Game theory and business strategy

Relative prices and backlog in the large turbine generator industry

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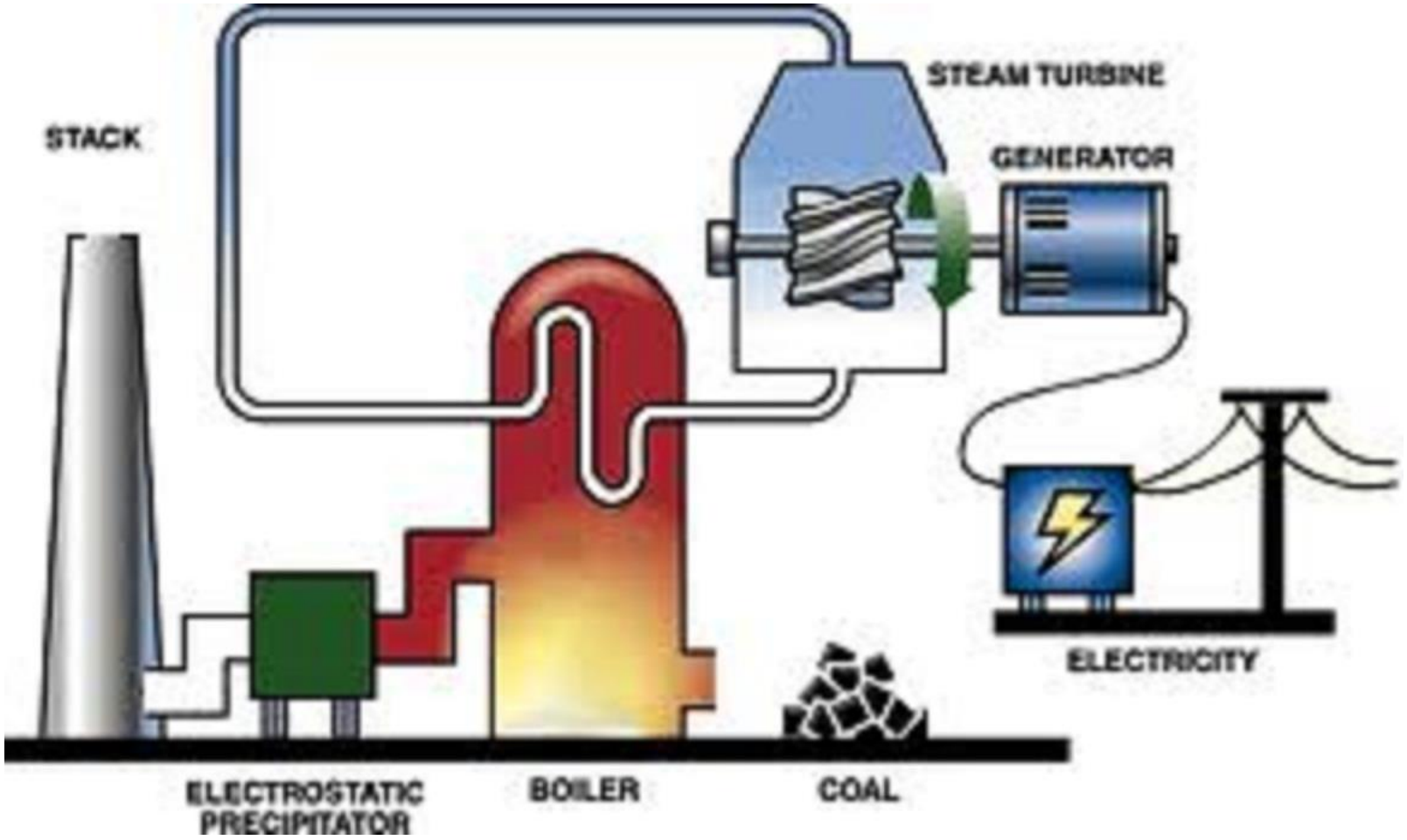

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Market

3 producers – GE (61%), Westinghouse (31%), Allis-Chalmers (6%).

buyers- local utilities, some State Owned (or by local Governs), other are private.

Segmented Markets but they share the same Economic Cycle.

Low long period elasticity but there is some possibility to buy from foreign suppliers.

We focus on 1951 - 1963

Relative prices and backlog in the large turbine generator industry

Production and costs

Constant Marginal costs till 85% of productive capacity. After this level fast increasing

Products are partially customized.

Cost for kilowatt decrease with turbine dimension and learning by doing.

Direct cost per Kw: GE 15$, West 17$, Allis 25%

Two years on average to produce a new turbine. You cannot stock finished products.

Need time to build new productive capacity.

Relative prices and backlog in the large turbine generator industry

When you have limit on your productive capacity there are 3 variables to manage a fluctuating demand:

1. Prices
2. stocks
3. Backlog (longer delivery time)

Analisi teorica

Research Question:

- efficiency based Hp: efficiency levels influences prices when there is an excess of supply but not when there is an excess of demand (in this case willingness to pay is more important than costs) =>
- This implies that GE should fix lower prices when backlog are low because it is more efficient while should have similar prices with other firms when backlog are longer

VS

Game theory hp

Game Theory

Research Question:

GT based hp: it is not easy to define. There are several alternative models.

3 aspects allow use to reduce the number of possible models.

- No entry

No limit pricing model – Entry deterrence

- Non strategy to push someone out of the market (even if Allis exit) also for Antitrust

No war of attrition model

- Productive capacity ia key factor.

Look for oligopoly model with constraints on productive capacity.

theory

- Short run: period too short to adapt productive capacity or to complete a cycle of production but longer enough to sign new contracts and doing so stretching backlogs
- The sale of turbines is seen in relation with backlog and with productive capacity (given that we limit on the short run we don’t hendogenize productive capacity)
- We limit to a duopoly model because it is easier and because the first two players cover 90% of the market

Structure

- x_i (i=1,2) initial productive capacity with $x_1 \geq x_2$
- Total production costs firm i = cq_i if $q_i < x_i$

Otherwise costs are infinite

To simplify we set c=0

It is plausible to set as an hypothesis that there are a limit to productive capacity.

It is not plausible to state equal efficiency

SO....

Efficiency based Hp => relative prices depends on backlog levels - is our Null Hp

GT models that neglect differences in efficiency are the alternative hypothesis.

To test this two alternative in a data set where we know there are differences in efficiency levels implies the decrease of type 1 error (improper rejection of the Null hp)

But increases type 2 error (to accept, wrongly, the Null Hypothesis =>

If data make us reject the Null Hp this would be a strong result in favor of GT models.

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Given that we have an inelastic demand:

Let suppose we have Q buyers, everyone buys a turbine if the price is ≤ u

Uniperiodal model

Q are at the same time on the market (or duopolists have to fix prices ex ante)

Proposition 2.1

Given that $x_1 \geq x_2$ and defining j the one is not i

a. if $Q \leq x_2$

The only equilibrium price is $p_1 = p_2 = 0$ and revenue i =0

b. if $x_2 < Q < x_1$ there is only one equilibrium in mixed strategies

The price i probability distribution is supported by:

$(u(Q-x_2)/Q, u]$ and $\psi_i = [1 - \frac{u(Q-x_2)}{pQ}] \cdot \max(\frac{Q}{xi})$

Uniperiodal model

Revenues of firm i = $u(Q-x_2)$. $\min\left(\frac{xi}{Q},1\right)$

c. If $x_1 \leq Q < x_1 + x_2$

price has the support $(u(Q - x_2)/x_1, u]$ and is

$$\psi_i(p) = \frac{[u(Q - x_2) - px_1]}{p(Q - x_2 - x_1)} \cdot \frac{x_j}{x_1}$$

Firm i's expected revenue is

$$R_i = u(Q - x_2) \cdot \min\left(\frac{x_i}{x_j}, 1\right).$$

d. if $Q \geq x_1 + x_2$ $p_1=p_2=u$

Consequences of Undercutting versus Being Undercut

Regime b

$x_1 \geq Q$ (and $x_1 + x_2 > Q$ and $x_2 \leq Q$)

	Minmax volume if undercut	Incremental volume from undercutting
Firm 1	$Q - x_2$	x_2
Firm 2	0	x_2

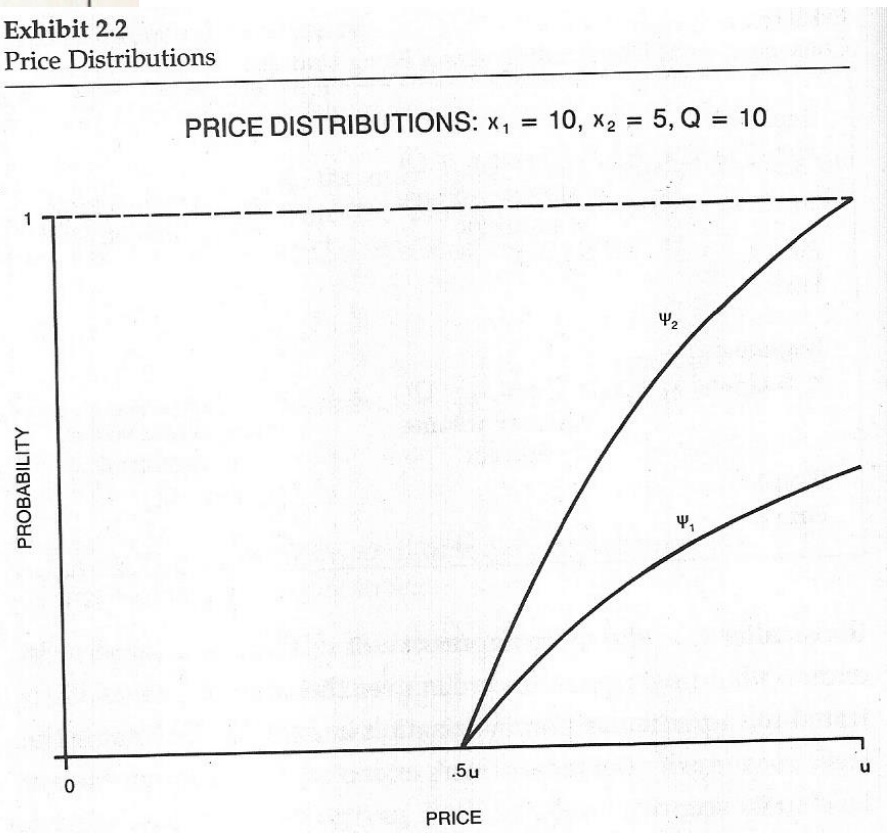
Regime c

$x_1 \leq Q$ (and $x_1 + x_2 > Q$ and $x_2 < Q$)

	Minmax volume if undercut	Incremental volume from undercutting
Firm 1	$Q - x_2$	$x_1 + x_2 - Q$
Firm 2	$Q - x_1$	$x_1 + x_2 - Q$

When there is a low demand but not so low to be satisfied by the smaller firm – the larger firm can aspect an higher price than the rival. This is the opposite result of our Null HP that implies that the larger firm should have lower prices when we face a lower demand.

Exhibit 2.2
Price Distributions



Two periods model

New: to get an order on period 1 influences the possibility to get orders in period 2

2 periods: there are Q/2 buyers per period

The Productive capacity that I use in the first period cannot be used in the second.

To simplify we assume: $x_1 = 2\,x_2 \equiv 2x$

$\Delta = \frac{Q}{x}$ parameterizes the ratio between q and total capacity 3x

more

- We have a two period game and I have to find an equilibrium that is

Sub Game Perfect, thinking backward therefore starting from period 2 (that works as we so for the uniperiodal model but with different quantities)

Also here we 4 possibilities based on the value of parameter $\Delta = \frac{Q}{x}$

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a. $\Delta \leq 1$ ($\Delta = \frac{Q}{x} \Rightarrow Q < x$) demand is so low compared to productive capacity of both firms that each firms can cover total demand in both periods. We go back to Bertrand with prices equal to marginal costs.

b. $1 < \Delta \leq 2$ Firm 1 gives the market in period one to firms 2 fixing a higher price. If this is not the case in period 2 we would have p= marginal cost because every firm would have productive capacity (2x-Q/2 and x respectively) to satisfy the entire demand.

more

c. $2 < \Delta \leq 3$ here is more complex because there is only an equilibrium in mixed strategies. We can show that firm 1 has convenience that firm 2 sells in period 1 to have longer backlog so that it can be stronger in period 2.

d. $\Delta > 3$ here total demand exceed total productive capacity. All firms sell at u

Two period model have similar result with uniperiodal model. There is an incentive to «buffer» the smaller competitor only at intermediate level of productive capacity utilization.

multiperiodal model

Model is to complex: to many variables and possible strategies.

Lets focus on a peculiar case:

Δ=1, x=1 so every period had demand =1 and productive capacity are 2 and 1.

Given that production takes one period the larger firms prefer that the smaller one wins in the first period so that it can have u in the second one..as far as concern backlog this means that the larger firm fix prices so to loose when the small has 0 backlog and wins when the smaller has backlog = 1

conclusions

- In all three models (with different hps) the larger firm prefers to «buffer» the smaller one when supply is bigger than demand unless the smaller on has enough productive capacity to cover all the market alone.
- buffering is designed so that the smaller firm has backlog bigger enough not to start a price war.

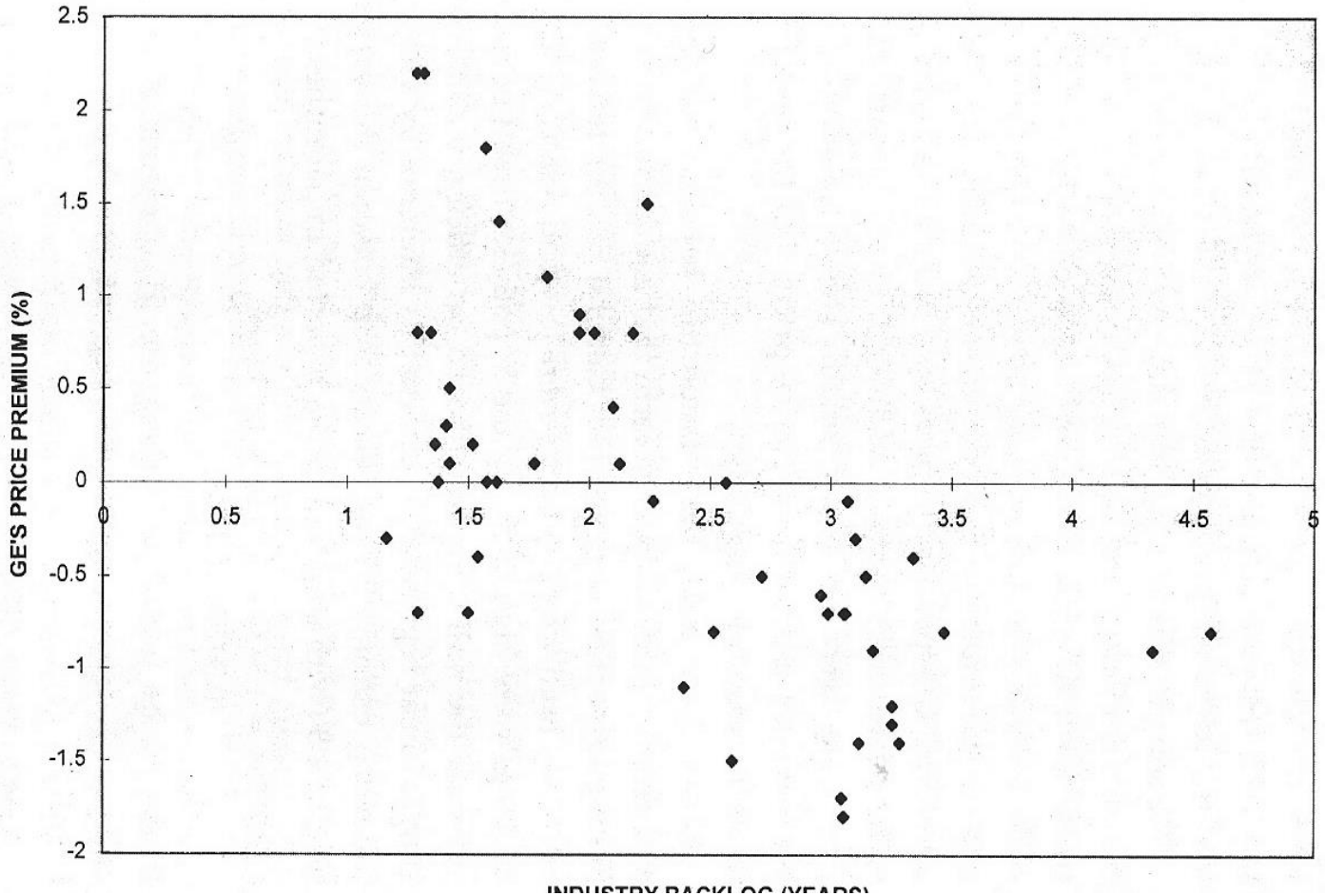
Let see what data show

Efficency hp: larger firm has to lower prices when demand, and so backlog are low.

Gt hp: larger firm has to fix higher prices when backlog are low

- We need GD and average prices.
- We need backlog data
- And productive capacity data

Exhibit 2.3
General Electric's Pricing Strategy, 1951–1963



reflections

There are other factors that plays a role in this game:

1. Concentrated competition: it is a very concentrated industry. What happen if we have more players?
2. Mutual familiarity: here firms know each others very well and this make easier an agreement /equilibrium.
3. Repeated equlibrium and interaction on several markets: this helps stability.
4. Consistent strategic role: roles are will defined
5. Strategic complementarity: if one rises prices also the other have the same interest.