Chapter 2

LENDER'S LIABILITY FOR POLLUTION CONTROL --- A MODEL

The combination of small firms and potentially large accident costs raises the distinct possibility of an increase in the number of 'judgement-proof' firms, that is, firms which can cause accidents and become bankrupt but do not have sufficient asset left to compensate the victims. 'Judgement proof-ness' is a cause of concern because it results in a reduced incentive for the firm to be cautious. This problem is also possible in the case of firms which cannot be termed as 'small' in terms of their assets but might create environmental damages which might make then bear losses worth more than their total assets. One possible policy measure to avoid such circumstances is to increase the potential liability faced by lenders to firms. The risk of lenders is not only that their borrowers' environmental liabilities will lead to the loss of loan because of diminution of value of the collateral or inability of borrowers to repay their loans, but they also face the risk of possible liability under the law which makes them liable for clean up costs that could exceed the value of the loan involved.

We develop here a model for analysing lender liability for pollution control. It has been developed on the basis of the 'Gate-Keeping Analysis' proposed by Kraakman(1988). In the beginning, we consider a risk-neutral firm which has plans for a particular investment project. In order to execute the project, it must not only invest its own wealth, 'w', but must borrow additional funds 'F' from a lender which is generally a bank.

We assume that the project turns out to be environmentally damaging on a large scale with a probability 'π'. In that event the firm becomes bankrupt and it defaults on the loan the payment to the bank will be denoted by (-μ). 'μ' will be a composite variable including the capital yet to be returned to the bank and the bank's environmental liability (including any punitive sanctions) and any other costs incident upon it. In this case, the lender does not receive any payment from the firm but has to bear the cost of the damage wither in full or in part depending upon the extent of lender liability. Assuming that the project is successful and yields producer surplus of 'p' with a probability of (1-π). The firm retains the same net of the interest 'r'. This is paid to the bank for capital services rendered. In such a case, the lender will receive
an amount ‘r’ which includes part of the principal and the interest for the period. Policies extending lender liability will be captured by ‘s’. Depending upon the nature of lender liability (i.e., if there exists strict or partial lender liability) ‘s’ will take on any value in the closed unit interval. The closer is the value of ‘s’ to one, the stricter is the liability of the lender.

The overall probability ‘π’ that a given project will turn out to be damaging depends upon both the intrinsic characteristics of the plans for the project and the extent to which the safety stipulations contained in those plans are complied with during its execution. The intrinsic risk ‘a’, is the probability that the project will turn out to be damaging if it is carried out exactly as specified in the plans. The probability ‘a’ must lie in the unit interval. Its value is observed privately by the borrower (prospective) at the start of the project. The lender knows only the distribution of f(a) from which it is drawn. Additional risk is induced while executing the project the borrower engages in ‘cost-cutting’ --- departing covertly from the terms of the contract for safety and pollution control. It is assumed that the firm engages in cost cutting by an amount ‘b’, which increases the probability of occurrence of an accident. The overall probability that the project will result in environmental damage can be described by

$$\pi(a, b) = 1 - (1 - a)e^b.$$ ...........................(1)

If the project turns out to be non-damaging, the borrowers net return will be (p - r + b) and expected return from the project will be given by [(1 - π(a,b))(p - r + b)]. In the model, the bank i.e., the lender having observed the assets of a prospective borrower chooses whether or not to make a loan offer and if so on what terms. More precisely, what is the rate of interest that the lender will charge from a particular borrower. This is the only instrument in the hands of the lender with which he can either reject or accept a borrowers request for funds for a project. The borrower decides whether or not to accept any lending contract offered and if he does accept, how much of cost-cutting to do. For the firm, i.e., borrower, cost-cutting is the only way by which he can deviate from the terms of the contract to maximise his gains.
The Firm's Problem:

The firm knowing the 'intrinsic' riskiness of the project for which it holds plans, has to decide whether to apply for a loan or not. If, however, it does execute the project, it has to decide on how much cost-cutting to do. This, however, is a tacit decision since it is a deviation from the contract that it has already entered into with the lender. Solving the second state problem first, assuming that it is going ahead with the project, the firm chooses 'b' to maximise the expected value of its private return denoted by \( F(a, b) \):

\[
\text{Max } \{1 - \pi(a, b)\}(p - r + b) + \pi(a, b)\{-w - (1-s)r\}\]

After substituting for \( \pi(a, b) \) from equation (1) above, the firm's maximising equation takes on the following form

\[
\text{Max } \{1 - (1 - (1 - a)e^{-b})\}(p - r + b) + 1 - (1 - a)e^{-b}\{-w - (1-s)r\}\]

The first-order condition associated with an interior solution to the firm's problem is:

\[
F_b(a, b) = (1-a)e^{-b}\{l - (p-r+b) - (w + (1-s)r)\} = 0 \quad \ldots \ldots (3)
\]

Let \( b^*(r, s, w) \) be the optimal solution for equation (3) above. It is quite obvious that the second order condition necessarily holds. Equation (3) says that the firm, in executing its own project, will engage in covert cost-cutting up to a point at which marginal gains from so doing (in terms of a better return in the good state) equal the marginal costs (in terms of an increased probability that the bad state will be realised).

Application of the implicit function theorem to equation (3) yield the three comparative-statics of primary interest:

\[
db^*/dr = -[(1-a)e^{-b}/F_{bb}(a,b^*)] > 0 \quad \ldots \ldots (4)
\]

\[
db^*/dw = -[(1-a)e^{-b}/F_{bb}(a,b^*)] < 0 \quad \ldots \ldots (5)
\]

\[
db^*/ds = -[(1-a)e^{-b}.s\mu]/F_{bb}(a,b^*)] \geq 0 \quad \ldots \ldots (6)
\]

and

\[
ds/dr = [1/s\mu] \geq 0 \quad \ldots \ldots (7)
\]

Ceteris paribus, then the borrower will engage in less cost-cutting when the rate of interest is low and/or the wealth is large and/or their liability responsibility is
low. All three ensure that the firm has more to lose from the realisation of the bad state (the former in terms of the potential profits foregone and the latter two in terms of their own funds lost) and hence that the firm will be less willing to risk such a state occurring by ‘cutting corners’; i.e., by cutting cost or deviating from the contract agreed to with the lender of funds.

Returning to the firm’s initial participation decision, the firm will accept a loan offered to it if and only if it anticipates being able to make a positive (expected) return, that is if and only if

\[ F(a, b^*(r, w, s)) = \{(1 - \pi(a, b^*)) (p - r + b^*) - \pi(a, b) (w + s\mu) \} \geq 0 \] .......................... (8)

The firm will apply for loan if and only if its private information says that the intrinsic riskiness of the project for which it holds plans is not too great. Defining \( A \) to be that value of ‘a’ that satisfies equation (7) with equality that the firm will apply for funds if and only if \( a \leq A \), where A is characterised by

\[(1 - A)e^{b^*}(p - r + b^*) - (1 - (1 - A))e^{b^*}\{w + (1 - s)\mu\} = 0 \] .......................... (9)

Implicit differentiation of equation (8) yields (after application of envelope theorem in each case)

\[ \frac{dA}{dr} = \frac{(1 - A)\{(p - r + b^*) + w + (1 - s)\mu\}}{\{p - r + b^* + w + (1 - s)\mu\}} \] .......................... (10)

\[ \frac{dA}{dw} = \frac{\{1 - (1 - A)e^{b^*}\}/(p - r + b^*)}{\{(p - r + b^*) + w + (1 - s)\mu\}e^{b^*}} \] .......................... (11)

and

\[ \frac{dA}{ds} = \frac{1 - (1 - A)\mu}{\{(p - r + b^*) + w + (1 - s)\mu\}} \] .......................... (12)

Equations (10), (11) and (12) are all ambiguously negative. An increase in ‘r’, ‘w’ or ‘s’, then, serves to reduce the range of projects, which the representative firm will attempt to procure a loan. Prospective borrowers ‘self-respect’ --- those who know they have intrinsically risky ideas refusing loans offered to them --- with the stringency of the self-selection constraint being an increasing function of the rate of interest (as well as the firm’s private exposure).

The signs of the derivatives in equations (4) and equation (10) combine to give an interesting ambiguity to the effect of a change in ‘r’ on the overall environment characteristics of projects executed. An increase in ‘r’ tightens the self-selection constraint (in accordance with equation (9), causing would-be-borrowers at the high-risk margin to deselect them. At the same time, however, that increase
encourages those firms that do execute projects to do so in a less scrupulous way. In effect, the increase serves to reduce ‘intrinsic’ environmental risk at the expense of increasing ‘induced risk’.

**The Lender’s Problem:**

The bank (i.e., the lender) having observed the asset of the applicant, ‘\(w\)’, it has to choose whether or not to offer to lend the required sum of money. And if it does agree to lend then it has to decide on what terms it will lend. Assuming that a loan offer is made ‘\(r\)’ will be set to maximise the expected return on the bank’s capital, \(R(a, b)\), subject to the firm’s self-selection constraint, given by (9) and the reaction function (4). In other words, the bank anticipates both the willingness of the firm to accept contracts and its propensity to cost-cut. Formally, the bank’s problem is to choose ‘\(r\)’ conditional on ‘\(w\)’ to maximise a function \(R(r, A(r, w, s), b(r, w, s))\):

\[
A(r, w, s)
\]

\[
\text{Max}_{r>0} \{\int [1-\pi(a, b^*(r, w, s)).r + \pi(a, b^*(r, w, s))(-s\mu)] f(a).da \} \quad (13)
\]

The interior solution to the bank’s problem, the equilibrium interest rate, will be characterised by the associated first-order condition:

\[
dR/dr = \int \{(1-a)e^{b^r}f(a)\}.da + dA/dr\{(1-A)e^{b^r}.r - s\mu[1-(1-A)e^{b^r}]\}
\]

\[
+ \int db'/dr[-(1-a)(r + s\mu).e^{b^r}] f(a).da + \int ds/dr.[(1-a).e^{b^r}\mu] f(a).da \quad (14)
\]

The first term captures the direct effect of an increase in ‘\(r\)’ – that if the project goes ahead and is completed successfully the bank’s share of the surplus created increases correspondingly --- and is positive. The second term captures the expected profit implications of the ‘adverse selection impact’ of an increase in ‘\(r\)’ – that a subset of would-be-borrowers at the high risk margin are induced to reject lending contract – and is of ambiguous sign. The third term reflects the expected profit implications of the ‘moral hazard impact’ – that an increase in ‘\(r\)’ induces both borrowers who do not attain funds to engage in more ‘cost-cutting’ during the execution of the project – and is negative. The final term captures the impact of the degree of lenders’ liability. The surplus that results from the regime (which specifies
the nature of lender liability) increases with the decrease in the share of the damage that the lender has to bear.

**The Impact of Regulatory Reform on Interest Rates:**

Of particular interest is the comparative static change in the policy parameter \( \mu \). Application of implicit function theorem to equation (13) yields the following:

\[
\frac{d\pi^*}{d\mu} = -\left[\frac{dA}{dr} \left\{s(1-(1-A)e^{-b\pi}) + \int_0^A \left\{-s(1-a)e^{-b\pi}\right\} f(a) da \right] \\
+ \int_0^A ds/dr \left\{(1-a)e^{-b\pi}\right\} f(a) da \right\} / R_m
\]

The value of this derivative (15) is quite ambiguous. The denominator is negative in the vicinity of equilibrium (by the associated second order condition) such that the sign of \( \frac{d\pi^*}{d\mu} \) coincides with the sign of the numerator of the expression in brackets, which is ambiguous.

When the damage cost of a project \( \mu \) is increased it is rational on the part of the bank to reduce the riskiness inherent in the project that it is financing. However, there exists an ambiguity over the direction of the change in \( \pi^* \) that is required to bring about such a reduction. If we closely look at the first expression in the numerator of equation (15), we find that an increase in \( \pi^* \) reduces \( A, \) (since \( dA/dr \geq 0 \)), i.e., firms with intrinsically risky projects are induced to drop out of the market such that the first term becomes positive. This implies that the bank would like to raise the interest rate. Those that remain would be likely to resort to post-contractual cost-cutting (\( db/dr \leq 0 \)) such that the second term becomes negative, implying that the bank would like to cut interest rates. The last term which involves the lender participation constraint, shows that an increase in \( s \) raises \( \pi^*, \) (\( ds/dr \geq 0 \)) i.e., an increase in the lender’s share \( s \) would raise the rate of interest. So only when firms which have inherently risky projects have opted out of the market for loans will the bank de-link the rate of interest from its share in the damage cost that it has to pay in case of an accident. In fact it would want to cut interest rates. Under such a circumstance, the third term become positive. Thus, only when the first term (associated with the marginal impact of changes in \( \pi^* \) in reducing the adverse selection problem) is sufficiently large vis-à-vis the second (which captures the
marginal impact on the moral hazard problem) and the third term (which captures the analogous marginal impact on the lender participation terms) will the expression be positive and conventional wisdom will be satisfied. The ultimate outcome on the rate of interest charged will depend on which of these effects dominate.

Under pure adverse selection, by which we might assume that borrowers have little or no scope of covert cost-cutting during execution of the project and 'b', is fixed and equals to zero, so equation (15) takes on the following form;

$$dr/d\mu \approx -(dA/dr\{(1-(1-A).e^b)\} + (ds/dr\{(1-A).e^b\}) / R_r$$

This expression is unambiguously positive and conventional wisdom holds. In contrast, in the case of pure moral hazard, with intrinsic risk of all projects fixed exogenously at some $a = a^*$, equation (15) then becomes,

$$dr/d\mu = -[db^*/dr\{(1-a^*)e^b\} + (ds/dr\{(1-a)e^b\}) / R_r$$

This expression is unambiguously negative and conventional wisdom is violated, necessarily.

**The Impact of Regulatory Reform on Lender Participation**

Another interesting result can be obtained from the comparative static implications of change in the policy parameter 's'. The results are obtained by the application of implicit function theorem to equation (13).

$$dr^*/ds = -[dA/dr\{-\mu(1-(1-A).e^{b^*}) \} + \int_0^A db/d\mu\{-\mu(1-a).e^{b^*}\} f(a).da] / R_r$$

Here, again, the sign of the expression $dr^*/ds$ is ambiguous. The denominator is negative in the vicinity of equilibrium (by the associated second order condition) such that the sign of $dr^*/ds$ coincides with the sign of the numerator of the expression in brackets, which is ambiguous.

The universally accepted view is that the impact will necessarily be positive. When 's' is increased (by policy prescription or other means) it is unambiguous that *ceteris paribus*, the bank will want to reduce the equilibrium rate of interest that it wishes to charge from the borrower. We know that $dA/dr$, is negative which implies
that an increase in ‘r’ reduces ‘A’. This will remain till the borrowers with substantially risky projects drop out of the market and the first term in the expression becomes positive. An obvious outcome is that the bank will want to raise interest rates. In the second part of the numerator of expression (18), db/dr is negative and this makes the second part positive, which suggests that the bank will try to cut interest rates. Thus the entire expression will be positive only when the first term is larger than the second term. Under such circumstances conventional wisdom holds.

Here, we, once again take up the case of adverse selection and that of moral hazard. As before, we assume b to be fixed and equal to zero under pure adverse selection. Thus, equation (18) takes on the following form;

$$\text{dr/ds} \approx \left[-\frac{\mu(1-(1-A)e^{b^*})}{R_r}\right] / \text{dr}$$ ........................(19)

and this expression is unambiguously positive. Under pure moral hazard, we set, as before, a = a*. The expression in (18) then becomes,

$$\text{dr/ds} = \left[-\frac{\mu(1-(1-A)e^{b^*})}{R_r} \right] / \text{dr}$$ ........................(20)

This expression (20) is negative. It may be observed that both in equation (19) and (20), we find that the expressions remain invariant in terms of their signs since ‘μ’ is positive, by assumptions of the model. It has been assumed here that the value of ‘μ’ remains fixed for a particular contract.

Thus, the implications of extending lender liability, on the rate of interest charged and hence the cost of capital by the lender are quite ambiguous. This ambiguity arises from the fact there are two types of asymmetric information that exists between the lender and the borrower regarding the environmental consequences of the project being financed. It is necessary for the adverse selection considerations to dominate the moral hazard ones for conventional results to follow.

In the context of environmental protection, one regulatory motive for the implementation of lender liability is to induce banks and lending institutions to act as gate keepers with the industrial borrowers. Interest rate is likely to be the key instrument used by lenders in acting as ‘bouncers’(to eliminate wrong-doers) and
'chaperone')(disrupt misconduct post-contractually). This is possible since what value 'r' takes on has significant implications on the nature of projects that gets financed and how well the ones that are financed are carried out. Thus the interest rate acts as a dual 'efficiency wage' function.

By increasing either 'µ' or 's', the regulatory authority induces the bank to keep stricter vigil on their borrowers and also screen them better before providing the loan amount. These come in the form of increased credit rationing and an increase in the amount of the minimum level of wealth of the borrower.

The other mode is a change in the form of the rate of interest charged. Eliminating bouncers (i.e., eliminating adverse selection) requires raising the rate of interest. While chaperoning (doing away with moral hazard) calls for lowering the rate of interest. Thus the overall change in 'r' is ambiguous. However, it may be possible that both the situations coexist in a given state of the world. There may be borrowers who may be thwarted from availing of loans at any cost while there might be other borrowers who, have not been excluded, may be charged lower interest rates. The rate of interest charged may vary between borrowers that is charged by the lender depending upon the lenders' judgement about the riskiness of the project planned.

Here, risk refers to the probability of realisation of an undesired state. The qualitative ambiguity of interest results from the fact that a decrease in 'r' serves to mitigate the moral hazard problem but exacerbates the adverse selection one. In other formulation(e.g., Stiglitz and Weiss) there exists no such trade-off and a decrease in 'r' mitigates both types of agency problem.

This model is a highly stylised representation of the real world. The assumption that a bank chooses to lend or not and at what rate of interest is quite a big assumption by itself. The other instrument that is assumed to be in the hands of the bank and which we look at in the following sections of this thesis are assessing the credit worthiness of the borrower and also screening their environmental performance.

Another major assumption is that the bank knows only about the wealth of the borrower but in a real world situation the bank gets to access much more information about the borrower; viz. their financial and environmental history etc.
Two, quite distinctive informational asymmetries, likely to be present between borrowers and lenders, have been presented in this analysis. They are likely to be of varying degrees of importance depending upon the nature of the industrial sector in which the project is being planned. It further provides evidence of how a particular policy may have markedly different effects in different sectors of the economy. It is, thus, prudent to adopt a sector-wise approach to the extension of lender liability.

However, as has been discussed above, mere extension lender liability will not help achieve the goals of industrial environmental pollution control. It has to be packaged along with other tools like assessing credit worthiness of borrowing firms and screening their environmental performance. In the following section we attempt to assess the credit worthiness of firms in a growth theoretic set up.