Sensor guidance
Exam SØK2010, spring 2022

Sensor guidance

Question 1 (20%)
Briefly explain the following terms:

a) Discounting
A methodology to compare values at different times. The discount factor for money is the interest rate.

b) Real interest rate
The interest rate minus the inflation rate.

c) The policy rate
The interest rate on banks' deposits in the central bank, determined by the central bank. This is the lowest interest rate.

d) NOWA
The interest rate that banks pay each other overnight / daily interest rate between banks.

e) Net present value
The discounted sum of money streams over time. For investment project it is the discounted income from the investment, minus the investment.

f) Credit rating
An assessment of credit quality. Credit quality is determined by the expected loss of lending money to a borrower (firm, bank, government, etc), for example in the form of providing loans or buying bonds.

g) Liquid asset
Money is liquid. All assets that that can be sold in the market on very short notice (liquid markets) without losing value are also liquid assets.

h) Money
Money has three, or perhaps four, features. First, it is a medium of exchange. It is generally accepted as payment. Second, it is a unit of account. It is a measure of value in the economy. Third, it can be used for storing of value at low risk. All features need to be fulfilled. A fourth feature that is included in the textbook is standard of deferred payment.

i) Money creation
The majority of money in the modern economy is created by commercial banks making loans. When a bank makes a loan, the bank credits the bank account of the borrower with a bank deposit of the size of the loan. At that moment, new money is created.

j) Cryptocurrency
It is a digital currency issued without the involvement of any authorities or a specific institution. It does not have coins and notes. Such currencies are based on digital technology to build trust and to determine the supply. It is not based on intermediates such as banks, but use digital trading platforms.

k) Intertemporal optimization
An optimization problem that involves multiple time periods. It separates income and consumption and determines optimal consumption in different time periods.

Question 2 (20%)

Consider the market for a specific bond with a given maturity.

a) What is the difference between a coupon bond and a fixed term bond?
A coupon bond pays a yearly yield in nominal terms determined at the time of issuing the bond, in addition to the payment at the maturity of the bond. A fixed term bond repays the bond to the determined price at maturity. It does not include any payment before that date.

b) Develop the relationship between the price and the interest rate of a fixed term bond.
This is an inverted net discount value approach. If the price of the bond when it is issued is P and the repayment at maturity after n years is FV, then the relationship between the price and the interest rate i is $FV = (1+i)^n P$ *or* $P = \frac{FV}{(1+i)^n}$.

c) Use a demand and supply framework to discuss the effect on the price and the interest rate of the bond in the following cases.
It is necessary to develop the demand of a specific bond and the supply of the bond. It is appropriate to use the market for an existing bond, not the market for a new bond issued. Draw a figure for the market, with price and quantity on the axes. The supply curve has a positive slope because more bond owners want to sell the bond when the price they get is higher. The demand curve has a negative slope because more investors want to buy the bond when it becomes cheaper. A negative relationship between the price and the interest rate follows from question b).

i. Weaker credit rating of the issuer of the bond.
The larger probability of default shifts the demand curve inwards. Reduced price and higher interest rate.

ii. Increased total investments in the economy.
The increased investment needs funding. More investors want to sell bonds in order to raise money for investment. The supply curve shifts outwards. Reduced price and higher interest rate.

iii. The central bank increases the policy rate.
The return on other assets increases. The bond becomes relatively less attractive. The demand curve shifts inwards. Reduced price and higher interest rate.

iv. Increased uncertainty in the stock market.
The attractiveness of other assets declines. The bond becomes relatively more attractive. The demand curve shifts outwards. Higher price and lower interest rate.

v. The war in Ukraine.
There is no final answer on the effect of this event. It has many effects that are relevant for bond markets. It seems reasonable to argue for more uncertainty in the financial markets (answered in iv) and a negative macroeconomic shock (answered in ii and iii).

d) It is sometimes claimed that bonds only have downside risk, whereas stocks have upside as well as downside risks. Is this claim correct? Explain
No, this is not correct. The answers in c) illustrate that the price of a bond can both increase and decrease.

e) Why do governments issue bonds?
1. *To finance public investment and public sector budget deficits*
2. *To contribute to well-functioning financial markets by constructing liquid markets determining long term interest rates.*

Question 3 (10%)
Researchers find that it is easier for firms to get a loan from their regular bank, where they have their regular checking accounts, than from other banks. Present possible reasons for this finding.
The regular bank has more information about the firm than other banks. More information comes from learning during a long-term relationship. It is therefore easier for the bank to consider potential adverse selection and moral hazard problems. It is also easier for the bank to follow up on covenants related to loans. Solid firms can bargain better loan conditions when they have proved that they are solid compared to using the open market.

Question 4 (10%)
a) What is a bank run?
Many depositors want to withdraw their deposits from the bank at the same time ("running to the bank to get my money").

b) Present policies implemented to avoid bank runs.
It is not expected that all policies used in different countries are presented. It is expected that the following are included: Deposit guarantee, Liquidity requirements, Capital requirements and something related to the role of the central bank.

Question 5 (40%)

Consider the following case:

- It is a two-period case. The projects have an investment I in Period 0 and receive a payoff in Period 1. The investor has equity of E and need a loan L, where L = (I – E).
- There are two types of investment projects in the market
    - Type 1 projects are safe with known payoff A > I.
    - Type 2 projects are uncertain. The payoff is U with probability p and zero with probability (1 - p). The sizes of the values are such that U > A > I ≥ L.
    - The share of Type 1 projects is s and the share of Type 2 projects is (1 - s).

It is easiest to assume that the risk-free interest rate is equal to zero, which is done consequently here.

Consider a Type 2 project.

a) Formulate the condition that the investor will invest in the project.
The investor will invest if the discounted expected payoff is larger than the investment. The expected payoff is U minus the repayment to the bank with probability p, and the investment of the investor is E. The condition is
$p * (U - (1 + r) * L) \geq E$,
where r is the interest rate on the loan.

b) Formulate the condition that the bank will provide a loan.
The bank will only provide the loan when the expected repayment is at least equal to the loan. This implies that
$p(1 + r)L \geq L$.

c) What will be the interest rate on the loan?
The answer depends on the market situation for loans. This must be described. One reasonable answer provides a range of the interest rates, where the highest rate is the case when a bank has a monopoly and the lowest rate is the case with perfect competition in the market.
With perfect competition, the bank does not earn any profit. $p(1 + r)L = L$ *, which implies that*
$(1 + r) = 1/p$.
With monopoly, the bank set the interest rate such that it takes all the profit. There is no profit for the investor, which implies that $p * U = E + p * (1 + r) * L$*, and*
$(1 + r) = (p * U - E)/(p * L)$.
The actual interest rate will be in the interval
$\frac{1}{p} \leq (1 + r) \leq \frac{U}{L} - \frac{E}{p*L}$.

d) What is the effect on the interest rate of an increase in p?
This follows from the answer in c). For the intuition, it is useful to recall that p is a measure of risk. Higher p implies lower risk in the project. Under perfect competition $(1 + r) = 1/p$ *. If p increases, the right hand side of the equation declines. For the equality to hold, that must happen also for the left hand side. r declines.*
$\partial(1 + r)/\partial p = -1/p^2 < 0.$
With monopoly $(1 + r) = (p * U - E)/p * L$ *. When p increases, the right hand side of the equation increases. For the equality to hold, that must happen also for the left hand side. r increases.*
$\partial(1 + r)/\partial p = E/p^2 > 0.$
Thus, the effect depends on the market situation. With high competition in the market for loans, less risk implies lower interest rate because the bank offer better conditions to the investor. With little competition, the bank extracts some of the higher profit in the project by setting a higher interest rate.

In addition to the assumptions above, assume the following:

- There are many investors. Each investor has only one investment option. The investor knows whether the project is of Type 1 or Type 2.
- The information available for the bank is I, E, A, U, D, p and s. The bank cannot observe the investment option for a specific investor.

e) Describe the asymmetric information in this case.
This is a case of adverse selection because the asymmetry is related to the situation before the contract is determined.

f) Formulate the condition that the bank will provide a loan to an investor.
The bank will only provide the loan when the expected repayment is at least equal to the loan. This implies that
$s(1 + r)L + (1 - s)p(1 + r)L \geq L$.
With probability s the bank faces the safe project and get the loan repaid. With probability (1 – s), the bank faces the risky project and get the loan repaid only with probability p.

g) What will be the interest rate on the loan?
The answer depends on the market situation for loans. This must be described. One reasonable answer provides a range of the interest rate, where the highest rate is the case where the bank has a monopoly in the market and the lowest rate is the case of perfect competition in the market.
With perfect competition, the bank does not earn any profit. $s(1 + r)L + (1 - s)p(1 + r)L = L$ *, which implies that*
$(1 + r) = 1/(s + (1 - s)p)$.
With monopoly, the bank set the interest rate such that it maximizes profit. In order to avoid default, the bank must ensure that firms with safe project will invest. Thus, for the bank it is optimal to set the interest rate such that there is no profit for firms with the safe project. This implies that $A - (1 + r)L = E$*, and*
$(1 + r) = (A - E)/L$
The actual interest rate will be in the interval
$\frac{1}{(s+(1-s)p)} \leq (1 + r) \leq \frac{A-E}{L}$

h) What is the effect on the interest rate of an increase in p?
With the same logic as in d), it follows that under perfect competition
$\partial(1+r)/\partial p = -(1-s)/\big((s+(1-s)p)\big)^2 < 0$
and under monopoly
$\partial(1+r)/\partial p = 0$
It follows that the effect, over the range of possible interest rates, is non-positive.

i) Compare the interest rates found in questions c) and g) and provide intuition for the differences.
The risk from the bank's point of view is lower in the adverse selection case g) than in the full information case c). Under perfect competition, this implies a lower interest rate. The interest rate is lower if $\frac{1}{(s+(1-s)p)} < \frac{1}{p}$. *This can be rewritten s(1 – p) > 0, which holds because both s and (1 – p) have positive values.*
Under monopoly, the bank takes all the profit in the risky project in case c) and all the profit in safe project in g). The difference in the interest rate thus depends on the difference in the expected payoff in the two types of projects. Formally, the interest rate is highest in case c) if $\frac{U}{L} - \frac{E}{p*L} > \frac{A-E}{L}$,
which implies
$p(U-A) > (1-p)E.$
Whether this holds depends on the values of U, A, E and p. In the case E = 0, the equation holds and the interest rate is lower in the adverse selection case.

j) Explain how the kind of asymmetric information in this case can give inefficient market outcomes. Is it possible that the market will be efficient with this kind of asymmetric information? Explain.
Adverse selection makes firms with safe projects worse off. Under perfect competition they must pay an interest rate above the risk free rate. Risky firms are better off because they pay a lower interest rate. Since the bank does not earn profit under perfect information, this implies that there is a negative payoff for risky projects for the banks. Safe projects subsidize risky projects. There is no guarantee that projects with negative net present value will be financed. The market will be efficient in the sense that only profitable projects are financed if pU > E + L.

k) Consider the following values of the parameters in the model: U=7, A = 6, I = 5, E = 2, p = 0.7 and s = 0.5. For these parameter values, calculate the net present value of the two types of projects, the expected profit for the two types of investors and the expected profit of the bank. Comment the results.
The interest rate under perfect competition is $(1+r) = \frac{1}{(s+(1-s)p)}$ *=1.18*
The interest rate under monopoly is $(1+r) = \frac{A-E}{L} = 1.33$

<u>For safe projects</u>
Net present value: A – I =1
Expected profit for the firm, perfect competition: A – (1 + r)L – E = 0.47
Expected profit for the firm, monopoly: A – (1 + r)L – E = 0

The expected profit for the firm is in the interval $[0, 0.47]$
For risky projects
Net present value: pU – I = -0.1
Expected profit for the firm, perfect competition: $p * (U - (1 + r) * L) - E = 0.42$
Expected profit for the firm, monopoly: $p * (U - (1 + r) * L) - E = 0.10$
The expected profit for the firm is in the interval $[0.10, 0.42]$
The bank
Expected profit under perfect competition: $s(1 + r)L + (1 - s)p(1 + r)L - L = (1 + r)(s + (1 - s)p)L - L = 0$,
Expected profit under monopoly: $(1 + r)(s + (1 - s)p)L - L = 0.39$

In this numerical case, the average net present value is 0.45 (the average of 1 and -0.1 where both have probability 50%). With perfect competition, this average profit is shared almost equally between the firms. Under monopoly, the bank extract most of the profit, but the risky project also gets some profit.