Raith (2003): Competition, Risk and Managerial Incentives

Key intuition:
Consider the profit function of a firm

$$\pi_i = (p_i - c_i)q(p_i, \overline{p}_{j\neq i})$$

where $\overline{p}_{j\neq i}$ is a vector of prices of all other firms.

Firm i chooses p_i to maximize π_i.

Consider now the effect of a cost reduction. Using the envelope theorem, this is given by

$$\frac{d\pi_i}{dc_i} = -q(p_i, \overline{p}_{j\neq i}).$$

Thus, in equilibrium, the benefit of cost reduction is positively related to the equilibrium output.

Raith considers 3 ways in which competition can increase. Importantly, the number of firms is not one of these, as it is an endogenous variable in a free-entry/exit equilibrium. The incentives such changes in competition create are related to whether, in equilibrium, output is higher or lower.

- Greater product substitutability: In free entry equilibrium this leads to lower N but higher q. So incentives for cost reduction increase.
- Change in market size: new firms enter and each firm also producs more. So incetives for cost reduction increase.
- Decrease in entry costs: New firms enter and firm-level output falls, leading to lower incentives for cost reduction.

Consider the following demand curve:

$$p_i = a - q_i - b\sum_{j\neq i} q_j$$

$$p_j = a - q_j - b\sum_{j\neq k} q_k$$

Firms compete in prices. We can show the following:

- $\pi_i = \frac{(1-b)(1+(n-2)b)(a-c)^2}{(1+(n-1)b)(2+(n-3)b)^2} - f = 0$.(free-entry equilibrium condition)

- $q = (a-c)\,\frac{bn-2b+1}{(1+(n-1)b)(2+(n-3)b)} = \sqrt{\frac{(1+(n-2)b)}{(1+(n-1)b)}\frac{f}{1-b}}$

The last relationship shows that with entry cost and degree of substitution constant, output and the number of firms are positively related (both increase in the industry demand parameter a).

Notice:

- $\frac{d(\frac{(1-b)(1+(n-2)b)(a-c)^2}{(1+(n-1)b)(2+(n-3)b)^2})}{da} > 0$

- $\frac{d(\frac{(1-b)(1+(n-2)b)(a-c)^2}{(1+(n-1)b)(2+(n-3)b)^2})}{dn} = b\,(a-c)^2\,\frac{b-1}{(bn-b+1)^3}\,(bn-3b+1) < 0$

- Hence, for the free entry condition hold to hold, $\frac{dn}{da} > 0$.

- Since $q = \sqrt{\frac{1+(n-2)b}{1+(n-1)b}(\frac{f}{1-b})}$, differentiating, we get $\frac{d(\frac{1+(n-2)b}{1+(n-1)b})}{dn} = \frac{b^2}{(bn-b+1)^2} > 0$.

- Hence, $\frac{dq}{da} > 0$.

Also, clearly, $\frac{dn}{df} < 0$. Moreover,

- $\frac{1+(n-2)b}{1+(n-1)b}(\frac{f}{1-b}) = \frac{(1+(n-2)b)^2(a-c)^2}{(1+(n-1)b)^2(2+(n-3)b)^2} = \left(\frac{(1+(n-2)b)}{(1+(n-1)b)(2+(n-3)b)}\right)^2 (a-c)^2$.

- Hence, $q = \left(\frac{(1+(n-2)b)}{(1+(n-1)b)(2+(n-3)b)}\right)(a-c)$.

- Differentiating, $\frac{d(\frac{(1+(n-2)b)}{(1+(n-1)b)(2+(n-3)b)})}{dn} = \frac{b^2}{(bn-b+1)^2} > 0$.

- Since $\frac{dn}{df} < 0$, it follows that $\frac{dq}{df} < 0$.

Finally,

- $\frac{d(\frac{(1-b)(1+(n-2)b)(a-c)^2}{(1+(n-1)b)(2+(n-3)b)^2})}{db} = -\frac{(a-c)^2}{(bn-b+1)^3}\left(n-b+bn^2-2bn+1\right)$

  $= -\frac{(a-c)^2}{(bn-b+1)^3}(1-b+n(1+bn-2b)) < 0.$

- Hence, higher b leads to lower n. Moreover,

- $\frac{d(\frac{(1+(n-2)b)}{(1+(n-1)b)(2+(n-3)b)})}{db} = -\frac{1}{(bn-b+1)^2} < 0.$

Thus, higher b leads to lower n, which lowers $\frac{(1+(n-2)b)}{(1+(n-1)b)(2+(n-3)b)}$. It also directly lowers $\frac{(1+(n-2)b)}{(1+(n-1)b)(2+(n-3)b)}$. Thus, q falls as b increases.