Monday
Diamond
(*) Stahl
(*) Sorensen - read this first

Today
Rotemberg-Saloner
Maskin-Tirole
Harrington
Athey-Bagwell

Ellison
Noel

Cyclical Demand: Rotemberg

- 2 firms
- compete in prices $t=0,1,2,\dots$
- Demand $\underbrace{D_t(p)}_{\text{demand is time indexed}}$ goes to low-priced firm
- $D_t(p) = \begin{cases} D^H(p) & \text{w/prob. } \frac{1}{2} \\ D^L(p) & \text{w/prob. } \frac{1}{2} \end{cases}$ demand state is observable before pd t prices chosen

$$D^H(p) > D^L(p) \ \forall p, \quad p_L^M < p_H^M, \quad (p-c)D^i(p) \text{ for } p < p_i^M$$

Optimal collusion:
- consider $p_i(h^t) = \begin{cases} p^H & \text{if demand is high and no one has cheated} \\ p^L & \text{if demand is low and no one has cheated} \\ c & \text{if someone cheated in the past} \end{cases}$

- This is a SPE.

I. No deviation when $p=c$. This is satisfied

[2] No deviation when $p = p^H$ if

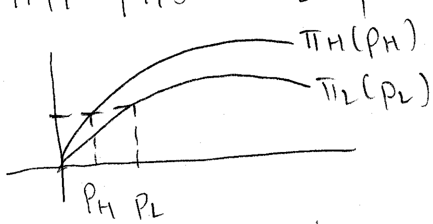
$$\underbrace{\tfrac{1}{2}\Pi_H(p_H)}_{\text{SR gain to cheating}} \le \frac{\delta}{1-\delta}\left[\frac{\tfrac{1}{2}\Pi_H(p_H) + \tfrac{1}{2}\Pi_L(p_L)}{2}\right]$$

SR gain to cheating: $\Pi_H(p_H) - \tfrac{1}{2}\Pi_H(p_H)$

[3] No deviaten when $p = p^L$ if

$$\tfrac{1}{2}\Pi_L(p_L) \le \frac{\delta}{1-\delta}\left[\frac{\tfrac{1}{2}\Pi_H(p_H) + \tfrac{1}{2}\Pi_L(p_L)}{2}\right]$$

- <u>Case 1:</u> δ close to 1
  - can sustain $p^H = p_H^M$ and $p^L = p_L^M$ and $p^H > p^L$
- <u>Case 2:</u> δ smaller
  - constraint [2] binds
    - $p_H < p_H^M$ and $p_L = p_L^M$
- <u>Case 3:</u> δ smaller still (in this model, $\delta = \tfrac{1}{2}$)
  - constraints [2] and [3] bind
    - $\Pi_H(p_H) = \Pi_L(p_L) \Rightarrow p_H < p_L$



- countercyclical pricing

<u>Observation:</u>

[1] Countercyclical pricing if firms are fairly impatient

[2] Title has "price wars in booms"

- This is not a model of price wars. In booms, need to have lower <u>collusive</u> prices.

Ellison: "Theories of Cartel Stability and the JEC."
- Porter → Two supply regimes
- Green-Porter - focus on "do price wars follow signals of cheating?"

Model:
- Demand like Porter, but $u_t = \rho u_{t-1} + v_t$
- Supply is like Porter with I_t unobservable
- Regime change $Pr[I_{t+1} = 1 | I_t] = \frac{\exp\{\gamma' W_t\}}{1 + \exp\{\gamma' W_t\}}$
  - where W_t contains I_t.
  - If v_t is high, this would signal cheating
  - $Bigshare_t$ (firm w/ large mkt share relative to what is normal signals cheating.)

Observations:

1) I_t is clearly highly correlated
2) Weaker evidence that v_t and $Bigshare_t$ cause price wars.

Rotemberg-Saloner: collusion is harder in booms
- Booms in the JEC: seasonal cycle, (ie just before the lakes melt) when u_t is high (if ρ is not close to 1)
- Test if these affect
  1) prices in $I_t = 1$ regime
     - possible but not sign.
  2) prob $I_t = 1 \Rightarrow I_t = 0$ transition
     - no evidence at all

(*) There are lots of people that do not mind sharing data after having published their paper

Markov Equilibrium

- a solution concept that extends static Nash to inherently dynamic settings
- consider dynamic game but <u>assume</u>
  - $s_i(h^t) = s_i(h'^t)$ if continuation gains at h^t and h'^t are identical.
- require $s_i(h^t)$ is a SPE.
- a strategy profile $(s_1^*, \ldots, s_N^*)$ is a Markov perfect equilibrium of G if it is a SPE and
  - $s_i^*(h^t) = s_i^*(h'^{t'})$ whenever $G|_{h^t}$ and $G|_{h'^{t'}}$ are equivalent.

- $G|_{h^t}$ and $G|_{h'^{t'}}$ are equivalent if
  $u_i(s|_{h^t} | h^t) = a u_i(s|_{h'^{t'}} | h'^{t'}) + b_i \quad \forall s$

Maskin-Tirole

Markov equilibrium in an alternating move Bertrand game

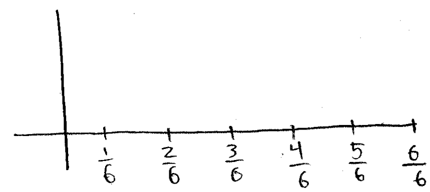
- firm 1 sets price at $t = 0, 2, 4, \ldots$
- firm 2 sets price at $t = 1, 3, 5, \ldots$

Now, Markov equilibrium has $p_{it}(p_{-i,t-1})$

- "What I charge today depends on what the opponent has been charging since yesterday."

<u>Conclusions</u>

1. all MPE have $\pi > 0$ if δ not too small
2. There are multiple MPE.
   - some look like standard collusion
   - eg $D(p) = 1 - p$



- can get
  - $p_{it}(\frac{1}{2}) = \frac{1}{2}$
  - $p_{it}(\frac{1}{3}) = \frac{1}{6}$
  - $p_{it}(\frac{1}{6}) = \begin{cases} \frac{1}{2} & \text{prob } \alpha \\ \frac{1}{6} & \text{prob } 1-\alpha \end{cases}$
  - $p_{it}(0) = \frac{1}{2}$
- will give standard collusion results
- also find other equilibria

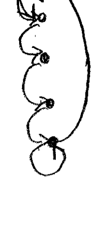
<u>Edgeworth cycle</u>

$p(1) = \frac{4}{6}$ $\quad p(\frac{2}{6}) = \frac{1}{6}$

$p(\frac{5}{6}) = \frac{4}{6}$ $\quad p(\frac{1}{6}) = 0$

$p(\frac{4}{6}) = \frac{3}{6}$ $\quad p(0) = \begin{cases} 0 & \text{prob } \beta \\ 5/6 & \text{prob } 1-\beta \end{cases}$

$p(\frac{3}{6}) = \frac{2}{6}$

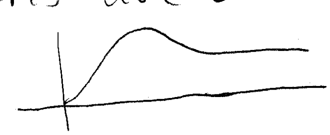


Noel: Edgeworth price cycles; Evidence from Toronto Retail Gas Market

Data: ◦ 22 gas stations: twice daily prices for 131 days in a row.

Predictions: adds asymmetry to Maskin-Tirole.
- ◦ market shares are not 50-50 with equal prices
- ◦ cost shocks
  1. small firms more likely to cut prices at the top of cycle
  2. Large firms more likely to raise prices at the bottom of cycle.
- ◦ cycles are not synchronous. They have differing cycle lengths.

Harrington: Collusion could be harder due to antitrust authorities.
- ◦ adds detection function $\varphi(p_t, p_{t-1}, \ldots)$
  eg. $\tilde{\varphi}(p_t - p_{t-1})$ which is minimized at 0
- ◦ adds penalties x_t

Several results
1. Gradual build-up of collusion if firms are patien
2. Can get non-monotone price paths due to increasing penalty over time 
3. detection can make collusion easier

- cheating may signal to the regulator that there is collusion

Athey-Bagwell

- add private cost shocks: $\tilde{c}_{1t}, \ldots, \tilde{c}_{Nt}$
- want to collude on lowest cost firm today produces
  but private info and no side payment constraint

Ideas:

- Trade future promises for what to do if costs are similar.

The no side payments rules out Groves mechanisms.

Next time:

Read 1. Sorensen
2. Stahl