prominent after the financial crisis of 2007-9: It seeks to prevent firms’ creating a situation conducive to systemic failure, focuses on externalities and spillovers, and seeks to mitigate the “too big to fail” problem.

9. Fabozzi et al., pp. 49-51, Lecture 13 on “Banks.”

Different asset classes are assigned different risk-weights, higher weight for more risky classes. Then, the amounts with which certain asset classes appear on a bank’s balance sheet are multiplied by the risk weight and added up, resulting in the bank’s risk-weighted assets. Subsequently, the risk-weighted assets are used to determine a bank’s capital requirements.

10. Fabozzi et al., pp. 409-410.

A group of banks, called a syndicate, provides funds to a single borrower. An arranger lines up banks to participate in the syndicate, and banks in the syndicate have the right to sell their parts of the loan to other banks.

Part II.

Question 1

The relevant formula for a coupon bond is

$$P = C \cdot \left(\frac{1 - \frac{1}{(1+\gamma)^n}}{\gamma} \right) + \frac{M}{(1+\gamma)^n},$$

with the following notation:

- P: price of the coupon bond contract today,
- C: coupon payment in each period,
- γ : yield referring to one period,
- M: maturity value,
- n: number of periods.

As stated in the question, $M = \$25,000$. A period always refers to a six months. Therefore, the coupon payment in each period equals $0.5 \cdot 3\% \cdot \$25,000 = \375 .

(a) In this part, $n=2 \cdot 2=4$.

As the price of the coupon bond is lower than the principal value, the yield of the bond cannot be lower than 3%, which is the coupon rate. So, the yield cannot be equal to 2%.

In order to check whether the yield is equal to 4% or 5.5%, it is sufficient to check one of the two yield values, as the hint states that one of the yield values is the correct answer.

Applying the price formula with $\gamma=0.5 \cdot 5.5\%=2.25\%=0.0225$, one obtains

$$375 \cdot \left(\frac{1 - \frac{1}{(1.0225)^4}}{0.0225} \right) + \frac{25,000}{(1.0225)^4} \approx 24,290.36.$$

Therefore, 5.5% is the approximately correct yield.

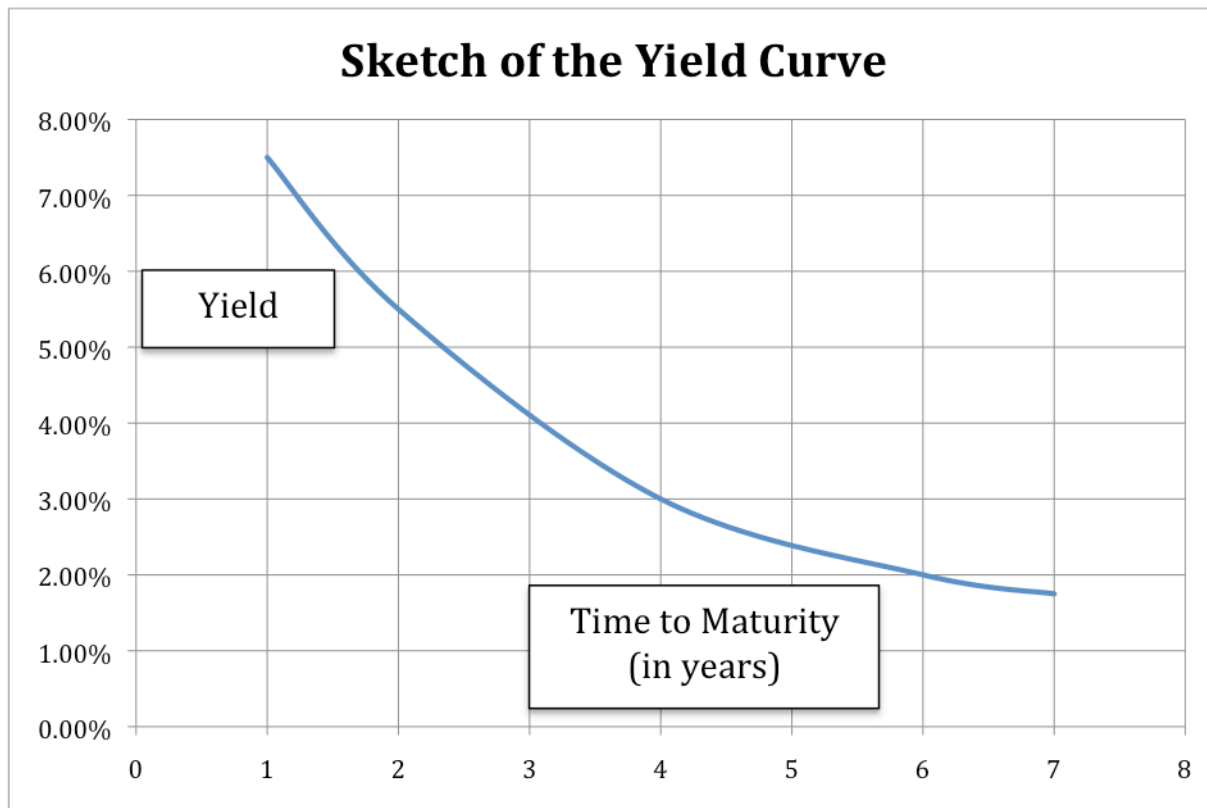
(b) In this part, $n=2 \cdot 4=8$.

As the price of the coupon bond equals the par value, the yield necessarily equals the coupon rate. That is, the yield is equal to 3%.

(c) In this part, $n=2 \cdot 6=12$.

As the price of the coupon bond is higher than the principal value, the yield of the bond cannot be higher than 3%, which is the coupon rate. So, the yield cannot be equal to 3.25% or 3.75%. As one of the yields is the correct yield, according to the hint, the answer is 2%.

(d)



The displayed yield curve is inverted.

Question 2

As stated, a time period refers to six months.

(a) It is possible to compute the 42-month spot rate.

Denote the one-period quantity of the desired 42-month spot rate by z .

The 18-month spot rate for one period is $0.5 \cdot 2.5\% = 1.25\% = 0.0125$. The forward rate between 18 and 42 months for one period is $0.5 \cdot 3.5\% = 1.75\% = 0.0175$.

18 months corresponds to 3 periods and 42 months to 7 periods. In consequence, there are 4 period between 18 and 42 months.

One therefore obtains that z satisfies the following identity:

$$(1.0175)^4 = \frac{(1+z)^7}{(1.0125)^3}.$$

This implies that $z \approx 1.535\%$. That is, the annualized 42-month spot rate equals approximately 3.07%.

- (b) As in part (a), the 18-month spot rate for one period is $0.5 \cdot 2.5\% = 1.25\% = 0.0125$. Moreover, the 42-month spot rate for one period has been computed as $0.5 \cdot 3.07\% = 1.535\% = 0.01535$.

The investment strategy is as follows:

- Borrow $\$a / (1.0125)^3$ today at the 18-month spot rate, to be repaid 18 months from now.
- Invest the borrowed money at the 42-month spot rate for 42 months.

The balance of this investment strategy evolves as follows:

- Today:
You invest all of the borrowed money. That is, you do not need to put up any of your own capital and there is no capital left over at the end of today.
- 18 months from now:
The 18-month loan matures. So, you need to repay the originally borrowed amount multiplied by the 18-month spot rate for three periods, that is,

$$\frac{a}{(1.0125)^3} \cdot (1.0125)^3 = a.$$

You use the $\$a$ that you collect 18 months from now to repay the loan.

In summary, you start with $\$a$ and you have no capital left at the end of 18 months from now.

- 42 months from now:
The 42-month investment matures. So, you collect the invested amount multiplied by the seventh power of the 42-month spot rate for one period. The seventh power originates from the fact that seven periods pass between today and 42 months from now. That is,

$$\frac{a}{(1.0125)^3} \cdot (1.01535)^7 = a \cdot \frac{(1.01535)^7}{(1.0125)^3}.$$

So, you start with no money at all and you have $\$a \cdot (1.01535)^7 / (1.0125)^3$ at the end of 42 months from now.

In summary, the investment strategy turns \$a into $a \cdot (1.01535)^7 / (1.02)^3$. The factor $(1.01535)^7 / (1.02)^3$ exactly corresponds to the factor $(1.0175)^4$, which gives rise to an annualized forward rate between 18 and 42 months of 3.5%.

- (c) The Pure Expectation Theory states that the expected 24-month spot rate 18 months from now is equal to the forward rate between 18 and 42 months (that is, between 18 months and 24 months later than that). Therefore, the expected 24-month spot rate 18 months from now is 3.5% according to the Pure Expectations Theory.

Question 3

(a) The loan-to-value ratio (LTV) is

$$LTV = \frac{225,000}{350,000} = 0.643 = 64.3\%.$$

(b) The monthly payment is determined according to the formula

$$MP = MB_0 \cdot \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right],$$

where

- n: number of months of the mortgage loan, that is $n=12 \cdot 15=180$,
- i: note rate divided by 12, that is $i=8.4\%/12=0.7\%=0.007$,
- MB_0 : original mortgage balance, that is $MB_0=225,000$,
- MP: monthly mortgage payment.

It follows that

$$MP = 225,000 \cdot \left[\frac{0.007(1.007)^{180}}{(1.007)^{180} - 1} \right] \approx 2,202.49.$$

The outstanding mortgage balance in the beginning of month 121 is computed as the outstanding mortgage balance at the end of month 120 from the following formula:

$$MB_t = MB_0 \cdot \left[\frac{(1+i)^n - (1+i)^t}{(1+i)^n - 1} \right],$$

where

- n: number of months of the mortgage loan, that is $n=12 \cdot 15=180$,
- i: note rate divided by 12, that is $i=8.4\%/12=0.7\%=0.007$,
- MB_0 : original mortgage balance, that is $MB_0=225,000$,
- MB_t : remaining mortgage balance at the end of month t.

It follows that

$$MB_{120} = 225,000 \cdot \left[\frac{(1.007)^{180} - (1.007)^{120}}{(1.007)^{180} - 1} \right] \approx 107,604.81.$$

The interest rate in a given month is computed as 0.7%, which is the note rate divided by 12, multiplied by the remaining mortgage balance in the beginning of the respective month.

Subsequently, one obtains the principal repayment in a given month from the fact that the interest payment and the principal repayment in a given month add up to the monthly mortgage payment.

In consequence, the full amortization table has the following form:

Month	Interest Payment	Principal Repayment	Remaining Mortgage Balance in the Beginning of the Month
121	\$753.23	\$1,449.26	\$107,604.81
122	\$743.09	\$1,459.40	\$106,155.55

- (c) If the borrower prepays \$10,000 in month 122, the principal repayment in month 122 will increase from \$1,459.40 to \$11,459.40.

The remaining mortgage balance in the beginning of month 123 after the prepayment in month 122 is $\$106,155.55 - \$11,459.40 = \$94,696.15$.

Question 4

- (a) Using the outstanding mortgage balance in the beginning of month 190 as well as the pass-through rate, the net interest in month 190 equals

$$(5\% \cdot 180,000,000) \cdot \frac{1}{12} \approx 750,000.$$

The scheduled principal is the difference between the mortgage payment and the gross coupon interest. The gross coupon interest can be computed from WAC and the outstanding balance in the beginning of month 190 as follows:

$$(5.5\% \cdot 180,000,000) \cdot \frac{1}{12} \approx 825,000.$$

Therefore, one obtains the scheduled principal in month 190 as

$$1,500,000 - 825,000 \approx 675,000.$$

- (b) The SMM in month 190 follows from the PSA assumption and the WAM via the CPR. Given the WAM is 330 months, the CPR in month 190 of the mortgage pass-through security for 100 PSA is 6%. Therefore, the CPR in month 190 for 200 PSA is

$$200\% \cdot 6\% = 12\% = 0.12.$$

In consequence, the SMM in month 190 for 200 PSA is

$$1 - (1 - 0.12)^{1/12} \approx 0.010596.$$

Making use of the SMM, the outstanding balance, and the scheduled principal for month 190, it follows that prepayment in month 190 equals

$$0.010596 \cdot (180,000,000 - 675,000) = 1,900,127.70.$$

- (c) The outstanding mortgage balance in month 191 is the difference between the outstanding mortgage balance in month 190 and the sum of the scheduled principal in month 190 as well as the prepayment in month 190, that is

$$180,000,000 - (675,000 + 1,900,127.70) = 177,424,872.30.$$