Imperfect Competition, Market Power, Collusion

Borenstein & Shepard. "Dynamic Pricing in Retail Gasoline Markets." (1996)

Innovation - paper doesn't look at equilibrium (hard to prove observed price/quantity is actually an equilibrium); instead it focuses on strategic interaction: current action is function of expected future events
Action - in this paper the "action" is the price-cost margin: $P - \mathrm{MC}$

Supergame - model in which tacitly collusive outcomes are supported by repeated play; "self-enforcing collusion depends on the current gain from defecting being smaller than the anticipated future loss from the punishment triggered by defection"
Collusion - price > static Nash equilibrium price; a credible threat can only reduce price to Nash equilibrium (lower would mean negative profits); want to punish long enough that there is no incentive to deviate

Gasoline - really a homogeneous product; maybe differentiated by location, but don't expect strategic interaction in this market... B&S use it because it's very easy to change price and price is posted (i.e., easy to detect cheating so it's easy to enforce collusive agreement)

Rotemberg & Saloner (1986) - original theory on tacit collusion; "when current demand is higher (lower) than expected future demand, collusion is more (less) difficult to sustain... collusion is more (less) difficult to sustain when current costs are lower (higher) than expected future costs"
- D > ED $\Rightarrow$ more difficult
- MC < EMC $\Rightarrow$ more difficult

Haltiwanger & Harrington (1991) - "holding constant the current level of demand and cost, collusion is more difficult to sustain when demand is declining or cost is increasing"
Theory for This Paper - combines R&S and H&H... "current margins will respond to expected future demand or cost when firms are pricing collusively... current margins will respond positively to expected future demand and negatively to expected future cost"

Slade (1986) - evidence from single retail market (Vancouver) that "station-level demand is not perfectly elastic and rejects the hypothesis of competitive pricing"
Slade (1987) - "pricing in the Vancouver market is characterized by implicit collusion in which periods of cooperation alternate with price wars triggered by demand shocks"
Borenstein (1991) & **Shepard (1991)** - "show that U.S. gasoline stations have sufficient local market power to implement price discrimination across gasoline grades or service levels"
Ellison (1994) - closest work to this paper; used R&S model on railroad prices and outputs during era of the Joint Executive Committee cartel; found no evidence of an effect on current margins
Model - principle (not exact model): $(P - \mathrm{MC})_t = f(D_t, \mathrm{MC}_t, ED_{t-1}, E\mathrm{MC}_{t-1}, ED_{t-2}, E\mathrm{MC}_{t-2})$
Ai - if you replicate someone else's work, do it with different data or model specification

Data -
Retail Price - average price for unleaded, 87 octane, self-service gasoline in 43 cities (actually 59 cities, but randomly choose 1 from each state so the 43 cities are from different states); averages reported by Lundberg Survey... always done on Friday; "prices have been adjusted to exclude all sales and excise taxes"

Terminal Price - best proxy for marginal cost; "selecting the appropriate wholesale price is complicated by the structure of gasoline product and distribution and by observability... wholesale gasoline markets are defined by terminal location... from the terminal, gasoline is trucked to gasoline stations"; if wholesaler owns the station there is no additional market transaction; if wholesaler doesn't own, there is a transaction, but the price is not publicly available; independently operated stations buy at the "dealer tank wagon" price (DTW)

JC - recent article (Wall Street Journal?) says terminals use zone prices (sometimes specific to one side of the street at a particular intersection) so the terminal price may not be a good proxy for marginal cost

Retail Margin - retail price minus wholesale price

Crude Oil Price - "gulf coast spot price for West Texas Intermediate crude as reported by *Dow Jones International Petroleum Report* and published in the *Wall Street Journal*"; data for all prices from 1986 to 1991

Demand - "data on gasoline consumption (U.S. Federal Highway Administration) are the total retail volume of gasoline sold in each state in each month"; tied to payment of federal excise tax; follows clear seasonal pattern (but different for each state)

Problem - need to match price with quantity... depends on which Friday of the month the price survey was done; "we therefore use a linear interpolation approach to construct a weighted average of the daily volumes in adjacent months"

Estimation -

Simple Model - ran simple OLS and OLS-AR1 just to see what the data looked like; got expected results, but there are lots of econometric problems with it

Fixed Effects - used 72 monthly and 43 city fixed effects

Model 1 - simpler version; only looks at the next month; Eqn (1) in paper

$MARGIN_{it} = \alpha_1 NVOLUME_{it} + \alpha_2 EXP\ NVOLUME_{it+1} + \alpha_3 TERMINAL_{it}$

$+ \alpha_4 EXP\ TERMINAL_{it+1} + \alpha_5 \Delta TERMINAL_{it} + \varepsilon_{it}$ ... interested in α_2 & α_4

Model 2 - allow for more complex lag structure that can be asymmetric wrt terminal prices (e.g., retail prices rise quickly when terminal prices rise, but tend to fall slower); Eqn (2)

$MARGIN_{it} = \alpha_1 NVOLUME_{it} + \alpha_2 EXP\ NVOLUME_{it+1} + \alpha_3 EXP\ TERMINAL_{it+1}$

$+ \beta_1 \Delta TERMINAL^{+}_{it} + \beta_2 \Delta TERMINAL^{+}_{it-1} + \beta_3 \Delta TERMINAL^{+}_{it-2}$

$+ \beta_4 \Delta TERMINAL^{-}_{it} + \beta_5 \Delta TERMINAL^{-}_{it-1} + \beta_6 \Delta TERMINAL^{-}_{it-2}$

$+ \beta_7 \Delta RETAIL^{+}_{it-1} + \beta_8 \Delta RETAIL^{+}_{it-2} + \beta_9 \Delta RETAIL^{-}_{it-1}$

$+ \beta_{10} \Delta RETAIL^{-}_{it-2} + \beta_{11} RETAIL_{it-1} + \beta_{12} TERMINAL_{it-1} + \varepsilon_{it}$ ... interested in α_2 & α_3

Vector Autoregressive (VAR) Treatment - details spelled out in the paper's appendix

Problem - no monthly dummy in either model assumes no seasonal variation in the retail price margin (i.e., all variability in wholesale price is passed on to the consumer)

JC - recent paper said this is true for gasoline markets because of inelastic demand

Finding Expected Demand - construct $EXP\ NVOLUME$ using Eqn (3); only worry about predictions (don't care about econometric problems that affect parameter estimates, but don't affect predictions)... only uses 1 lag; sum of months to capture seasonality; time and time squared to capture macro economic effects; fitted values have $R^2 =$ .8-.95

$$NVOLUME_{it} = \alpha_0 + \alpha_1 NVOLUME_{it-1} + \alpha_2 RETAIL_{it-1} + \sum_{j=2}^{12} \delta_j MONTH_j + \alpha_3 TIME_t + \alpha_3 TIME_t^2 + \varepsilon_{it}$$

- **Finding Expected Cost** - construct $EXP\ TERMINAL$ city by city using Eqn (4); this is another VAR treatment allowing asymmetric... uses 3 lags (2 lags with Δ uses 3 periods); fitted values have $R^2 =$ .3-.6

$$TERMINAL_{it} = b_1 \Delta TERMINAL^{+}_{it-1} + b_2 \Delta TERMINAL^{+}_{it-2} + b_3 \Delta TERMINAL^{-}_{it-1} + b_4 \Delta TERMINAL^{-}_{it-2} + b_5 \Delta CRUDE^{+}_{it-1} + b_6 \Delta CRUDE^{+}_{it-2} + b_7 \Delta CRUDE^{-}_{it-1} + b_8 \Delta CRUDE^{-}_{it-2} + b_9 TERMINAL_{it-1} + b_{10} CRUDE_{it-1} + \sum_{j=2}^{12} \delta_j MONTH_j + \varepsilon_{it}$$

- **Ai** - "they probably tried a lot more" models to estimate the future demand and future cost; tradeoff because each lag means less data for regression... "there's no economics here"
- **Econometric Overkill** - only considered Eqn (1) in class; authors addressed all these issues (but weren't very good at explaining it)
  - **Endogeneity** - just about everything is endogenous... use 2SLS using lagged dependent variable as instrument
  - **Serial Correlation** - in Eqn (1) but not in Eqn (2)
  - **Heteroskedasticity** - in both (1) and (2)

Other Explanations - alternative explanations for how retail margin changes

- **Loyalty** - "suppose that some kind of switching cost causes consumer to prefer buying next period at the station at which they buy this period... implies that margins will be lower when demand is increasing and higher when cost is increasing. This is the reverse of our empirical findings"
  - **Ai** - loyalty for gasoline stations seems ludicrous (no switching costs and homogeneous good), but this was probably answering a question from a presentation or bought up by a referee
- **Inventory** - "firms responding to expected changes by altering their inventory levels"; build inventory by raising wholesale price... "implies that higher demand tomorrow would lead to lower margins today. This prediction has the opposite sign to the one we find for future expected volume"
  - **Problem 1** - "National Petroleum Council estimates that total inventory capacity at the 170,000 retail gasoline outlets in the United States in 1989 was 3.49 billion gallons. This implies an average capacity of approximately 20,000 gallons per station. Stations sell about 200,000 gallons per month on average, so they must accept delivery more than ten times per month on average" (i.e., don't have much inventory)
  - **Problem 2** - rather than raise price wholesalers could just buy more since crude oil market is competitive

Results - "consistent with the predictions of the collusive pricing models"

- $ED\uparrow$ by 10% $\Rightarrow$ current margin$\uparrow$ by \$0.0042 (average margin is \$0.11)
- EMC$\uparrow$ by \$0.10 (actually used wholesale price not MC) $\Rightarrow$ current margin$\downarrow$ by \$0.0063
- "Supergame models of tacit collusion show that supportable price-cost margins increase with expected future collusive profits... controlling for *current* demand and cost, current margins increase with expected net-month demand and decrease with expected next-month cost"

Bresnahan. "Competition and Collusion in the American Automobile Industry: The 1955 Price War." (1987)

Abstract - "Movements in total quantity and in quality-adjusted price suggest a supply-side shock in the American automobile market in 1955. This paper tests the hypothesis that the shock was a transitory change in industry conduct, a price war... In Nonnested (Cox) tests of hypotheses, the collusive solution is sustained in 1954 and in 1956, while the competitive solution holds in 1955."

Ai - this is one of the first papers to address game theory

Puzzle - Table I shows jump in production from 1954 to 1955 of over 50% (5.51M to 7.94M) then returned to "normal" (5.80M) in 1956; prices look the same (0.99, 0.95, 0.97... based on CPI), but they are not adjusted for quality; when adjusted, price drops from 54 to 55 and rises again from 55 to 56; so Q↑ and P↓... this cannot result from a change in demand; question is whether supply curve shifts or its just movement along the same supply curve (if it shifts, have to explain why it shifts back in 56)

Not Demand - Table II shows macroeconomic data; per capita income increased ("mild macroeconomic expansion), but not by much (can't justify 50% increase in production); non-auto durable goods expand in 1955, but don't contract in 56 like cars do; firm profit is not a good measure: "The technology of automobile manufacturing is characterized by large fixed costs: plant costs and product development costs are joint costs of production in many years. Standard accounting practice spreads these costs out smoothly over many years. As a result, there is no stable time-series relationship between accounting profit and price-cost margins in the economic sense. High unit sales years, like 1955, tend to be 'profitable' in the accounting sense no matter what is going on in the economic sense."

Model - author looks at either competitive or collusive behavior; doesn't address why it would be one or the other; just lets data decide which is a better fit

Demand - consumers buy at most 1 car: $U(x,Y,v) = vx + Y - P$

$x =$ automobile quality

$Y =$ income

$v =$ marginal utility of quality

$P =$ price of automobile... $Y - P =$ money not spent on autos

Author uses γ & E for quality & price of next best good ("used car")

Assumes n types of cars with quality distributed uniformly with density δ on $[0, v_{\max}]$

Better & Worse - only goods that are immediately better or worse than a given level of quality affect the demand for that level; pp. 461-463 talk about deriving demand function for products (quality levels) 1 to n by considering cases where consumer is indifferent between the goods:

Worse - $U(x_h, Y, v_{hi}) = U(x_i, Y, v_{hi})$ where $x_i > x_h \Rightarrow P_h - x_h v_{hi} = P_i - x_i v_{hi}$

Solve for $v_{hi} = \dfrac{P_i - P_h}{x_i - x_h}$

Better - $U(x_i, Y, v_{ij}) = U(x_j, Y, v_{ij})$ where $x_j > x_i \Rightarrow P_i - x_i v_{ij} = P_j - x_j v_{ij}$

Solve for $v_{ij} = \dfrac{P_j - P_i}{x_j - x_i}$

Demand - product i is bought by consumers in the interval $[v_{hi}, v_{ij}]$

(9) $q_1 = \delta[v_{12} - vmu(P_1, x_1)] = \delta\left[\frac{P_2 - P_1}{x_2 - x_1} - \frac{P_1 - E}{x_1 - \gamma}\right]$

(10) $q_i = \delta[v_{ij} - v_{hi}] = \delta\left[\frac{P_j - P_i}{x_j - x_i} - \frac{P_i - P_h}{x_i - x_h}\right]$

(11) $q_n = \delta[vmu(P_n, x_n) - v_{nn-1}] = \delta\left[v_{\max} - \frac{P_n - P_{n-1}}{x_n - x_{n-1}}\right]$

Parameters - $E, \gamma, v_{\max}, \delta$

Supply - constant marginal cost that depends on quality: (12) $C(x,q) = A(x) + mc(x)q$

Increasing - higher quality means higher marginal cost

Convex - "all products for which the fixed cost is sunk are sold in positive quantity"; author picks $mc(t) = \mu e^t$ ... "the functional form is arbitrary"

Profit - (14) $\pi_i = P_i q_i - mc(x_i)q_i - A(x_i)$

Behavior - "The collusive one has all firms setting prices to maximize the sum of all their profits, as if they were one monopolist. The competitive behavioral assumption has each firm setting the prices of its products to maximize its own profit, taking the prices of all other firms' products as given."

Competitive - (15) $\pi_i' = q_i + (P_i - mc(x_i))\frac{\partial q_i}{\partial P_i} = 0$

Collusive - specify relations between firms using $\mathbf{H}$ matrix where:

$$H_{ij} = \begin{cases} 1 \text{ if products } i \text{ and } j \text{ are cooperating} \\ 0 \text{ otherwise} \end{cases}$$

Collusive uses $\mathbf{H} = \mathbf{1}$ (matrix of ones); competitive uses $\mathbf{H} = \mathbf{I}_n$ (identity matrix)

$$\pi_i' = q_i + (P_i - mc(x_i))\frac{\partial q_i}{\partial P_i} + H_{ii+1}(P_{i+1} - mc(x_{i+1}))\frac{\partial q_{i+1}}{\partial P_i} + H_{ii-1}(P_{i-1} - mc(x_{i-1}))\frac{\partial q_{i-1}}{\partial P_i} = 0$$

(20)

Equilibrium - simultaneously solve (9)-(11) and (20) to get equilibrium price and quantity vectors: $\mathbf{p} = \mathbf{p}^*(\mathbf{x}, \mathbf{H}, \gamma, v_{\max}, \delta, \mu)$ and $\mathbf{q} = \mathbf{q}^*(\mathbf{x}, \mathbf{H}, \gamma, v_{\max}, \delta, \mu)$

Quality - $\mathbf{x}$ is exogenous, but not observed; need a proxy; use function of observed physical characteristics $\mathbf{Z}$ (based on Rosen (1974)); "arbitrarily assumed to take the square-root form: $x(c) = \sqrt{\beta_0 + \sum_j z_j \beta_j}$

Aggregation Problem - "level of disaggregation used in this paper is finer than the detail in which automobile manufacturers reported the quantities produced... the solution to this problem is to aggregate predicted quantities up to the level of the data... Since the coarseness of quantity aggregation varies over the sample, a problem of heteroskedasticity arises"

Solution - "it is assumed that the underlying quantity variance is $\sigma^2 q$ and that a predicted quantity formed as the sum of k products has variance $k\sigma^2 q$

Other Specifications - author uses two other specifications

Hedonic - "loglinear price and quantity empirical hedonic model introduced by Cowling and Cubbin (1971)"; predicted prices and quantities in a recursive structure:

$$P_j^* = \exp\left[\alpha_0 + \sum_j \alpha_j z_{ij}\right] \text{ and } q_j^* = \exp\left[\lambda_0 + \lambda_1(P_j - P_j^*)\right]$$

"Products" - "this model follows exactly the theoretical development of the oligopoly models, except that each automobile product is treated as if it were manufactured by a separate firm. The matrix $\mathbf{C}$ for this specification is an identity matrix, since no two products are presumed to cooperate."

Translation - according to Ai, this is the no collusion (competitive) setup using quantity-setting rather than price-setting so it basically uses Eqn (15):

$$\frac{\partial \pi_i}{\partial q_i} = P_i - mc(x_i) + \frac{\partial P_i}{\partial q_i} q_i = 0$$

Len - "Do authors get bonus points for being vague?"... nowhere in that paragraph does the author refer to quantity

Empirical Results -

Cox Test - Nonnested test; "hypothesis to be tested is confronted with the data and with an alternative, nonnested hypothesis."; Ai said he'd cover this in econometrics; "One attractive feature of the test statistic so obtained is that it is known to be asymptotically a standard normal under the maintained hypothesis so that one knows what a significant difference is"

Translation - (I'm really starting to not like this guy!)... if the absolute value of the test statistic is greater than 2, reject the null hypothesis

Careful - if H_0 is rejected by all three alternatives, that doesn't mean H_0 is true; there could be other models out there so the conclusion is "not enough evidence in the data to say there is not H_0"

No Further Assumptions - author makes the comparisons year to year; didn't impose any assumptions on demand or supply curve shifts (addresses this later); comparisons made between four specifications: C (collusion), N-C (Nash competition; no collusion), "p" (products), H (hedonic); take one as given (H_0) and test individually against the other three; repeat for all four specifications... total of 12 tests per year

Result - Table III

1954 - Collusion is not rejected by any alternatives (N-C, "P", H); other specifications are all rejected by at least one of the others

1955 - Collusion is rejected by all alternatives; Nash competition is not rejected by any alternatives; others ("P" & H) are rejected by at least one of the others

1956 - Collusion is not rejected by any alternatives (N-C, "P", H); other specifications are all rejected by at least one of the others

The Estimates - on p.473 of paper, author goes back to estimate the parameters in the supply & demand equations

Table IV (p.472) - under non-rejected H_0 from previous section (i.e., collusion for 54 & 56; competitive for 55); parameters are roughly the same which suggests no shifts

Table V(i) - repeats estimates assuming all three years are collusive; large jumps in values... author doesn't address the implication other than to say there are jumps

Table V(ii) - repeats assuming all three years are competitive; "similarly chaotic"

Table V(iii) - repeats assuming all three years are hedonic

Another Test - as if the author hadn't confused you by now, he then goes on to look at another way to justify the conclusion that 54 & 56 are collusive and 55 is competitive; "Table VI gives part of the intuition behind the formal test results"... simple regressions of price and quantity using the four models for each year. For 54 & 56, collusion has highest R^2; for 55, competitive has highest R^2

Final Complication - modify demand specification on page 478 to account for "stock of used cars 'like' model i. Here 'like' means within ten percent in weight, and used cars are assumed to depreciate at 15 percent per year."
Result - "Cox test results of Table III are unaltered"

Brander & Zhang. "Market Conduct in the Airline Industry: An Empirical Investigation." (1990)

Industry Dynamics - in airline industry there are cycles of new entrants and then consolidating mergers; don't know why (demand fluctuations or new innovations)

Debate -

- **Too Much Competition** - firms not making positive profit
- **Not Enough** - many routes served by only one or two airlines

"This article calculates conduct parameters (or "conjectural variations") for a set of duopoly airline routes... the Cournot model seems much more consistent with the data than either the Bertrand or cartel model."

Prior Stuff

- **Estimation of Cost** - Caves, Christensen & Tretheway (1984)
- **Estimation of Airline Demand** - Oum, Gillen & Noble (1986), Anderson & Kraus (1981), Stranszheim (1978)
- **Pricing Behavior** - Bailey, Graham & Kaplan (1985), Borenstein (1989), Borensten & Rose (1989)
- **Contestable Markets** - Morrison & Winston (1987), Whinston & Collins (1988), Berry (1989), Hurdle et al (1989)
  - **Contestable Market** - profits may be positive, but adding another firm drives profits below zero

Innovation - "what distinguishes our article is the explicit estimation of conduct parameters and the attempt to isolate a single strategic setting by focusing only on duopoly routes"

Static Model - only looking at a single period; ignores predatory practices and other multi-period interactions between firms (e.g., don't know if the period studied was punishment from a collusive arrangement)

Conjectural Variations - at the time this was a "very hot" topic; according to Ai, if you did CV, you could get a job, but nowadays, you couldn't

Theoretical Structure

2 firms

$x_i =$ output from firm i total output

$X = x_i + x_j =$ total output

$p(X) =$ inverse demand; $p' = dp/dX$

$C^i(x_i) =$ cost for firm i; $c^i = dC^i/dx_i$

$\pi^i = x_i p(X) - C^i(x_i) =$ profit for firm i

Conjectural Variation Model - firm i views industry output as function of it's own output, $X(x_i)$, so FOC is:

Notation $$\frac{\partial \pi^i}{\partial x_i} = \pi_i^i = p + x_i p' \frac{dX}{dx_i} - c^i = 0$$

Sub $\frac{dX}{dx_i} = \frac{d(x_i + x_j)}{dx_i} = \frac{dx_i}{dx_i} + \frac{dx_j}{dx_i} = 1 + v_i$: $\frac{\partial \pi^i}{\partial x_i} = p + x_i p'(1 + v_i) - c^i = 0$ (Eqn 5)

Conjectural Variation - $v_i = dx_j / dx_i$

This is the general model which can accommodate the three specific models of firm behavior B&Z looked at:

Cournot - for Cournot competition, firm i maximizes profit wrt to it's own output taking firm j's output as given: $\pi_i^i = p + x_i p' - c^i = 0$

From Eqn 5, this requires $v_i = 0$

Bertrand - $p = c^i$ if firm i is the less efficient firm; $p > c^i$ if firm i is the more efficient firm

From Eqn 5, if we assume both firms are the same, this requires $v_i = -1$

Cartel - maximizing combined profit: $\pi = x_i p(X) - C^i(x_i) + x_j p(X) - C^j(x_j)$

FOC wrt x_i: $\pi_i = p + x_i p' - c^i + x_j p' = p + (x_i + x_j)p' - c^i = 0$

From Eqn 5, if we assume both firms produce the same amount, this requires $v_i = 1$

Solve Eqn 5 for v_i: $v_i = \frac{c^i - p}{x_i p'} - 1$

Problem - need to know the demand function to compute p'

Solution - manipulate the equation to get rid of p':

$$v_i = \frac{c^i - p}{x_i p'} - 1 = \frac{c^i - p}{x_i \frac{dp}{dX}} - 1 = \frac{c^i - p}{x_i \frac{dp}{dX} \frac{X}{p} \frac{p}{X}} - 1 = \frac{(c^i - p)\left[\frac{dX}{dp} \frac{p}{X}\right]}{p \frac{x_i}{X}} - 1$$

Note: the <u>positive</u> elasticity of market demand is $\eta = -\frac{dX}{dp} \frac{p}{X}$; market share is $s^i = \frac{x_i}{X}$

$$v_i = \frac{(p - c^i)\eta}{ps^i} - 1 \quad \text{(Eqn 6)}$$

Data - limit to cross-section data set of Chicago-based duopoly airline routes involving American Airlines and United Airlines; "restricting the routes to Chicago-based routes reduces the importance of variations in route-specific idiosyncratic factors, such as airport delays, climate, and whether or not the route involves a hub city for a particular airline" (Chicago is a hub for AA and UA)

Homogeneous Product - assumed in theoretical structure; it's difficult to tell difference between regular economy and discount fare so B&Z combine them into single category; first class is small enough proportion that it doesn't matter (resolved using weighted averages and it doesn't change results)

Chicago Only - "we used only "one-coupon" passengers, which effectively restricts attention to passengers on direct flights between the two cities in question";

Other Restrictions - AA & UA combine for at least 75% market share and had at least 100 passengers in the sample; results in 33 routes in third quarter of 1985

From Eqn 6, data needed include:

Price - fare; "quantity and price data were obtained from I.P. Sharp Associates. The I.P. Sharp data derive from Databank 1A of the U.S. Department of Transportation (DOT) *Origin and Destination Survey*."

Market Share - same source as price

Elasticity of Demand - Oum, Gillen & Noble (1986) "used 1978 data from 200 routes"; "Their estimated elasticities for discount travel range from 1.5 to 2.0, and the range for regular economy is from 1.2 to 1.4"; Mutti & Murai (1977) studied North Atlantic routes and got discount price elasticity of 1.4

B&Z used 1.6 (and then recompute using 1.2 and 2.0)

Marginal Cost - based on Douglas & Miller (1974) and Panzar (1979):

$C^i(x_i) = a_i x_i + b_i f_i(x_i) + F_i$, where

$x_i =$ # of passengers; $a_i =$ cost per passenger

$f_i =$ # of flights; $b_i =$ cost per flight

$F_i =$ fixed costs

Marginal Cost... $c^i(x_i) = a_i + b_i f_i'(x_i)$ $\therefore$ MC for some customers is a_i, but for others (the one that requires a new flight) is $a_i + b_i$

"In a stochastic world, we would want to attribute some fraction of extra flight costs to each additional passenger... thus, using this formulation, marginal cost is simply taken to be average variable cost"

Operating Expenses - proxy for variable cost; use cost from DOT Form 41 reports; use Base (includes general and administrative expenses) and Low (doesn't); summarizing cost data as operating cost per passenger-mile (cpm):

	American	United
Base	12.33	12.61
Low	11.62	12.07

Non-Linear - "cost is not linear in distance. A lot of crew time is used in boarding and deplaning, and fuel consumption is highest during take-off and landing, suggesting that costs are strictly concave in distance rather than linear"... that means elasticity of cpm wrt distance (D) is negative:

$$\theta = -\frac{d\text{cpm}}{dD}\frac{D}{\text{cpm}}$$

Estimate θ from cost function; Caves, Christensen & Tretheway (1984) used 1970-1981 data... got 0.15

Other option from Bailey, Graham & Kaplan (1985)... assume route-specific cost per passenger (c) is function of several variables including distance:

$c = c(D, \mathbf{z})$

"price is taken to be the product of costs and a markup function, $M(ms)$, where ms represents "market structure": $p = M(ms)c(D, \mathbf{z})$. Dividing through by passenger-miles and letting ppm denote price per passenger-mile then yields the equation $ppm = M(ms)cpm(D, \mathbf{z})$

θ is also the negative elasticity of ppm wrt distance; BG&K got 0.483

Morrison & Winston (1986) and Hurdle et al (1989) got "values of about 0.50"

B&Z used 0.5 (and then recompute using 0.25 and 0.75)

B&Z's way to making cost nonlinear, use AFL (average flight length) and get cost per passenger for firm i on route k: $c_k^i = cpm^i (D / AFL^i)^{-\theta} D$ (Eqn 12)

Ai - "very arbitrary, very subjective"; "lucky for him, he made it work"

Results - Table 3 shows almost all $v_i \in (-1,1)$

Base Case - hypothesis test for sample average:

AA - Mean 0.06; StErr 0.11

UA - Mean 0.12; StErr 0.13

Neither is significantly different from zero; both are significantly different than 1 and -1

Other Cases - Table 5 shows cases with $\eta =$ 1.2, 1.6. 2.0 and $\theta =$ 0.25, 0.5, 0.75; hypothesis tests in all cases strongly reject v_i being 1 or -1 (some also reject 0, but most don't)

Bayesian Analysis - Ai doesn't care fore it; "I don't know why people do it"

Overall - Ai liked this paper because of the theoretical framework

Sullivan. "Monopsony Power in the Market for Nurses." (1989)

Basics - author claims to be testing market structure, but is really just estimating the supply equation

Ai - "I don't like his approach"

Monopsony - only one buyer; has market power from upward sloping supply curve; in this case, author argues hospital have power over nurses

Profit - $\pi = R(N) - NW$ (revenue as function of # nurses minus cost, # nurses * wage)

FOC: $\frac{\partial \pi}{\partial N} = \frac{dR}{dN} - W - N\frac{dW}{dN} = 0 \Rightarrow \frac{dR}{dN} = W + N\frac{dW}{dN}$

Marginal Revenue Product (MRP) | Wage (marginal cost of hiring 1 nurse) | Additional cost of raising wage (# nurses * change in wage from hiring

Problem - if firm has to compete for resources, it pays the MRP; in this case price is wage so competition implies W = MRP; a monopsony doesn't have to compete for resources so W < MRP

Similar to Monopoly - recall problem with a monopoly is that it sells with P > MC... because lowering price to gain an additional customer causes it to lose revenue from other customers; in this case, raising the wage to hire an additional nurse, does not provide enough benefit to cover the additional cost of raising other nurses' wages (assuming no price discrimination)

Degrees of Power - since monopsony derives power from upward sloping supply curve, a steeper curve implies greater power; two factors:

Competition - more hospitals means more competition for hiring nurses (move from monopsony to "oligopsony")

Time - in short-run, nurses are less likely to quit if hospitals lower wages so supply is less elastic

Models - author proposes 3 different models:

(1) Competition in quantity: $W_1 = f_1(N_1, N_2, \ldots, N_k)$

(2) Competition in wages (price): $W_1 = g_1(N_1, W_2, \ldots, W_k)$

(3) "Conjectural variation": $W_1 = h_1(N_1, C_2, \ldots, C_k)$ ... uses case load (measure of output)

Ai - these are three different models, just different functional forms; "I don't know how this got published"

Elasticity - modify the FOC above:

$$\text{MRP} = W + N\frac{dW}{dN} \Rightarrow \text{MRP} - W = N\frac{dW}{dN} \Rightarrow \frac{\text{MRP} - W}{W} = \frac{N}{W}\frac{dW}{dN} = \frac{1}{\eta}$$

where $\eta =$ wage elasticity of supply

Log-Linear - use this form for supply function since we're looking for elasticity; that way, coefficients are elasticities:

(1) $\ln W_1 = \alpha_0 + \alpha_1 \ln N_1 + \alpha_2 \ln N_2 + \ldots + \alpha_k \ln N_k$

(2) $\ln W_1 = \beta_0 + \beta_1 \ln N_1 + \beta_2 \ln W_2 + \ldots + \beta_k \ln W_k$

(3) $\ln W_1 = \gamma_0 + \gamma_1 \ln N_1 + \gamma_2 \ln C_2 + \ldots + \gamma_k \ln C_k$

Result - author couldn't find any difference between α_1, β_1, & γ_1 and concluded market structure doesn't affect elasticity

Wrong - didn't't' really address market structure, just different specifications of supply (which turned out to give the same wage elasticity of supply)

Econometric Issues - endogeneity problem because of correlation between RHS regressors and error term; hospital specific factors that don't change over time are not in model so are incorporated in the error term... use panel regression:

I'm skipping the technical stuff... author is too vague with notation (and Ai didn't help either)

Use dummy variables for hospital, region, time and hospital-time interaction

Problem - number of hospitals in each region is not constant

Solution - assume $\beta_2 = \beta_3 = \ldots = \beta_k$

Problem - having data for other hospitals causes endogeneity problem because these variables are jointly determined (e.g., total number of nurses available)

Solution - take differences; this drops the hospital dummy; still have problem so difference the average too; this drops the other fixed effects

Problem - need an instrument for the number of nurses

Solution - author uses output (case load) arguing that the hospital can't control it, but that's wrong; hospital can refer patients to other hospitals or send them home so this isn't a good instrumental variable

Ai - "The short answer is he has no other data."

Better Instruments - use consumer side: population, % elderly, % children

Problem - error term is correlated over time and has heteroskedasticity

Solution - in a footnote, author says he corrected for it, but didn't say how

Tables - too many of them (probably because referee asked to see them); 11, 12, 13 are results (almost identical)

Differences - big difference going from 1-year to 2-year difference; author says 1-year is short-term

Good - Ai likes more than 1 year difference because in a 1-year difference measurement error dominates the variation... trade-off though because longer difference gives up more data and runs risk of structural change