ARE 202 - notes
Villas-Boas/Perloff – 2nd half

Second Handout: Current handout topics in Bold

Topics

1. Product Differentiation, Quality, Advertising, Asymmetric Information
   Problem Set 1
2. Imperfect information and Search models
3. **Repeated Games**
   Problem Set 2
4. Strategic Non-cooperative Behavior
5. Vertical Relationships, Theory of the Firm
   Problem Set 3 (empirical part last question)

Please see Course Outline at: http://are.berkeley.edu/~sberto/are202.html

Empirical Analyzes:

1. Stata and matlab code to estimate Salop and Stiglitz.

2. Strategic Interactions, Dynamic Collusion Models, Stata Code and Files
Data sources

main data page
http://research.chicagogsb.edu/marketing/databases/index.aspx

movement (store total sales by week) data files
http://research.chicagogsb.edu/marketing/databases/dominicks/download.aspx

3. Estimation of Structural Demand Model, recovery of Margins and Empirical Analysis of Margins, Stata Code

Main References:

1. 1 . Carlton and Perloff (2000): Modern Industrial Organization, Dennis W. Carlton and Jeffrey Perloff, 3rd Edition, Reading, MA: Addison-Wesley. Book web-page: http://occawlonline.pearsoned.com/bookbind/pubbooks/carlton_awl/
2. Tirole (1989) : The Theory of Industrial Organization, Jean Tirole, 1989, The MIT Press.

2. Notes on Strategic Games, Strategic Interaction

2.1. Overview

- **Strategic Cooperative behavior**

Carlton and Perloff (2000), chapters 5,6 and 11.

Antitrust, Carlton and Perloff (2000), chapter 19.

- **Supergames**

- ***Repeated games and collusion, Tirole (1989) chapter 6.***

Fluctuating Demand: Rotemberg and Saloner (1986) JSTOR link

Cyclical Demand: Haltiwanger and Harrington (1991) JSTOR link

Empirical paper: Reading for Topic "Dynamic Pricing", Borenstein and Shepard (1996) , Assignment

- ***Repeated games with Asymmetric information***

Green and Porter (1984) JSTOR link

Empirical papers:

Reading for Topic:"Cartel/Price Wars", Porter (1983) , Assignment,

Reading for Topic:"Cartel Collusion/Repeated Games with Asymmetric Information", Ellison(1994)(optional) , Assignment

- **More on identification of oligopoly models.**

2.2. Strategic Behavior

References: Lecture notes on factors that facilitate collusion, Carlton and Perloff (2000), chapters 5,6 and 11.Antitrust, Carlton and Perloff (2000), chapter 19.

° Strategic Behavior are actions that are taken with the objective of increasing firm's profits.

° These actions aim at manipulating the market environment:
- Other existing firms or by possible entrants
- Beliefs of consumers and of existing and potential rivals
- Technology and costs of firms and entry costs

° **Non-cooperative strategic behavior** (third set of notes) encompasses actions of one firm that wants to increase its profits by improving its position relative to its rivals
to harm its rivals
to benefit itself

Cooperative strategic behavior (this set of notes) are actions that increase the profits of all firms by reducing competition and by reducing uncertainty about each other.
These can take the form of explicit agreements as well as non explicit

- Practices that facilitate collusion
  - **Meeting-competition clauses**
  - **Most favored nations clauses**
  - **Dividing the market and Trigger prices**
  - **Applying a discount to past consumers** (penalty to lower price)
  - **Information exchange** (about identity of new customers, and the terms of the contract, so that other firms don't think when a customer changes supplier that it was due to a lower price.
  - **Advanced notice of Price increases and of Sales** (price decrease) *FTC versus Ethyl, du Pont, Nalco and PPG: A lawsuit against four producers of an additive to leaded gasoline that engaged in public press announcements of price changes, most favored nation clauses and advanced notice of price increases to buyers directly. Apparently most clauses were adopted when only one firm was in the market, so most likely not to facilitate collusion…*
- **Swaps and Exchanges**: in industries where good is homogeneous and transportation costs are high (chemicals, gasoline, paper), firms may want to swap among each other customers far away with closer customers.
  Antitrust cases: swaps were a way to divide the market, to deter entry (because a new entrant could not swap so easily due to having fewer locations)

• **<u>The role of Courts:</u>**

Sometimes the above practices may be engaged not to decrease competition but for efficiency reasons. Sometimes such practices are done in the context of a large number of firms where collusion can be difficult.

Example 1: Information exchange, where an Open Competition Plan was voluntarily joined by 465 lumber mills. There, price and quantity data are collected and disseminated. Such exchange has been found not to have anticompetitive impact on output and price.

Example 2: Advance notice of price changes that are reached by insistence of the buyers (to plan better) but not the firms themselves (to facilitate collusion)

• **<u>Factors that facilitate collusion</u>**

1.Inelastic demand facing the cartel
2. Low expectation of severe punishment
3. Low monitoring and organizational costs
4. Stable environments
5. homogeneous good
6. Repeated Interactions (starting with Chamberlin, 1929)

2.2. Supergames

References: Tirole, chapter 6, Rotemberg and Saloner (1986), Haltiwanger and Harrington (1991), Borenstein and Shepard (1996) , Green and Porter (1984), Empirical papers: Porter (1983) , Assignment; Ellison(1994)(optional).

• Supergames = repeated games & collusion

First Question in this literature:

Does the repeated interaction allow firms to sustain equilibria for the dynamic game which are more cooperative than the equilibria we obtain from "one shot"/ static game?

• Supergame is a special case of Dynamic Games
 where each period the <u>same</u> game is repeated
 we'll repeat the Bertrand game

• 2 firms, same constant marginal costs, homogeneous goods, choose prices. Perfect information.
• A strategy in a repeated game: what price to choose given previous history (previous set prices). Let the information set at time t be τt= { P_1, τi, P_2, τ} t=1 τ=2
• <u>T finite:</u>
Solved by backward induction/recursion=> unique equilibrium is Pt=mc
Each firm $\max\limits_{p_{it}} \pi_i (p_{it\setminus} p_{jt})$

$$D_{it} = 0 \quad if \quad p_{it} > p_{jt}$$

$= D(p_{it}) /2$ if $p_{it}=p_{jt}$
$=D(p_{it})$ if $p_{it}<p_{jt}$

- **<u>T finite</u>**. Why p_t=mc ∀t
 In the last period $p_{1T}=p_{2T}$ =mc. In the T-1 period the profits of $\pi_T=0$ regardless of decision in the T-1 period, so period T-1 is again a 'stand alone' period , therefore, $p_{1,T-1}=p_{2,T-1}$=mc, etc…

- The assumption that makes this result is that there is zero robability of playing after period T.
- If probability of playing after period T >0 even if small ⟹
 Possible to support higher prices than mc!

<u>T infinite</u> Infinitely repeated games
It is possible to sustain p>mc ! we can sustain $p \in [c, p^m]$.

- Grim Strategy
  Consider the following strategy: (2 firms)
  $p_{i,0}=p^m$, i=1,2 , where pm is the monopoly price
  $p_{i,t}= p^m$ if $\forall \tau<t$, $p_\tau=(p^m,p^m)$
  mc , otherwise. Plays mc forever if one person deviates once.

  Can we support p^m ?
  Compare discounted profits from deviating with the profits from collusion.
  Deviating in period T : $\pi_T = (p^m - \varepsilon - c) \bullet D(p^m - \varepsilon) = \pi_T^m$
  $\pi_t = 0$, t=T+1,T+2,…

  Not Deviating : Shares monopoly profits forever $\frac{\pi^m}{2} + \delta\frac{\pi^m}{2} + \delta^2\frac{\pi^m}{2} + \ldots$

  A firm will not deviate if $\pi^m < \frac{\pi^m}{2}(1+\delta+\delta^2+...) = \frac{\pi^m}{2} \bullet \frac{1}{1-\delta} \Leftrightarrow$ if δ>1/2 then it's possible to sustain $p_t=p^m$ ∀t
  --4—(Lecture3)

Extensions

- Punishment profits not zero, then it's harder to sustain monopoly price.
- More firms in market, then harder to collude.
- Growing market makes collusion easier
- Uncertainty about market occurring in period T
- Multi-market contact---punishment in both markets if one firm deviates in any market
- Limited true punishments.
- Asymmetric firms…

Folk Theorems

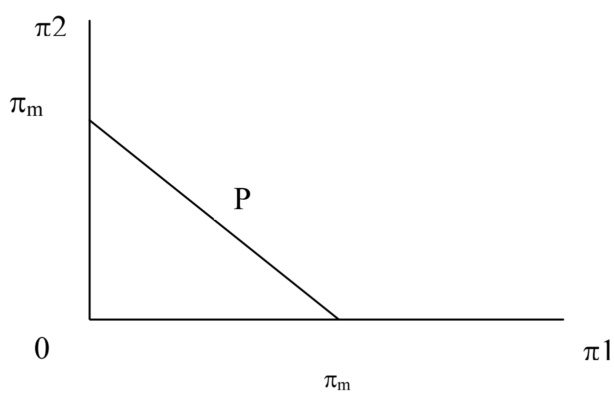
For the repeated price game, any pair of payoffs (π^1, π^2) such that $\pi^1 > 0$ and $\pi^2 > 0$ and $\pi^1 + \pi^2 \leq \pi^m$ is a per-period equilibrium payoff for δ sufficiently large.

- For large enough δ we can sustain π>0.
- Point p: symmetry + pareto=focal point
- Point 0: punishment point

Renegotiation

The punishment point is not good for who punishes, also not good for who is punished, which implies that it is not robust to renegotiation.

To be renegotiation proof, ex-post: the punishers must not want to change, if ex-post the other firm asks for renegotiation, whoever is punished should always be worse off if he deviates from punishment, meaning that renegotiation proof equilibrium should be Pareto optimal. (should be on the line).



Write up (by Leon and Villas-Boas)
For ARE202 Strategic Interactions, Dynamic Collusion Models

This document serves as lecture notes to accompany the second empirical analysis in ARE 202.

The objective is to address dynamic price competition using simple theory models. The first one consist of a supergame where homogenous firms repeatedly interact in Bertrand nash pricing game witout any uncertainty. We will introduce uncertainty about demand, using a simple version of Reotemberg and saloner (1986) to illustrate collusive opportunities for pricing given high and low demand states, and iid uncertainty about next period demand. Next we will relax the iid assumption and assume a simple version of Cyclical Demand as in Haltwinger and Harrington(1991). We will derive for all models testable predictions. We shall then collect data needed to test those predictions, and discuss the challenges inherent to such empirical analysis. The stata file and code is in the zipped folder, to do so, and the table of results Is included in the end of this file, as are complete references of theory used, with web links to the articles.

We shall test using beer scanner data, in the spirit of the paper previously discussed by Borenstein and Shepard, whether we find reduced form evidence consistent with H and H. The idea of the empirical investigation is as follows. If firms are colluding, then markups should move with expected demand. Suppose we have a very cyclical demand, so iid is not reasonable. If demand is expected to be high, controlling for the level of demand and level of costs, then firms have less incentives to lower prices (lower markups) to cheat collusion in that case. This is because when there is a price war to punish the deviation the firms then forego larger profits (when demand is getting large in the near future). If demand is expected to be low, controlling for current level of demand and costs, then deviations are more likely because subsequent punishments less hard (lower profits anyway)...

Readme and notes to use the data and the stata do file in the zipped folder " **CodeToUse.zip**" are described next.

Factors that affect collusion

1. elasticity of demand facing the cartel
2. expectation of severe punishment
3. monitoring and organizational costs
4. Stable environments
5. homogeneity of good
6. Repeated Interactions, finite horizon?

Rotenberg and Saloner(1986)

-Simple version: homogeneous good, 2 firms, symmetric, set prices
-2 states of nature: s=1, $D_1(p)$ with probability=1/2
s=2, $D_2(p)$ with probability =1/2
where $D_2(p)>D_1(p)$
-Demand is independent over time, that is, high demand today does not say anything about demand tomorrow, implying iid demand shock. In the example above demand takes two values, for simplicity.
-In each period all firms observe state of demand before choosing prices.
So what is p_2 such that collusion works?
Max [E(π)] s.t. no firms want to deviate for all states set $p_1 = p_1^m$ and $p_2 \in [c, p_2^m]$

- ⇨ Countercyclical pricing: charge p_1^m during low demand periods and below p_2^m when high demand (price war).

What's the implication of the iid assumption?

Cyclical Demand Haltwinger and Harrington(1991)

Deterministic demand cycles:
$D_t(p)$ are increasing until $t \leq t'$
$D_t(p)$ are decreasing until cycle is complete.

Repeated game:
$\forall$ t; same number of firms, costs, symmetric firms , homogenous goods.
Punishments as before = revert to Nash-Bertrand, $\pi_i = 0 \ \forall$ i
Conclusions:
.For equal current demand, the point when demand is falling will be more difficult / less able to sustain collusion than at the point at which demand is rising.
.2 Forces:
-Higher demand makes it more profitable to deviate
-Falling demand lowers punishment

- ⇨ when demand is high and falling it is that monopoly prices are hardest to maintain so prices fall.
- ⇨ (p - mc) =margins respond positively to changes in expected demand, given current demand.

This is the theoretical testable implication of this model!

Borenstein and Shepard (Rand, 1996) took those predictions to retail margin gasoline data, see next pages for a summary.

-Falling demand lowers punishment

⟹ when demand is high and falling it is that monopoly prices are hardest to maintain as prices fall.

⟹ $(p - mc)$ =margins respond positively to changes in expected demand, given current demand.

This is the theoretical testable implication of this model!

2 Dynamic Pricing in Retail Gasoline

Borenstein and Shepard, RAND, 1996

-Don't impose a structure. Reduced form paper

Question: Is pricing of retail gasoline consistent with predictions of Rotheberg-Saloner (Haltiwanger and Harrington_ type of models?

Collusion=means here implicit collusion supported by repeated interactions

PCM=price cost margins

Theory-3 predictions

1. General conclusion: collusive margins will respond to anticipated changes in cost and demand

2. Controlling for current demand, price cost margin will increase when expected (future-near) demand increases.

3. Controlling for current input prices, PCM decreases if input price increases.

Here, reduced form approach

They don't distinguish theories (like in Ellison structural paper next).

Given the coefficients, what do we get from them?

Data:

Panel data 43 cities (they abstract from intra-city competition), 72 months,

retail price, wholesale price=marginal cost , quantities

⟹margin=(retail-wholesale) price

-Differentiated product, mostly by location

-known seasonal changes -in demand (figure 2), in wholesale prices (figure 1)

-margins=retail-terminal price (figure 1) .... much more erratic that figure 2

Equation to be estimated:

$\text{margin}_t = \alpha_1 \text{ volume}_t + \alpha_2(\text{expectation volume change}) + \alpha_p \exp(\text{terminal price change}) + \text{controls} + \varepsilon_t$

controls=city fixed effects
time effects
past retail prices
past terminal prices

- Absent the incentives from collusive possibilities, then

Retail price $t = \alpha_1 \text{volume}_t$ + city effects + distributed lag of past retail and terminal prices

that is $\alpha_2 = \alpha_p = 0$,

- The Haltwinger-Harrington collusive theory implies $\alpha_2 > 0$ and $\alpha_p < 0$

AR, city by city:

- Predict Nvolume t = function of past Nvolume+ month dummies+ function of time

much of what they get is seasonal. Fit is between .8 and .96

- predict terminal t =function of month dummies+ past terminal prices and past crude prices

fit is less good than above, between .3 and .6 .

Conclusion: volume varies in a much more predictable way (seasonal) than terminal (input) prices - authors say that terminal prices follow crude prices which approximately follow a random walk.

Endogeneity (Problems)

volume t is on the RHS $p_t - \text{terminal}_t = \alpha_L \text{vol}_t + \ldots + \varepsilon_t$

but volume is a function of price itself (any unobservable determinant of price is in the residual and therefore also affect quantity (volume)).

$\text{volume}_t = f(\text{price}_t) + v$

If model for volume is given by $\ln(q_t) = x\beta + \eta \ln p + v$

If ε and v are orthogonal, η is identified

$\underbrace{\ln(q) - \hat{\eta} \ln p}$

Empirical Analysis of Markups in Beer retail Market in a US metropolitan major city

We shall test using beer scanner data, in the spriti of the paper previously discussed by Borenstein and Shepard, whether we find reduced form evidence consistent with H and H. The idea of the empirical investigation is as follows.

If firms are colluding, then markups should move with expected demand. Suppose we have a very cyclical demand, so iid is not reasonable. If demand is expected to be high, controlling for the level of demand and level of costs, then firms have less incentives to lower prices (lower markups) to cheat collusion in that case. This is because when there is a price war to punish the deviation the firms then forego larger profits (when demand is getting large in the near future).

If demand is expected to be low, controlling for current level of demand and costs, then deviations are more likely because subsequent punishments less hard (lower profits anyway)...

So we got prices and wholesale prices for 16 beer brands over several years, together with quantity. We regress "p - wholesale price" of a brand during week t on
weekly average demand "controlling for demad"
weekly average wholesale price "controlling for costs"
and expected demand ED, and test whether the coefficient on ED is positive and significant.

ED is measured by
"just before superbowl" indicator
"temperature in the summer"

see results below, both have positive and summer temp has significant estimate.
It has a term that interacts temperature with summer dummy:

Please use the stata do file in the zipped folder here “ **CodeToUse.zip**”.

	Dep. Variable: Retail margin = Retail Price – Wholesale price							
Average quantity sold per week	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Average wholesale price that week	0.895	0.126	0.850	0.819	0.788	0.853	0.902	0.850
	(0.284)***	(0.125)	(0.260)***	(0.278)***	(0.265)***	(0.260)***	(0.265)***	(0.269)***
Summer dummy* Average temperature	0.001				0.001			0.001
	(0.000)**				(0.000)**			(0.000)**
Monthly Average Temperature	-0.000			0.000				
	(0.001)			(0.001)				
Just Before Super bowl	0.045					0.041		0.053
	(0.039)					(0.036)		(0.036)
Xmas/New year week	0.065						0.055	0.068
	(0.052)						(0.051)	(0.052)
year 1992	-0.031		0.001	0.004	-0.013	-0.000	-0.004	-0.022
	(0.035)		(0.029)	(0.031)	(0.029)	(0.029)	(0.029)	(0.030)
year 1993	-0.101		-0.065	-0.061	-0.077	-0.067	-0.073	-0.090
	(0.046)**		(0.039)*	(0.042)	(0.039)**	(0.039)*	(0.039)*	(0.040)**
year 1994	-0.173		-0.134	-0.128	-0.145	-0.135	-0.142	-0.159
	(0.052)***		(0.044)***	(0.047)***	(0.044)***	(0.044)***	(0.044)***	(0.045)***
Year 1995	-0.204		-0.164	-0.154	-0.164	-0.166	-0.179	-0.184
	(0.076)***		(0.063)***	(0.071)**	(0.064)**	(0.063)***	(0.065)***	(0.065)***
Constant	-2.774	0.566	-2.629	-2.501	-2.326	-2.647	-2.857	-2.595
	(1.250)**	(0.576)	(1.153)**	(1.225)**	(1.176)**	(1.153)**	(1.175)**	(1.195)**
Observations	3030	3030	3030	3030	3030	3030	3030	3030
Number of id	15	15	15	15	15	15	15	15
R-squared	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03
rho	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Pending stuff to be tested:
What happens to the wholesale price?
Elasticity effect?
Reject iid of demand shocks?
Advertising effect?

```
. xtreg margin averageQ averageWp justbeforeSuperbowl summer_temp year_2-
year_5
> , fe r

Fixed-effects (within) regression           Number of obs      =      3030
Group variable: id                          Number of groups   =        15

R-sq:  within  = 0.0250                     Obs per group: min =       202
       between = 0.0096                                    avg =     202.0
       overall = 0.0184                                    max =       202

                                            F(8,3007)          =     11.13
corr(u_i, Xb)  = -0.0000                    Prob > F           =    0.0000

                                    (Std. Err. adjusted for clustering on id)
------------------------------------------------------------------------------
             |               Robust
      margin |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    averageQ |  -.0013754   .0002226    -6.18   0.000    -.0018119   -.0009389
   averageWp |   .7886192   .2648269     2.98   0.003      .269359    1.307879
justbefore~l |   .0505238   .0361829     1.40   0.163    -.0204221    .1214696
 summer_temp |   .0006479   .0003113     2.08   0.037     .0000375    .0012583
      year_2 |  -.0152143   .0293967    -0.52   0.605    -.0728541    .0424254
      year_3 |  -.0793934   .0391591    -2.03   0.043    -.1561747    -.002612
      year_4 |  -.1479789   .0439918    -3.36   0.001    -.2342359   -.0617219
      year_5 |  -.1658362   .0636447    -2.61   0.009    -.2906278   -.0410446
       _cons |  -2.328291    1.17624    -1.98   0.048    -4.634608   -.0219742
-------------+----------------------------------------------------------------
     sigma_u |  .26812373
     sigma_e |  .42817485
         rho |  .2816754   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.
```

files in Folder CodeToUse:

chicagoTempToMerge.dta   HHcyclicalMargins_takeOne.do   Readme.txt   weekControls.dta
Beerdata.dta   chicagoTemp.dta   weeks.xls   Temperatures chicago.xls