ECN 506

Liquidity Risk and Bank Panics

1. Consider an OLG economy with an infinite horizon. Individuals live for three periods. Young individuals are endowed with y goods that can either be stored (with a real one-period rate of return equal to one), or can be used to create capital (where one consumption good can be converted into one unit of capital). Capital has a two period return equal to $X > 1$, but takes two periods to mature. Unmatured capital can be bought and sold at the price v^k. Unmatured capital can be faked but can be verified for a cost $\theta > X - 1$.
Individuals do not want to consume when young and only want to consume in either middle-age or when old, however they do not know if they are the “early” type or “late” type until they reach middle age. Individuals are the early type with probability 0.5.

(a) What are the two-period returns on storage and capital?
The two-period return on storage is 1. The two-period return on capital is $X > 1$.

(b) What are the one-period returns on storage and capital? What is greater?
The one-period return on storage is 1. The one period return on capital is $v^k - \theta = x - \theta < 1$. This last inequality comes from the assumption that $\theta > X - 1$. The price $v^k = X$ as individuals are willing to pay X for a unit of capital that matures in next period and produces X units of the consumption good.

(c) Explain the problem that individuals face in this economy.
When young, if individuals knew they were the early type then they would put all of their goods in storage since the one-period return on storage is greater than the one-period return on capital. Conversely, if they knew they were going to be the late type then they would put all of their goods in capital as the two-period return on capital is greater than the two-period return on storage. Unfortunately, individuals do not know their type when young and therefore face a risk of being each type. As a result, regardless of how the young individual splits their good between storage and capital, there is a risk that they will earn a return that is lower than they otherwise could earn. That is, in expectation the individual will always have a lower return than if they had perfect information about their type.
Suppose now that there are banks that take deposits and promise returns that are infinitely lived but do not observe individual types. Banks simply see who shows up to withdraw.

(d) What return does the bank promise to early withdrawals? Late withdrawals?
The bank promises the return on storage, 1, for early withdrawals, and promises the return X on late withdrawals.

(e) How does the bank solve the problem described above?
The bank can use the fact that in expectation it knows that half the individuals will be the early

type and half will be the late type (since the probability of each occurs with probability 0.5). As a result, if the bank puts half the goods in storage and half in capital it should have exactly what it needs for each type. The bank is able to “aggregate” and eliminate the individual risks (the risk of an individual being early or late). That is, even though individuals face a risk of being the early or late type, the bank faces no risk.

(f) Do individuals have an incentive to “pretend” to be the other type? Explain, considering each type.

The early type definitely has no incentive to pretend to be the late type. If they do then they will receive return X when old and consume nothing in middle age, which is when they actually want to consume. If they reveal their true type then they will receive a return of 1 in middle-age, which is when they want to consume. Similarly, if they expect that all other individuals are revealing their true types, then the late type has no incentive to pretend to be the early type. If they wait then they receive a return of X and if they pretend to be the early type then they will receive a two-period of return equal to one. It is important to note that the late type not having an incentive to pretend relies on the fact that they believe that all other individuals are not pretending to be the other type (in particular the other late types are not pretending to be the early type).

(g) Suppose more people than expected show up to withdraw early. What does the bank do?

The bank must provide the promised return equal to one. Since more people show up than expected, the bank does not have enough goods in storage and therefore must liquidate some capital prematurely. For each unit liquidated prematurely, the bank receives $v^k - \theta = X - \theta < 1$.

(h) How many units of capital need to be sold to satisfy the withdrawal demand of the “extra” withdrawals?

To satisfy each additional withdrawal, the bank must liquidate $\frac{1}{X-\theta}$ units of capital per good withdrawn. Since $X - \theta < 1$, this means that more than one unit of capital must be liquidated for each additional unit of good withdrawn early. At some point, the bank will run out of capital to liquidate.

(i) If you are a late type and you hear that more people than expected are showing up to withdraw, what do you do?

If you believe that all other late types are going to withdraw early then you should do the same. If you wait then you will get nothing when old for the reason explained above. If you go early, then there might be a chance that you are early enough to withdraw some of your deposited goods.

2. Consider a simplified version of the model of liquidity presented in class. Individuals live for two periods. Individuals are able to acquire money or can create capital. Individuals get moved to the other island with probability π and if they are moved they can take their money with them but cannot take the capital. Individuals are moved after they make their money/capital decision. We assume that individuals only want to consume when old. Assume there is no tax or transfer τ . Both the population N and money supply M are constant. The one period return on capital is $x > 1$.

(a) Write down the young budget constraint.

The young individual has y goods available, which they can use to create capital k_t or acquire real money $v_t m_t$. The young budget constraint is: $k_t + v_t m_t \leq y$

(b) Write down the old budget constraint for movers.

Movers are unable to access the capital they created, k_t and therefore consumption of a mover, $c^m_{2,t+1}$ can only come from the money they acquired. The old mover's budget constraint is: $c^m_{2,t+1} \leq v_{t+1} m_t$

(c) Write down the old budget constraint for non-movers.

Non-movers can access both their capital and money. The old non-mover budget constraint is: $c^n_{2,t+1} \leq v_{t+1} m_t + x k_t$

(d) Describe the problem faced by individuals in this environment. Make specific reference to the returns on capital and fiat money.

Individuals face risk in that they do not know if they will have to move or not. If they knew they were going to have to move they would only acquire money and create no capital. Conversely, if they knew they did not have to move then they would only create capital. The expected consumption in the second period is $Ec_{2,t+1} = \pi c^m_{2,t+1} + (1 - \pi) c^n_{2,t+1}$.

Now assume there is a bank that takes deposits. Now individuals deposit with the bank and if they find out they must move then they can make a withdrawal before going to the other island. With deposits, the bank must decide how much to hold as reserves, how much to use to create capital, and what returns to pay to movers and non-movers.

(e) What proportion of deposits does the bank hold as reserves?

Again, the bank can aggregate and eliminate the individual risks faced by individuals since it knows that in expectation there will be a fraction π of individuals that will want to withdraw early and will need only money. As a result, the bank can perfectly meet this obligation by keeping a fraction π of deposits as fiat money reserves.

(f) How does the bank solve the problem individuals face on their own?

If there are N people on each island, then the bank knows that πN individuals on each island will move and demand their deposits as fiat money. If each individual deposits y goods then in total from each island it will need to give $\pi N y$ real money to individuals who have to move. It can perfectly satisfy this by keeping a fraction π of total deposits Ny as reserves. The bank is relying on the fact that it knows that in expectation there will be πN individuals moving and as a result is able to eliminate the individual risk.

Now assume that there is some small probability > 0 that the proportion of individuals that are moved is higher than normal. Call this proportion π^H and the normal proportion π^L where $1 < \pi^H > \pi^L > 0$.

(g) What proportion of deposits does the bank hold as reserves now?

Similar to above, the bank will keep a proportion equal to the expected proportion of movers as reserves. The expected proportion of movers is $\pi = \pi_H + (1 -)\pi_L$. This is a proportion greater than π_L and less than π_H. The bank will hold a proportion π of deposits as fiat money reserves.

(h) How does the uncertainty about π^i create risk for the bank?

Explain, referring to the reserves available when the π^L and π^H events occur. The risk of having a large number of movers is an aggregate risk that the bank cannot insure against. The bank holds reserves equal to π as defined above. If the low number of movers event occurs then the bank has enough reserves to satisfy withdrawals of movers, but could have earned a higher return (since it held more than it needed to as reserves since $\pi_L < \pi$). Conversely, if the high mover event occurs then the bank does not have enough reserves to satisfy withdrawals of movers and must liquidate capital (since $\pi < \pi_H$. As the bank starts to liquidate capital, it affects its ability to fulfill its obligations to non movers as the one-period return on capital is lower than the real rate of return on fiat money, which can result in a bank panic/run as described above. If non-movers have a belief that a high mover event is occurring (say through a rumor on social media) then it may be in their best interest to go to the bank to withdraw as soon as possible.