Module 11: A Simple Model of Reputation - Moral Hazard and Product Quality

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- Consider a firm that sells an "experience good".
  - *Experience good:* product or service where quality is difficult to observe in advance, but it can be ascertained upon consumption.
  - *Examples:* restaurant, bottle of wine, etc.
- Firm decides how much to invest product quality.
- Investments are unobservable, but consumers can learn the quality by purchasing the good.

Model

- N homogenous consumers.
- Each consumer has utility $u = \theta s - p$
  - Outside option 0.
  - So if a consumer expects quality s, then he will buy at price p iff $u = \theta s - p \geq 0$.
- The firm chooses price p and level of quality s.
  - Two possible levels of quality: $s = 1$ or $s = 0$.
  - Production cost of a good of quality s is c_s, where $0 < c_0 \leq c_1 < \theta$. ($c_1 < \theta$ implies that it is always efficient to choose $s = 1$.)
- If the firm sells to (all) consumers at price p and produces a good of quality s, then its profits are $N(p - c_s)$.
  - Otherwise, makes no sales, and its profits are 0.

- *Timing:*

  1. Seller chooses product quality s, which is unobservable to consumers.
  2. Seller sets price p.
  3. Consumers decide whether to buy or not at price p.
  4. Payoffs are realized for all parties.

Benchmark: First best

- Assume consumers observe quality.

- *Case 1:* Firm chooses $s = 0$. Then:
  - Consumers won't be willing to pay a positive price.
  - And so the firm's profit ≤ 0.
- *Case 2:* Firm chooses $s = 1$. Then:
  - Consumers will buy iff $u = \theta - p \geq 0$.
  - So the firm will charge $p = \theta$ and make profit $N(\theta - c_1) > 0$.

Moral Hazard

- Now assume that consumers cannot observe quality.

- Suppose there is an equilibrium in which the firm provides a high quality product.
- If consumers expect quality $s = 1$, then they will be willing to pay any $p \leq \theta$.
- But what will the firm do?
  - Given price $p > 0$, it is optimal to cut quality and set $s = 0$.
  - By doing this, the firm saves quality costs $c_1 - c_0$.
- Thus, there exists no equilibrium in which firm provides high quality goods.
- Consumers anticipate this, and so the firm can charge at most $p = 0$.
- If $p = 0$, then the firm's profit $= -Nc_0 < 0$, so the firm prefers to not make sales; *i.e.*, the market shuts down.

Can we do better?

- So far, the model assumed that consumers cannot learn quality before buying.
- In most cases, some consumers can learn quality in advance (*e.g.*, by reading consumer reviews).
- We will show that informed consumers exert a *positive externality* on the uninformed ones.
  - *i.e.*, they drive up the quality of the firm's product.

- Assume that $M < N$ consumers are perfectly informed:
  - They learn the quality of the good before buying.
  - *Simplifying assumption:* Ideas would still go through if they observed a signal of product quality.
- Informed consumers are willing to pay:
  - $p = \theta$ if quality is high, and
  - $p = 0$ if quality is low.
- The remaining $N - M$ consumers observe product quality after they buy the good.

- Suppose that the monopolist charges $p \in (0, \theta]$.
  - Informed consumers buy only if quality is high; otherwise, they don't buy.
    - If firm chooses $s = 1$, then it obtains profit $M(p - c_1)$ from informed buyers.
    - Otherwise, firm earns zero profits from informed buyers.
  - What would uninformed consumers do?
    - Suppose they don't buy, so that demand only comes from the informed consumers.
    - In this case, the firm's optimal strategy is to choose $s = 1$ (provided $p > c_1$).
    - Hence, if $p \in (c_1, \theta]$, the uninformed consumers should buy.

- Suppose next that uninformed consumers buy. Then the firm's profit is
  - $N(p - c_1)$ if it chooses $s = 1$ (*i.e.*, high quality).
  - $(N - M)(p - c_0)$ if it chooses $s = 0$ (*i.e.*, low quality).

- Therefore, the firm will provide high quality if and only if

$$\begin{aligned} N(p - c_1) &\geq (N - M)(p - c_0) \\ \iff p &\geq \frac{Nc_1 - (N - M)c_0}{M} \end{aligned}$$

  - If this inequality doesn't hold, there cannot be an equilibrium with high quality.
  - There is an equilibrium with high quality if and only if

$$\frac{Nc_1 - (N - M)c_0}{M} \leq \theta$$

- If the price is high, then the firm is afraid of losing a large profit margin on informed buyers, which makes low quality less attractive.
- Same is true if the number of informed consumers (*i.e.*, M) is large.
  - Increasing the number of informed consumers favors high quality (and efficiency).

Repeated Game

- Consider now an infinitely repeated version of the model above.
- In each period $t = 0, 1, 2, ...$, the firm chooses product quality $s_t \in \{0, 1\}$.
  - Assume that product quality is not observable by any consumers.
- After choosing quality s_t, the firms sets a price p_t.
- Consumers choose in each period t whether to buy or not.
- Let $\delta \in (0, 1)$ be the common discount factor.

- Consumers who bought in period t learn the quality that the seller chose (after buying).
- As we saw before, in a static model the seller will not choose high quality.

- We will show that the seller may sell a high quality good in this setting with repeated interaction.

- We look for an equilibrium of the following type:
  - Consumers base their expectations of quality on the firm's "reputation".
  - The firm's reputation at t is measured by quality at previous periods.
    - At $t = 0$, consumers expect quality to be high.
    - At $t > 0$, consumers expect quality to be high only if quality was high at all prior periods.
    - If quality is low at some period t, then consumers expect quality to be low forever.
  - After observing low quality, consumers are not willing to pay a price higher than 0.

- *Strategy:*
  - At $t = 0$ firm provides high quality and charges price $p_1 > 0$.
  - Firm keeps on providing high quality (and charging price p_1) if it has provided high quality in all previous periods.
  - After a deviation, it provides low quality and charges $p_0 = 0$.

- *Note:* The firm's payoffs after a deviation are zero forever.

- If firm never deviates, then its discounted profit is

$$\sum_{t=0}^{\infty} \delta^t N (p_1 - c_1) \quad = \quad \frac{N (p_1 - c_1)}{1 - \delta}.$$

- If firm instead deviates in period t, then its discounted profit is

$$N (p_1 - c_0) + \delta 0$$

  - It earns $N (p_1 - c_0)$ in the period that it deviates, and 0 forever after.

- Therefore, deviation is not profitable if

$$\begin{aligned} \frac{N\left(p_1 - c_1\right)}{1-\delta} &\geq N(p_1 - c_0) \\ \iff p_1 - c_1 &\geq (1-\delta)\left(c_1 - c_0\right) \end{aligned}$$

  - Profit margin that firm gets must be large enough.
  - If inequality holds, future profits are more valuable than short term gain from deviating.
  - Inequality more likely to hold if δ is large and when $p_1 - c_1$ is large.

- In this equilibrium, "reputation" only matters because the consumers believe that it matters.
- If they believed that the firm would produce low quality regardless of the previous history, the firm would have no incentive to produce high quality.
- Hence, the consumers' expectations would be fulfilled.

References

Ortner J., (2013), Lecture Notes.