Brander and Lewis (1986)

- Link the relationship between financial and product sides of a firm.
- The way a firm finances its investment:
(1) Debt: Borrowing from banks, in bond market, etc. Debt holders have priority over a firm's income.
(2) Equity: Stock market. Stockholders are residual claimers. That is, they receive devidend only after debts are paid. However, they have control right.
- This has two effects on a firm's investment behavior:
(1) As a firm takes on more debt, it has incentive to pursue output strategies that raise returns in good states but lower return in bad.
(2) Any firm's susceptibility to financial distress depends on its financial structure. Competitors can improve profitability by driving its rivals into financial distress. Firms might make product market decision that raise the chance of driving rivals into insolvency.
- This paper concentrates on the first.
- Two main points of the paper:
(1) Product market behavior is influenced by financial structure.
(2) Reversely, since firms foresee (1), product market conditions will influence financial structure.
- Model:
(1) Duopoly market.
(2) Two stages: First the two firms decide their financial structures. Then they select output level.
(3) Output decisions are made before realization of a r.v reflecting variations in demands and costs.
(4) After profits realize, firms need to pay debt claims out of profits. If profit < debt, the firm goes bankrupt. Limited liability implies that shareholders' incomes are zero (not negative).
- Details:
(1) $q_{i}$ : output of firm $i$.
(2) $R^{i}\left(q_{i}, q_{j}, z_{i}\right)$ : profit of firm $i$. $z_{i} \in[\underline{z}, \bar{z}]$ is a r.v. with density $f\left(z_{i}\right) . z_{i}$ and $z_{j}$ are IID.
(3) $R_{i i}^{i}<0, R_{j}^{i}<0, R_{i j}^{i}<0, R_{z}^{i}>0 . R_{i z}^{i} \quad$ can be either positive or negative.
(4) $D_{i}$ : Debt level of firm i.
- Solves for equilibrium behavior by backward induction.
- The second stage equilibrium:

The profit of shareholders is

$$
V^{i}\left(q_{i}, q_{j}\right)=\int_{\hat{z}_{i}}^{\bar{z}}\left(R^{i}\left(q_{i}, q_{j}, z_{i}\right)-D_{i}\right) f\left(z_{i}\right) d z_{i}
$$

where $R^{i}\left(q_{i}, q_{j}, \hat{z}_{i}\right)=D_{i}$.
Assume $\underline{Z}<\hat{Z}_{i}<\bar{Z}$.

- The firms choose $q_{1}$ and $q_{2}$ to maximize own $V^{i}$.
- It can be shown that

$$
\begin{aligned}
& d \hat{z}_{i} / d D_{i}>0, d \hat{z}_{i} / d D_{j}=0, \\
& d \hat{z}_{i} / d q_{i}=-R^{i}\left(\hat{z}_{i}\right) / R_{z}^{i}\left(\hat{z}_{i}\right), \\
& d \hat{z}_{i} / d q_{j}=-R_{j}^{i}\left(\hat{z}_{i}\right) / R_{z}^{i}\left(\hat{z}_{i}\right)>0 .
\end{aligned}
$$

- FOC:

$$
V_{i}^{i}=\int_{\hat{z}_{i}}^{\bar{z}} R_{i}^{i}\left(q_{i}, q_{j}, z_{i}\right) f\left(z_{i}\right) d z_{i}=0 .
$$

SOC: $V_{i i}^{i}<0$.

- Assume $V_{i i}^{i}<0, V_{i i}^{i} V_{j j}^{j}-V_{i j}^{i} V_{j i}^{j}>0$.
- Assume symmetry ( $q_{i}=q, D_{i}=D$ for all $i$ ). It can be shown that $\partial q / \partial D>0$ if $R_{i z}^{i}>0$ and $\partial q / \partial D<0$ if $R_{i z}^{i}<0$.
- A necessary and sufficient condition that financial structure has no effect on output is $R_{i z}^{i}=0$.
- If $R_{i z}^{i}>0$, then $d q_{i} / d D_{i}>0$ and $d q_{j} / d D_{i}<0$. If $R_{i z}^{i}<0$, then $d q_{i} / d D_{i}<0$ and $d q_{j} / d D_{i}>0$.

Figure 2

- Note that if the firm is controlled by debt holders, then it maximizes

$$
W^{i}=\int_{\underline{z}}^{\hat{\imath}_{i}} R^{i}\left(q_{i}, q_{j}, z_{i}\right) f\left(z_{i}\right) d z_{i}+D_{i}\left(1-F\left(\hat{z}_{i}\right)\right) .
$$

- It can be shown that output is higher in shareholder-controlled firm if $R_{i z}^{i}>0$, and lower if $R_{i z}^{i}<0$.
- This shows a conflict of interest between shareholders and bondholders.
- First stage: Selection of debt level.
- Suppose the objective of firm $i$ is to maximize the value of the firm, i.e., sum of $V^{i}$ and $W^{i}$, call it $Y^{i}$.
- Write $q_{i}$ as $q_{i}(D)$.
- $\mathrm{Y}^{i}\left(q_{i}(D), q_{j}(D), D\right)$
$=\int_{\underline{z}}^{\hat{z}_{i}} R^{i}\left(q_{i}(D), q_{j}(D), D\right) f\left(z_{i}\right) d z_{i}$
$+\int_{\hat{z}_{i}}^{\bar{z}} R^{i}\left(q_{i}(D), q_{j}(D), D\right) f\left(z_{i}\right) d z_{i}$,
which is exactly the expected profit over all states.
- Issuing debt is only a break-even transaction except that it affect output level.
- If output is, for some exogenous reason, fixed, then debt is neutral.
- $\mathrm{Y}_{D_{i}}^{i}=\left[\int_{\underline{z}}^{\hat{z}_{i}} R_{i}^{i}\left(z_{i}\right) f\left(z_{i}\right) d z_{i}\right] \frac{d q_{i}}{d D_{i}}$

$$
+\left[\int_{\underline{z}}^{\hat{\hat{z}_{1}}} R_{j}^{i}\left(z_{i}\right) f\left(z_{i}\right) d z_{i}+\int_{\hat{z}}^{\bar{z}} R_{j}^{i}\left(z_{i}\right) f\left(z_{i}\right) d z_{i}\right] \frac{d q_{i}}{d D_{i}} .
$$

- Since $R_{i}^{i}\left(z_{i}\right)<(>) 0$ for $z_{i} \leq \hat{z}_{i}$ if $R_{i z}^{i}>(<) 0$, we know that

$$
\begin{aligned}
& \int_{\underline{z}}^{\underline{z}_{i}} R_{i}^{i}\left(z_{i}\right) f\left(z_{i}\right) d z_{i}<0(>0) \text { iff } \\
& R_{i z}^{i}>(<) 0
\end{aligned}
$$

- But $d_{i} / d D_{i}>(<0)$ if $R_{i z}^{i}>(<) 0$, we know the first term is negative.
- If $R_{i z}^{i}<0$, then $d q_{i} / d D_{i}>0$. As a result, the second term is negative, and $Y_{D_{i}}^{i}<0$. That is, the firm will entirely be equity financed.
- This also implies that monopolist will take no debt.
- If $R_{i z}^{i}>0$, then $\partial q_{j} / \partial d D_{i}<0$ and the second term is positive. However, if $D_{i}=0$, then the $1^{\text {st }}$ term is 0 and second remains positive. This implies that $Y_{D_{i}}^{i}>0$ for sufficiently low level of debt.
- In summary, if $R_{i z}^{i}>0$, then debt level is strictly positive.
- If firm holds any debt, it will produce more output than the traditional oligopoly level.
- An increase in debt has two effects. The first is that it exacerbates the conflict of interests between debt- and equity-holders, and thus reduces firm value. The second is the strategic effect in influencing rival's output. If
$R_{i z}^{i}>0$, more debt confers strategic advantage. The firm will takes debt to balance the two effects. If $R_{i z}^{i}<0$, debt has only disadvantage. Thus $D_{i}=0$.

Maksimovic (1988)

- Debt structure can change the ability of firms in oligopoly to collude.
- There is an upper bound which limits the possible level of debt a firm can take if at the same time it intends to sustain collusion.
- Model
(1) $n$ identical firms compete repeatedly in Cournot fashion.
(2) Each period contains two subperiods. First production takes place. Then output is marketed, cash flow realized, and factor of production paid.
(3) $\gamma$ : discount rate.
- The firms can use trigger strategy to collude.
- Let $q_{j}^{\text {Nc }}$ be Cournot output for firm $j, q_{j}^{c}$ be the collusion output for firm $j$ which attains joint monopoly profit.
- A trigger strategy designates that firm $j$ produces $q_{j}^{c}$ in each period. If in any stage ant firm $i$ deviates from $q_{i}^{c}$, then every firm $j$ produces $q_{j}^{N c}$ forever.
- Collusion can be sustained iff

$$
\begin{gathered}
\pi^{c}+\pi^{c} / r \geq \pi^{d}+\pi^{N c}, \text { i.e., } \\
\gamma<\left(\pi^{c}-\pi^{N c}\right) /\left(\pi^{d}-\pi^{c}\right)
\end{gathered}
$$

where $\pi^{c}$, and $\pi^{N c}$ are per period profit under collusion and Cournot output, and $\pi^{d}$ is the maximum deviation payoff of a firm when others are producing output corresponding to $\pi^{c}$.

- Suppose firms issue debts so that they receive a lump-sum payment now but have to pay $\$ 1$ back in each of the following periods. Suppose firm $i$ issues $b^{i}$ debt instruments, so that it pays $b^{i}$ in each period.
- Obviously, debt level can’t be more than $\pi^{c} / \gamma$, and $b^{i}$ cannot be more than $\pi^{c}$ in each period; otherwise the firm goes bankrupt.
- If $b^{i} \in\left[0, \pi^{N c}\right]$, then bankruptcy will not occur, and there is no difference in collusive power between a firm with no debt and one with debt $b^{i}$.
- If $b^{i} \in\left[\pi^{N c}, \pi^{c}\right]$, then a deviation of a firm can drive firm $i$ into bankruptcy. Shareholders give out control to debtor, and receive a payoff of zero.
- The payoff of deviation for firm $i$ 's shareholder is $\pi^{d}-b^{i}$. Thus he deviates if

$$
\begin{gathered}
\pi^{d}-b^{i}>\pi^{c}-b^{i}+\left(\pi^{c}-b^{i}\right) / \gamma . \\
\text { i.e., } \gamma>\left(\pi^{c}-b_{i}\right) /\left(\pi^{d}-\pi^{c}\right) .
\end{gathered}
$$

- Let $\Delta=\operatorname{argmax}\left\{b_{i} \left\lvert\, \gamma \leq \frac{\pi^{c}-b_{i}}{\pi^{d}-\pi^{c}}\right.\right\}$. I.e., $\Delta=\pi^{c}-\gamma\left[\pi^{d}-\pi^{c}\right]$.
- In summary, the maximum possible debt coupon for firm $i$ in order to sustain collusion is $\max \left(\Delta, \pi^{N c}\right)$.
- Example of linear demand:
$P=a-m\left(\sum q_{i}\right)$.
c: marginal cost.
- $\pi^{c}=(a-c) / 4 m n, \pi^{N c}=(a-c)^{2} /\left(m(n+1)^{2}\right)$, $\pi^{d}=(a-c)^{2}(n+1)^{2} / 16 m n^{2}$.
- Can be shown that

$$
\partial\left(\Delta / \pi^{c}\right) / \partial \gamma<0 \text { and } \partial\left(\Delta / \pi^{c}\right) / \partial n<0 .
$$

That is, maximum leverage at which equilibrium can be sustained declines as interest increases, and as number of firms increases.

See figure 1

