Lecture Notes

The Role of Demandable Debt in Structuring Optimal Banking Arrangements

Calomiris and Kahn (AER, 1991)

1 Basic Model

As usual, there are two agents; in this case, labelled a banker and depositor. The banker has no wealth, but has an investment opportunity that requires capital expenditure k. The depositor has capital k. Both agents are risk-neutral, and the depositors outside opportunity is Rk. For simplicity, normalize $k = 1$.

There are three time periods; $t = 1, 2, 3$. The project generates a random return $y \in \{y_l, y_h\}$, which is realized at date 3. Let π denote the probability of the low outcome and assume $(1-\pi)y_h + \pi y_l > R$. The realization y is observable *ex post* only by the banker.

Subsequent to the realization of y, the banker has an opportunity to abscond with the project output. Doing so, however, entails a social cost; the banker only absconds with θy units of output $(0 < \theta < 1)$. The banker cannot be punished for absconding with funds.

1.1 Benchmark

It will be useful to first characterize the allocation assuming no information frictions and no theft. Let's assign all bargaining power to the banker and assume no discounting across periods. The depositor needs an expected return equal to R. Let $P(y)$ denote the payment made to the depositor in state y. Then $P(y) \leq y$ must satisfy:

$$(1-\pi)P(y_h) + \pi P(y_l) = R.$$

If $y_l < R < y_h$, then a constant payment $P = R$ is not feasible. In this case, $P(y_l) < R < P(y_h)$. On the other hand, if $R < y_l < y_h$, then the constant payment $P = R$ is feasible. In any case, the banker's expected payoff is given by:

$$V^* = (1-\pi)\left[y_h - P(y_h)\right] + \pi\left[y_l - P(y_l)\right].$$

Of course, the payment structure is largely indeterminate here (although, the respective expected utility payoffs are pinned down).

1.2 Theft

Now, let us introduce the possibility of absconding with funds. At date 3, the banker has the option of making good on his promise $P(y)$, or stealing the output y (which yields him θy units of output). Since theft is socially wasteful here, preventing it is likely desirable; and this would require:

$$\begin{aligned} y_l - P(y_l) &\geq \theta y_l; \\ y_h - P(y_h) &\geq \theta y_h. \end{aligned}$$

or,

$$\begin{aligned} P(y_l) &\leq (1-\theta) y_l; \\ P(y_h) &\leq (1-\theta) y_h. \end{aligned}$$

These conditions look a lot like debt-constraints. In particular, imagine that theft is possible but is not socially wasteful, so that $\theta = 1$. Then essentially, what we are saying here is that the banker cannot commit to repay any output (and hence autarky is the only solution). At the other extreme, if all value is dissipated in the act of theft, so that $\theta = 0$, then theft will not occur, even if it is feasible. In this case, there is no debt constraint; the banker can credibly pledge to pay back any amount up to what is budget (resource) feasible. And so, the effect of varying θ here is to vary the degree of commitment on the part of the banker.

It seems clear that with $\theta > 0$, we need a stronger condition to hold than simple positive NPV; in particular, we need:

$$(1-\theta)\left[(1-\pi)y_h + \pi y_l\right] > R.$$

O.K., this is no big deal. Think of this as a debt-constraint; i.e., the amount of lending k is constrained by the pledgeable collateral. The collateral value is the expected NPV of the project; and the pledgeable component is determined by the factor $(1-\theta)$; i.e.,

$$k \leq (1-\theta)\left[\frac{(1-\pi)y_h + \pi y_l}{R}\right].$$

If $\theta = 0$, then the value of the loan cannot exceed the expected NPV of the project.

1.3 Private Information

Let us now abstract from theft and instead assume that y is observable only by the banker. By the revelation principle, we can restrict attention to making P conditional on the banker's report $m \in \{y_l, y_h\}$. IC requires:

$$\begin{aligned} y_l - P(y_l) &\geq y_l - P(y_h); \\ y_h - P(y_h) &\geq y_h - P(y_l). \end{aligned}$$

These conditions imply $P(y_l) = P(y_h) = P$, so that only a debt (constant payment) contract will be IC. The banker is driven to set $P = R$. If $R < y_l < y_h$, then debt is feasible and we are done. If $y_l < R < y_h$, then debt is not feasible and it appears that autarky is the only equilibrium.

1.4 Theft and Private Information Combined

If R is sufficiently small, then the first-best is implementable. Imagine, however, that:

$$(1-\theta)y_l < R < y_l < (1-\theta)y_h < y_h. \tag{1}$$

This case is interesting because if theft was impossible ($\theta = 0$), then a simple debt contract can implement the first-best even in the presence of private information. The possibility of theft, however, appears to preclude first-best implementation.

One question to ask is whether any allocation other than autarky is implementable. Since theft is inefficient, it would make sense to minimize its incidence. But the private information friction here makes it impossible to condition P on the banker's report. Participation requires that $E[P] = R$. Clearly, the banker will renege on this promise when $y = y_l$; that is, he will abscond with the output in the low state, leaving the depositor with nothing. Thus, depositor PC requires:

$$(1-\pi)P^0 = R.$$

That is, the depositor demands a risk-premium:

$$P^0 = \left[\frac{R}{1-\pi}\right] > R.$$

For this payment to be credible, it must be in the banker's interest not to abscond with funds in the high state. This requires the restriction:

$$R \leq (1-\pi)(1-\theta)y_h. \tag{2}$$

And so, assume that this is the case. Then the equilibrium dominates autarky, but is not first-best. In particular, the banker's expected payoff is:

$$V^0 = (1-\pi)y_h + \pi\theta y_l - R < V^*.$$

Keep in mind that this applies for parameter restrictions that satisfy (1) and (2).

The equilibrium above is not first-best because theft will occur in expectation; and theft is socially wasteful here. Notice that the ability to steal makes the **banker** worse off; not the depositor (at least, in *ex ante* terms). Hence, if there was any way to prevent theft–or at least mitigate the probability that it occurs–it will improve the *ex ante* welfare of the banker.

2 Signals

2.1 Public Signal

Let us now modify the environment slightly by assuming that everyone observes a signal $s \in \{b, g\}$ at date 1 (bad news, good news). Let $\Pr[s = g] = 1/2$. The new information allows agents to update the probability of failure; i.e., assume

$$\pi_g < \pi < \pi_b.$$

and

$$0.5\pi_g + 0.5\pi_b = \pi.$$

In this case, it is now possible to condition the payment P on the signal s; denote this by P_s. Note that one possibility here is to set $P_s = P^0$ as described above. But is it now possible to achieve a better allocation? The answer is not clear; see Appendix 1.

2.2 Private Signal

The authors in fact assume that the signal is private information (for the depositors). In this case, the payment can be made conditional on the report of the signal by depositors; i.e., $P(m)$ for $m \in \{g, b\}$. I am not sure that this added complication is needed; but we will see.

2.3 A Liquidation Technology

The authors suggest that one method that may thwart theft is liquidation of the bank in period 2. Liquidation means that the bank's assets k are effectively seized by the depositors. Assume that liquidation reduces the value of the assets by the factor $0 \leq \theta < \lambda \leq 1$. I presume that this means that the project is aborted.[1] Note that liquidation is less sociably wasteful than theft.

Now, how is this liquidation possibility supposed to help matters? I think that the intuition is as follows. Absent liquidation, the banker promises payment P^0; which he only repays in the event that output is high. That is, theft occurs when output is low; and theft is socially wasteful.

Now, if agents receive good news, they know that the probability of theft will be diminished. As such, they will be more inclined to keep their money in the bank. But if agents receive bad news, the know that the probability of theft is increased. As such, they may be willing to liquidate their deposit in this event. The banker may want to give them this option, if it reduces the incidence of theft (the banker will then be able to extract a greater surplus).

[1] Their footnote 13 suggests this may not be the case–which sounds weird.

Assume, for the moment, that the banker will not steal when output is high, but will steal when output is low (we will have to check that this is rational). Let P_s denote the payment conditional on signal s (this payment only occurs when output is high).

Now, imagine that the depositor observes signal s; he must now decide whether to liquidate or not. If he does not liquidate, then his expected payoff is $(1-\pi_s)P_s$. If he does liquidate, his payoff is simply λk (with $k=1$).

To improve efficiency, it cannot be the case that the depositor always liquidates or never liquidates. Intuition suggests that efficiency may be improved by liquidating only when news is bad. Hence, consider a payment schedule such that:

$$\begin{aligned}(1-\pi_g)P_g &\geq \lambda;\\ (1-\pi_b)P_b &< \lambda.\end{aligned}$$

Since liquidation makes the payment P_b redundant, set it to zero.

From an ex ante perspective then, P_g must satisfy the PC:

$$0.5(1-\pi_g)\hat{P}_g + 0.5\lambda = R;$$

or,

$$\hat{P}_g = \left[\frac{2R-\lambda}{1-\pi_g}\right].$$

Of course, to ensure that the banker does not steal, we need:

$$\left[\frac{2R-\lambda}{1-\pi_g}\right] \leq (1-\theta)y_h.$$

This condition can be ensured by making y_h sufficiently large.

Now, the banker's *ex ante* payoff is given by:

$$\hat{V} = 0.5\left[(1-\pi_g)(y_h-\hat{P}_g)+\pi_g\theta y_l\right];$$

or

$$\hat{V} = 0.5(1-\pi_g)y_h - R + 0.5\lambda + 0.5\theta\pi_g y_l.$$

Let's suppose that the signal is perfect, so that $\pi_g = 0$ and that $\lambda = 1$. Then,

$$\hat{V} = 0.5y_h + 0.5 - R.$$

How does this compare to:

$$V^0 = (1-\pi)y_h + \pi\theta y_l - R.$$

Suppose $\pi = 0.5$. Then

$$V^0 = 0.5y_h + 0.5\theta y_l - R.$$

Hence, if $\theta y_l < 1$, then the demandable contract improves efficiency.

Appendix 1

Let χ_s denote the probability that the bankers does not steal in state s when the outcome is low. Then depositor PC requires:

$$0.5\left[(1-\pi_g)P_g + \chi_g \pi_g P_g\right] + 0.5\left[(1-\pi_b)P_b + \chi_b \pi_b P_b\right] = R.$$

Note that by setting $P_b = (1-\theta)y_l$, theft can be avoided ($\chi_b = 1$) when news is bad; so let's give this a try. In this case, depositor PC becomes:

$$0.5\left[(1-\pi_g)P_g + \chi_g \pi_g P_g\right] + 0.5(1-\theta)y_l = R.$$

Hence, given some χ_g, PC demands:

$$P_g = \left[\frac{2R - (1-\theta)y_l}{1-(1-\chi_g)\pi_g}\right]$$

Clearly, the higher the χ_g, the lower the P_g (increasing the banker's payoff). But as $P_g > P_b$ will be necessary to induce participation, it seems clear that the banker will find it in his interest to steal when the news is good and the outcome is bad; i.e., $\chi_g = 0$. Hence, PC requires:

$$P_g = \left[\frac{2R - (1-\theta)y_l}{1-\pi_g}\right].$$

Now the question is whether the banker will find it in his interest to pay P_g when the news is good and the outcome is good. This will be the case iff:

$$\left[\frac{2R - (1-\theta)y_l}{1-\pi_g}\right] \leq (1-\theta)y_h.$$

This condition can certainly hold if, for example, y_h is sufficiently large. Assume that this is so.

The banker's expected payoff can then be computed as:

$$\begin{aligned}
V^1 &= 0.5\left[(1-\pi_g)\left(y_h - P_g\right) + \pi_g \theta y_l)\right] + 0.5\left[(1-\pi_b)y_h + \pi_b y_l - P_b)\right]; \\
&= 0.5\left[(1-\pi_g)y_h - 2R + (1-\theta)y_l + \pi_g \theta y_l\right] + 0.5\left[(1-\pi_b)y_h + \pi_b y_l - (1-\theta)y_l)\right]; \\
&= 0.5\left[(1-\pi_g)y_h + \pi_g \theta y_l + \pi_g y_l - \pi_g y_l\right] + 0.5\left[(1-\pi_b)y_h + \pi_b y_l\right] - R; \\
&= (1-\pi)y_h + \pi y_l - (1-\theta)\pi_g y_l - R.
\end{aligned}$$

Compare this to:

$$V^0 = (1-\pi)y_h + \pi\theta y_l - R.$$

Define $\Delta = V^1 - V^0$, so that

$$\begin{aligned}
\Delta &= \pi y_l - (1-\theta)\pi_g y_l - \pi\theta y_l; \\
&= (1-\theta)\left(\pi - \pi_g\right) y_l < 0.
\end{aligned}$$

Well, so much for this plan; of course, this does not exhaust possibilities.