

EE431/438 Economics of Financial Markets and Institutions

Exercise 6 : Theory of Financial Intermediation

Guidance and Solution

Consider an economy in which n identical firms seek to finance projects.

- Each entrepreneur owns a firm and each firm requires an investment of $m = 100$ units of capital.
- The returns of each firm are identically independently distributed.
- The total number of lenders is $100n$, each lender owns 1 unit of capital to lend out.
- The project's realized value is a random variable with realization denoted by \tilde{y} .
- $Y = 160$ with probability 0.75 and 80 with probability 0.25.
- The distribution of Y is known to all borrowers and lenders
- The realization of Y is observed freely by the owner of the firm.
- The other cannot observe the total output of the project without paying a cost.
- L is total loan repayment(principal + interest) promised by each firm.

Answer the following questions.

1. Is an entrepreneur willing to speak the truth about the outcome of his/her project? Describe the moral hazard problem in this economy.

The moral hazard problem arises due to asymmetric information problem in this economy. The realization of Y is freely observed by the entrepreneur alone. The other cannot observe the total output of the project without paying a cost. After the loan is granted, the borrower (the entrepreneur) is not willing to speak the truth about the outcome of his/her project. The smaller the amount of output the entrepreneur reports to his/her lender, the lower the amount of actual repayment he/she will repay and the higher the amount retains for his/her own. The entrepreneur always gains more by reporting the smallest possible value, no matter what the true value of output. If there is no cost to the entrepreneur of understating the amount, the entrepreneur always does. The lender will never be paid.

2. If we impose a punishment system such that the borrower will be forced liquidation if he/she pay equal to or lower than a specified amount. Assume that liquidating gives no proceeds to the lenders and the borrower. Each lender needs a repayment of at least 1.05. What should be the value of L ?

Any L between 80 and 160 forces the borrower into liquidation when the project returns 80 and is paid in full when the project returns 160. This gives the lender an expected return of $0.75L$, because nothing is received when liquidation. Solving for the minimum value of L , $L = 140$.

3. Describe how the punishment system in question 2 help solving the moral hazard problem.

When $Y = 80$, the entrepreneur can pay $< L = 140$. The entrepreneur will be forced into liquidation. When $Y = 160$, the entrepreneur will pay $L = 140$ and keep the rest. The expected return to the 100 lenders is equal to 140×0.75 which is equal 105. The rate of returns from lending is equal the required rate. After we impose the punishment system, whenever the entrepreneur has enough money to repay the debt, they will always repay. This is because the entrepreneur will get nothing after liquidation. If the entrepreneur has enough to repay the debt, it is better to repay and keep the rest than not to repay and get nothing. Hence, once we impose “the punishment”, the truth about their project’s outcome will be revealed.

*Notice that when $Y = 80$, we have to force the entrepreneur into liquidation. We cannot accept any payment which is lower than L . The punishment system is set and it works out this way. If we ever accept any payment lower than L , the payment will never be equal to or greater than L even when the entrepreneur is able to pay the amount L . In this case, the lender/the bank does not pay any monitoring cost. The lender and the bank does not know what the true output is.

4. How many entrepreneurs we have to punish?

We have to punish all the entrepreneurs who fails to repay $L = 140$. All the entrepreneur whose project yields $Y = 160$ will repay $L = 140$ to avoid liquidation. All the entrepreneur whose project yields $Y = 80$ will be punished. There are n entrepreneurs in the economy. The probability that the project yields $Y = 80$ is equal to 0.25. Assume that n is large enough. The law of large numbers can be used. $0.25 \times n$ entrepreneurs will fail to repay L because their project value is equal to 80, which is less than L . All $0.25n$ will be punished (forced into liquidation).

5. Let the cost of punishment is equal to P per one entrepreneurs. π is the probability of borrower default. Define the value of π and calculate total punishment cost of this economy for the two financial systems (i) direct finance and (ii) indirect finance.

The punishment cost for the two financial systems are the same. It is equal to the number of entrepreneurs to be punished \times cost of punishment per one entrepreneurs. The number of entrepreneur to be punished is equal to the probability of borrower default (π) \times the number of entrepreneurs in the economy(n). In this case, the entrepreneur will default when his/her output is lower than $L = 140$. The probability that the output of an entrepreneur’s project is lower than 140 is equal to 0.25. Thus, $\pi = 0.25$. Total punishment cost of this economy is equal to $n\pi \times P = 0.25nP$.

6. Suppose that a lender observe the entrepreneur’s output by paying a monitoring cost. Then, in stead of liquidating when less than L is paid, the lender who monitors can use the threat of liquidation and offer to refrain from liquidation as long as the borrower repays as much as possible. Monitoring cost is paid ex ante. Lenders must learn in advance about the borrower’s business to properly interpret any data about the project returns. Let K be the cost of monitoring a borrower’s project and $K = 0.1$. The lenders then can verify the true outcome of the project. Calculate total cost of monitoring entrepreneurs in this economy for the two financial system (i) direct finance and (ii) indirect finance.

- Direct Finance:

There are many lenders. It is hard to cooperate. All the lenders will pay the monitoring cost in order to be able to verify the true outcome of the project. Duplicated monitoring by each of $100n$ lenders would cost = the number of lenders \times the monitoring cost per one borrower = $100n \times K = 100nK = 10n$.

(Assume that one individual lenders can lend to only one borrower. This assumption is quite realistic. The denomination of a bond is big compared to an individual lender’s amount of

saving. The bank can lend to many borrowers because the bank gives out loans for a large scale. Individual lenders have lower capacity to diversify their investment portfolio than the bank.)

- Intermediate Finance :

All lenders deposit their money to the bank. Then, the bank is the sole lender to the firms (entrepreneurs). Monitoring (auditing) job is delegated to the bank. Only the bank monitors the borrowers on the behalf of the lenders. Delegating monitoring to the bank avoids duplication. Total monitoring cost is equal to cost of monitoring one borrower \times the number of borrowers in the economy. Total cost of monitoring = $K \times n = nK = 0.1n$

7. Assume that the number of borrowers n is large enough. The law of large numbers (LLN) can be used. $L = 140$. What is the maximum deposit rate the bank can offer to its depositors?

nL is the total loan repayment promised to the bank. The actual repayment the bank received is less than nL because some borrowers will fail to repay.

Let Y_i be the actual realization value of borrower i 's project. X_i is the actual repayment the bank receive from borrower i .

With monitoring, $X_i = \min(L, Y_i)$. $E(X_i) = E[\min(L, Y_i)] < L$.

If $Y_i = 160, X_i = 140$.

If $Y_i = 80, X_i = 80$.

Then, $E(X_i) = 0.75(140) + 0.25(80) = 105 + 20 = 125$ which is < 140 .

* In this case, the bank can accept a payment which is lower than 140. This is because the bank has paid the monitoring cost. The bank is then able to observe the true outcome of the project. When the output of a borrower's project is equal to 80. In stead of forcing the borrower into liquidation and get nothing, the bank can force the borrower into liquidation only when the borrower pay any amount less than 80. By this way, the borrower whose project fails will repay 80 to avoid liquidation. For the borrower whose project succeeds, he or she is able to repay $L = 140$. The bank will not accept any payment lower than $L = 140$, from successful borrowers. The bank knows the true outcome of the project. The bank can distinguish unsuccessful borrowers from successful borrowers. Hence, the bank can treat these two groups of borrowers differently.

Bank's total income from lending is equal to $\sum_{i=1}^n X_i$.

$$\frac{\sum_{i=1}^n E(X_i)}{n} = E(X_i) \text{ when } n \text{ is sufficiently large.}$$

Thus, the bank's total income from lending is equal to $\sum_{i=1}^n X_i = nE(X_i) = n125$. (for certain)

The bank's total income from lending net of monitoring cost is equal to $nE(X_i) - \text{monitoring cost} = 125n - 0.1n = 124.9n$.

As long as the bank can promise its depositors ex ante at most (in total amount) $nE(X_i) - nk = 124.9n$ (or 1.249 for each depositor), the bank will have enough money to repay their depositors.

As long as the deposit rate, $r_d, r_d \leq 24.9\%$, the bank will be able to repay the depositor the promised amount with certainty.

8. Discuss the economies of scale and the benefits of diversification in the banking sector.

$nK < nmK$. Total monitoring cost for intermediated finance is lower than that for direct finance due to ***economies of scale***. Monitoring (auditing) costs per \$ lent is low if lending at a large scale. For example, lending \$1 million dollar to a company incurs the same auditing cost (for example: information cost, transaction cost) as lending \$100 to the same company.

Deposits in question 7 are asymptotically riskless because of ***diversification***. The banks lend to many borrowers so their income becomes certain. All depositors get their money back as promised by the bank. Compare the number with direct finance. Not all lenders get their money back as promised by the borrowers for direct finance case. Only $0.75mn$ ($75n$) lenders get their money back as promised by the borrowers. The rest $0.25mn$ ($25n$) lenders would not get their money back as promised. The $0.25mn$ ($25n$) lenders would make a loss in lending when the borrower's project fails.

(Plus, We can always trust the bank. The bank has no incentive to misreport. If the bank underreports its income and refuse to pay the amount promised to its depositors, the bank will be forced into liquidation. The bank will get nothing. Hence, there will be no punishment to the bank because the bank will never default. We do not have to pay any cost to punish the bank.)

*** Read Diamond(1996). ***