Cartel Detection
The Case of Collusive Basing-Point Pricing

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Agenda

1. Cartel Detection

2. Tell-Tale signs of Collusion

3. Basing-Point Pricing

4. Detecting Collusive Basing-Point Pricing

5. Concluding Remarks

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Cartel Detection

- Cartels are discovered as a result of:
  - ‘Accidental’ leaks (employees, former or confused)
  - Complaints from victims (biased towards Type I errors) and the public (confused)
  - Self-reporting (biased towards Type II errors)
  - Active detection by competition authorities

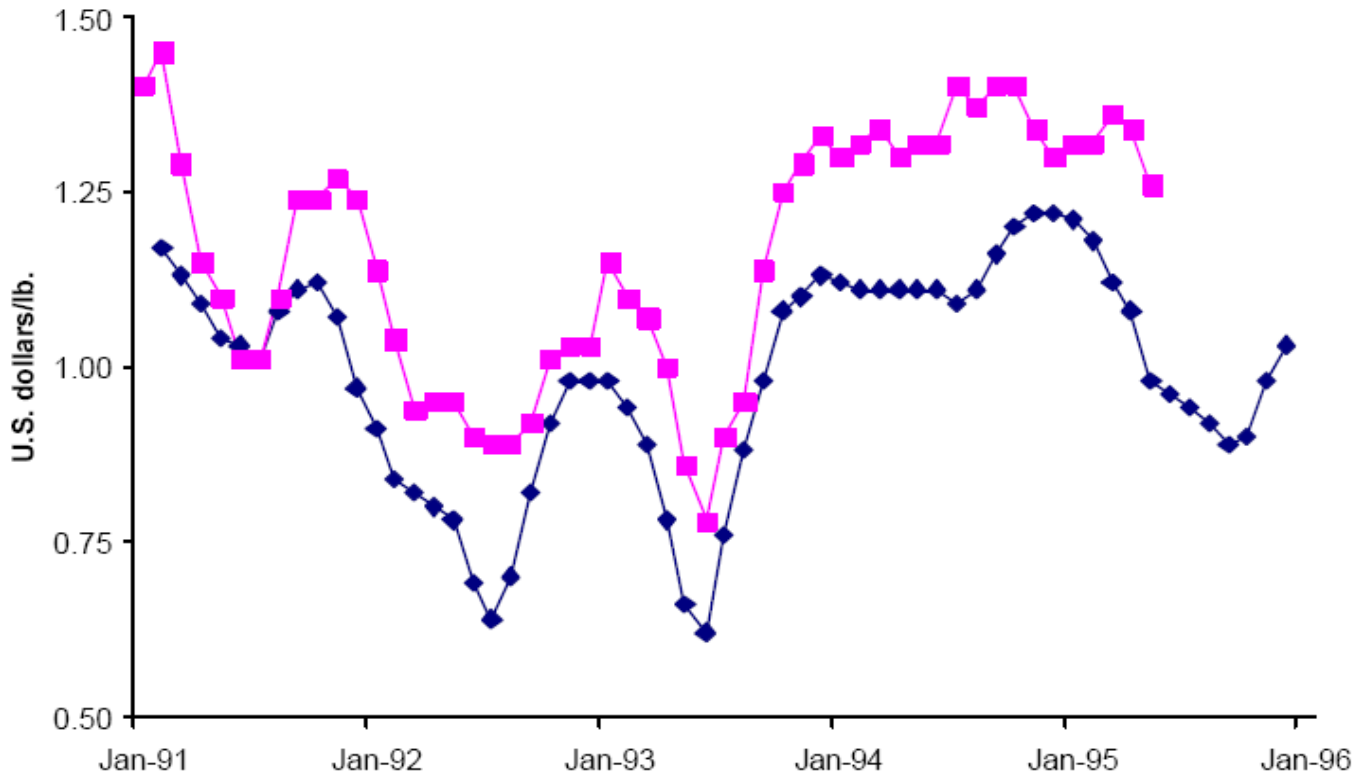
- Active detection crucial (Porter, 2006; Harrington, 2006a, 2006b)
- Growing awareness with the authorities (Friederiszick and Maier-Rigaud, 2007)
- Hammond-misconception (“You cannot catch thieves with economists”)

- All cartel investigations result from someone being suspicious
- Focuses the deployment of enforcement resources
- N.B.: Found-out-Fools dilemma (hysteresis; Grout, 2006)

Tell-Tale Signs of Collusion

- Price effects:
  - Cartel price-path over time (Harrington, 2004; 2006b)
  - Mean-variance across clusters in partial collusion (Abrantes Metz, *et al*., 2006)
  - Skewed price distributions (Connor *et al*., 2005)
  - International benchmarking (von Weizsaecker, 2004)
- Bid-rigging in auctions:
  - Bid-distance correlations (Porter and Zona, 1993; 1999; Bajari and Ye, 2003)
  - Bid-signalling (Klemperer, 2007)
- Market shares and excess capacity (Osborne and Pitchik, 1987; Blair and Romano, 1990)
- Correlated rates of return, business profits and stock prices

Figure 1. Lysine Transaction Prices, U.S. and EU Markets, 1991-1996.



Source: Connor (2007)

Somewhat More Fantastic Cartel Traces

- Fraudulently ‘made-up’ prices (Benford’s Law, Odd-Eights Quotes)
- Reduced/withheld quality (variety, durability)
- Typical sales conditions (English clauses, delivered pricing)

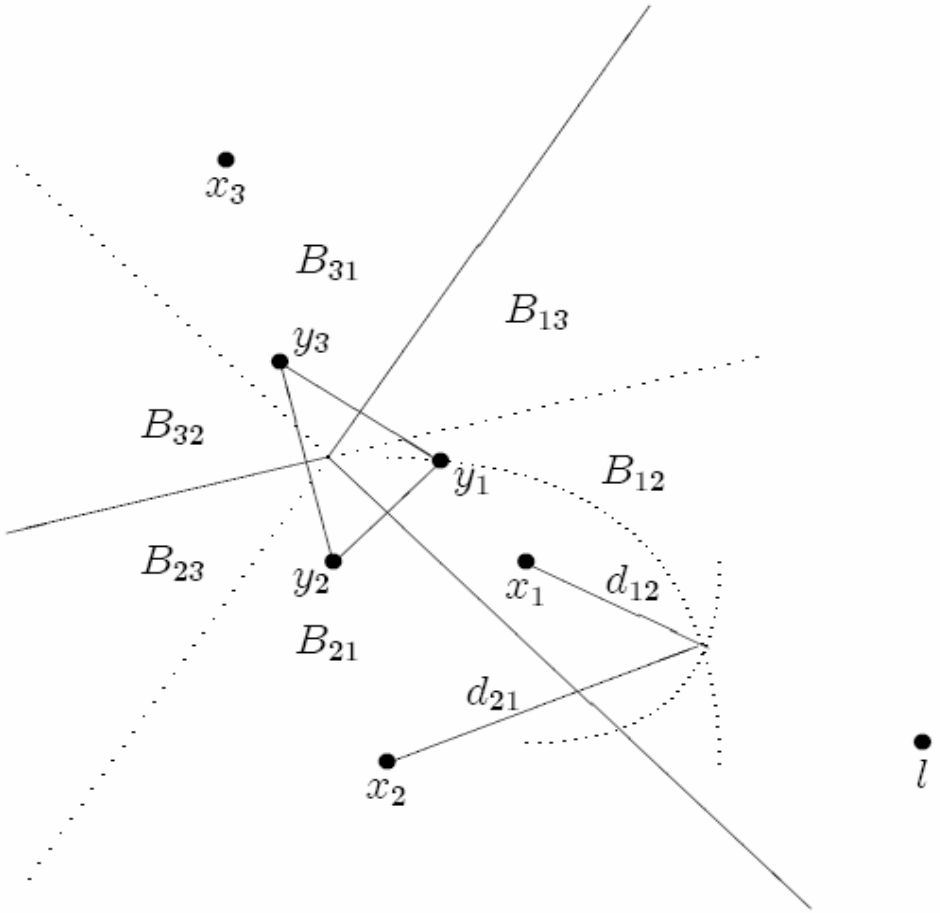
- Timed telephone patterns (Australian gasoline)
- Suspicious internet traffic (Sleeper-cell monitors)
- Clustered traveling (Lysine-tapes)

- Any of the above, correlated with pathological price-paths

Basing-point Pricing

- Delivered pricing, i.e. prices are inclusive of transportation costs
- Homogeneous bulky products
- Specialized, risky and expensive transportation (cement, chemicals, steel)

- Spatial product differentiation
- Creates possibility to perfectly price-discriminate (c.t. ‘mill-pricing’)
- Competitive versus collusive basing-point pricing



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Collusive Basing-Point Pricing

- Facilitates cartels (Stigler, 1949; Benson *et al.*, 1990):
  - Easy to hide:
    - Clear and simple rule
    - Little communication necessary
    - Homogenous bids per customer
    - Wide bid spread across customers
  - Suitable for blocking entry into local market
  - Natural punishment system

- Empirical evidence of abuse (Karlson, 1990)

- Long *per se* illegal in US (*Cement Institute vs. FTC*, 1948)

Competitive Basing-Point Pricing

- Not so convenient for collusion (Carlton, 1983):
  - No natural collusive base location
  - No natural market division:
    - Costly cross-hauling and end-of-year compensation
    - Difficult to detect cheating

- Efficient transport (Haddock, 1982)

- Empirical evidence of competition (Gilligan, 1992)

- Today under rule of reason and hardly enforced (Hylton, 2003)

Detecting Collusive Basing-Point Pricing

•“Tracing the Base: A Topographic Test for Collusive Basing-point Pricing” (Bos and Schinkel, 2007)

•Recover the base location from all-inclusive (transaction) prices

•Akin to forensic technique of ‘Geographical Profiling’ (Rossmo, 1999), used to catch arsonists and serial killers

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A Model of Basing-Point Pricing

- Continuous and bell-shaped distribution of consumer projects (unimodal)
- Locally isolated mills, clustered around ‘center of the market’
- Lexicographic altruism in placing orders (strong under collusion)
- Defines natural home markets (H_j) and ‘base areas’ (B_{jv})
- Euclidian distances:

$$d_{\alpha\beta} = \sqrt{(a_\alpha - a_\beta)^2 + (b_\alpha - b_\beta)^2}.$$

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$$P_{ji} = cq_i + F + T\left(q_i, d_{li}\right),$$

Assumption 3 $T_j(q_i, d_{ji})$ satisfies for all $j = 1, \ldots, J$,

(i) $T_j(q_i, d_{ji}) = T(q_i, d_{ji})$;

(ii) $\frac{\partial T(q_i, d_{ji})}{\partial d_{ji}} > 0$.

$$\pi_j = \sum_{v=1}^{V_j} \iint_{B_{jv}} f(a,b)\left[T\left(q_i, d_{li}\right) - T\left(q_i, d_{ji}\right)\right] dadb,$$

Competitive versus Collusive Basing-Point Pricing

Proposition 1 *In competition, firm j uses mill location y_v as a base for all customers $i \in B_{jv}$, and y_j for all $i \notin H_j$.*

Corollary 1 *Any convex combination of competitive base locations is in the convex hull of firm locations $\mathcal{C}$.*

Proposition 2 *Collusive base candidates are located outside $\mathcal{C}$.*

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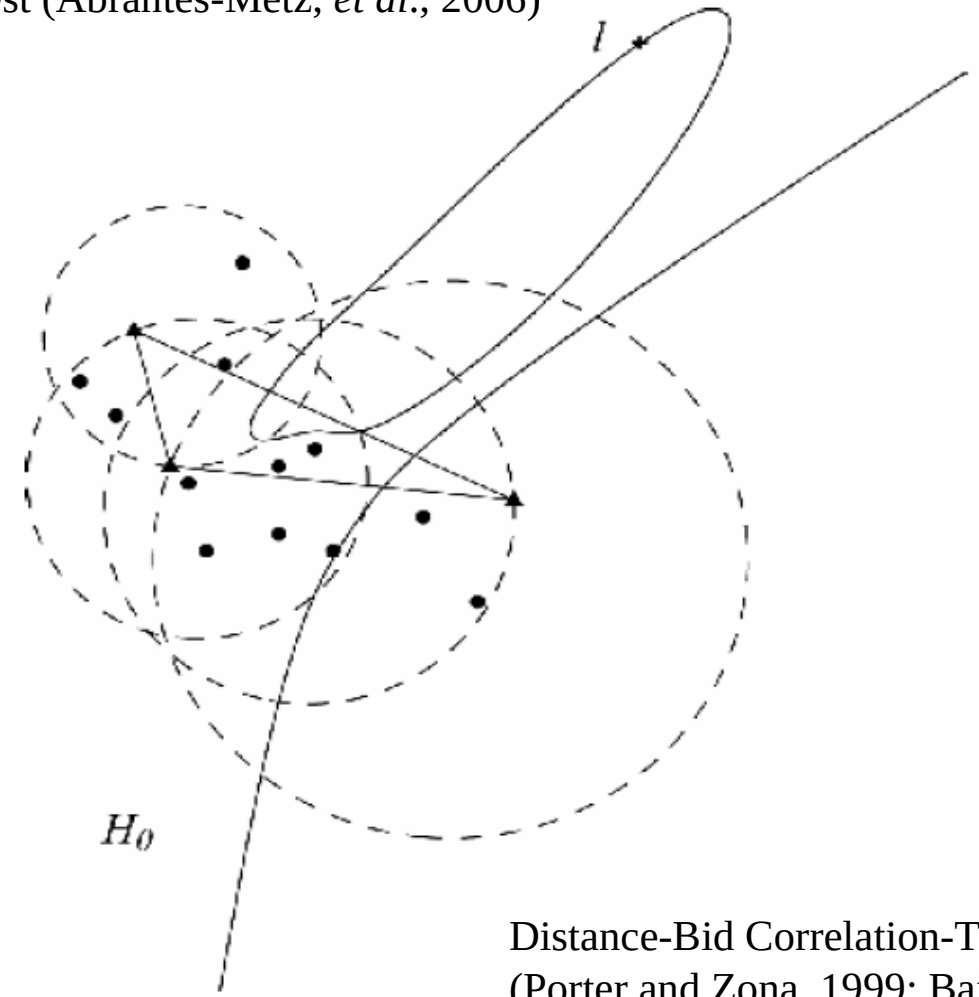
Mean-Variance-Test (Abrantes-Metz, *et al.*, 2006)



Distance-Bid Correlation-Test
(Porter and Zona, 1999; Bajari and Ye, 2003)

Consumer	Volume	Price/unit$_{comp}$	Price/unit$_{coll}$	Net overcharge
(470,420)	980	70.5	86.4	15582
(500,370)	1070	79.6	91.6	12840
(440,460)	1160	61.4	90.5	33756
(480,410)	1140	71.7	100.9	33288
(600,470)	1060	68.2	91.4	24592
(580,330)	820	67.5	94.2	21894
(520,420)	900	71.4	95.9	22050
(410,510)	1090	62	102.2	43818
(610,320)	1100	72.8	86.9	15510
(540,360)	930	68.7	88.5	18414
(470,350)	830	66	98.9	27307
(430,460)	1010	59.1	100.7	42016

Table 1: Prices per unit and profits under competitive and collusive basing-point pricing.

$Mean_{comp} = 68.2$
$Mean_{coll} = 94.0$
$Var_{comp} = Var_{coll} = 29.3$

Testing for Collusive Basing-Point Pricing: Tracing the Base

$$P_{ji} = cq_i + F + T\left(q_i, d_{li}\right), \qquad T\left(d_{li}\right) = td_{li},$$

$$P_{ji} = cq_i + F + t\sqrt{\left(a_l - a_i\right)^2 + \left(b_l - b_i\right)^2}.$$

$$a_l = a_i \pm \sqrt{\left(P_{ji} - cq_i - F\right)^2 - \left(b_l - b_i\right)^2}.$$

- Known: P_{ji} (delivered bid), q_i (volume) and (a_i, b_i) (project location x_i)
- Unknown: c and F (cost) and (a_l, b_l) (base-location). Normalize t = 1

- Sort bid data by base area (using mill locations)
- Every set of 4 observations per base area returns a base

Likelihood-of-Collusion Measure

$$\overline{a} = \frac{1}{N}\sum_{l=1}^{N} a_l \text{ and } \overline{b} = \frac{1}{N}\sum_{l=1}^{N} b_l.$$

$$\sigma = \sqrt{\frac{\sum_{l=1}^{N}(\alpha_l - \overline{a})^2 + \sum_{l=1}^{N}(b_l - \overline{b})^2}{N}}.$$

$$S^{\lambda} = \left\{(a,b) : \sqrt{(a-\overline{a})^2 + \left(b-\overline{b}\right)^2} \leq \lambda \times \sigma\right\}.$$

$$\lambda \geq \frac{\max d_{lj}}{\sigma}$$

$$LoC = 1 - \frac{S^{\mathcal{C}} \cap S^{\lambda}}{S^{\mathcal{C}}},$$

$$LoC \in [0,1].$$

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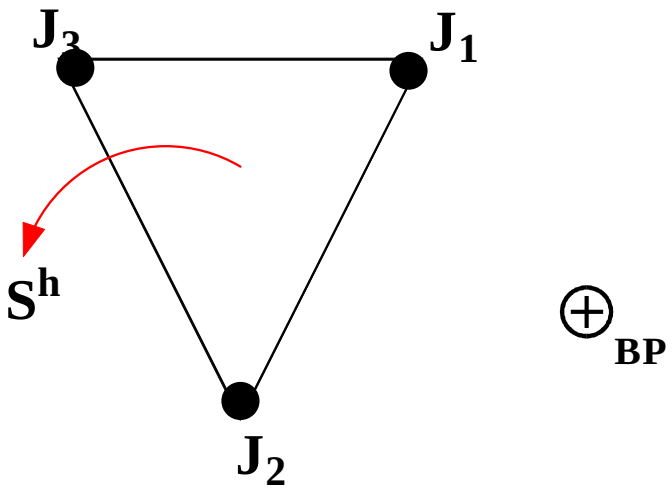
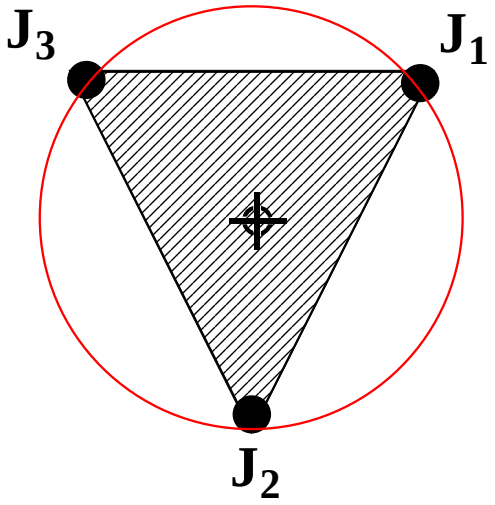
Collusive Basing-point Pricing



$$LoC = 1 - \frac{S^{\mathcal{C}} \cap S^{\lambda}}{S^{\mathcal{C}}} = 1 - \frac{0}{S^{\mathcal{C}}} = 1$$

Competitive Basing-point Pricing



$$LoC = 1 - \frac{S^{\mathcal{C}} \cap S^{\lambda}}{S^{\mathcal{C}}} = 1 - \frac{S^{\mathcal{C}}}{S^{\mathcal{C}}} = 0$$

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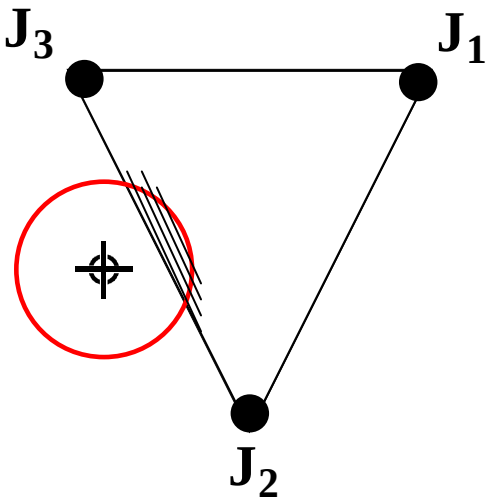
Fit and Measurement Errors in Collusion



$$LoC = 1 - \frac{S^{\mathcal{C}} \cap S^{\lambda}}{S^{\mathcal{C}}} \approx 0.9$$

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Implementation: The Base-Locator™

- Algorithmic implementation of LoC-measure
- Applicable to public data (locations and transactions)
- Confidence intervals LoC endogenous
- First screen to direct further investigation (e.g. LoC > 3/4)
- Practical, non-invasive and inexpensive

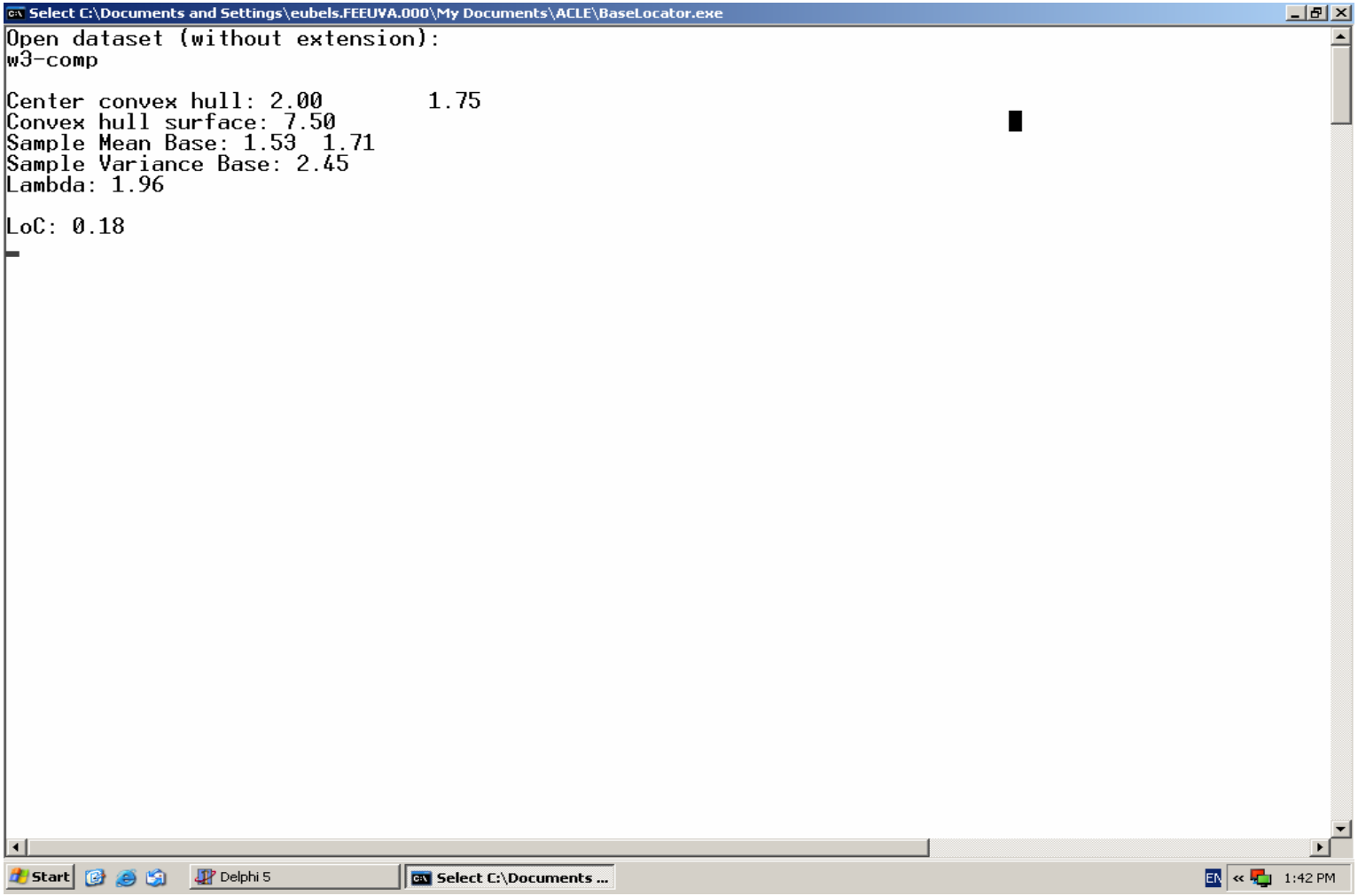
- Distributions need to satisfy assumptions (check)
- Bid-structure non-linear (variations possible)
- Noise in bids (miscalculations or measurement errors)

#Consumers
23

x1	x2	p	q
1.00	2.00	441.00	88.00
-7.00	13.00	184.21	34.00
6.00	12.00	204.06	39.00
1.00	4.00	83.00	16.00
-8.00	-3.00	282.62	55.00
2.00	6.00	384.00	76.00
1.00	-8.00	138.25	26.00
5.00	4.00	313.61	62.00
8.00	3.00	71.08	13.00
-3.00	9.00	398.60	78.00
9.00	1.00	177.07	34.00
-12.00	10.00	230.44	44.00
1.00	-10.00	350.00	66.00
-3.00	2.00	64.12	12.00
-6.00	9.00	105.30	19.00
12.00	-1.00	395.44	77.00
8.00	-2.00	52.21	9.00
1.00	0.00	387.00	77.00
-13.00	9.00	50.00	7.00
-3.00	12.00	506.18	99.00
0.00	0.00	6.41	1.00
2.00	21.00	53.25	7.00
-2.00	-7.00	47.07	8.00

#Industries
6

1.00	1.00
2.00	2.00
-4.00	-2.00
2.00	3.00
5.00	3.00
-1.00	0.00



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Possible Extensions of the Test

- Method can be used for antitrust damage calculations in basing-point cases

- Cluster Analysis and Incomplete Collusion:
  - Determine Optimal Number of Clusters
  - Apply Topographic Test per Cluster
  - Example: *Addyston Pipe and Steel* (1899)

- Beating the test:
  - Moving or rotating the base-point over time, or between offer invitations
  - Recursive algorithm approach to the data
  - Find combinations of data points associated with same (collusive) base

Concluding Remarks

- Active detection crucial for effective cartel law enforcement
- Look for specific tell-tale signs of collusion
- Cartel theory is developing to provide these

- Collusive basing-point pricing leaves idiosyncratic traces
- Our detection method exploits those

- Game of hide-and-seek
- Competition authorities need to be at forefront techniques (software)
- A Google-earth-approach to cartel detection needed
- At a minimum it makes it harder, more expensive to collude