The Model: Demand and Production

Model is like Pakes-McGuire/Ericson-Pakes except: (i) alter investment process; (ii) mergers/bargaining; (iii) antitrust authority

- Demand: $Q(p) = B(A - p)^{\gamma}$
- Production: $F(K, L) = \left(K^{\beta} L^{1-\beta}\right)^{\theta}; \beta \in (0,1), \theta > 1$
- Marginal cost reduction from symmetric merger:

$$R \equiv \frac{C_Q(2Q|2K)}{C_Q(Q|K)} = \frac{C(2Q|2K)/Q}{C(Q|K)/Q} = 2^{\left(\frac{1}{1-\beta}\right)\left(\frac{1-\theta}{\theta}\right)}$$

For $\beta = 1/3$:

θ	1.05	1.1	1.15	1.2	1.3	1.4
R	0.95	0.91	0.87	0.84	0.79	0.74

The Model: Capital

- Capital Augmentation: each unit j of capital a firm owns can be doubled at cost $c_j \in [\underline{c}, \overline{c}]$ drawn iid from a distribution F
- Greenfield cost per unit: a firm can build as many capital units as it wants at a cost $c_g \in [\overline{c}, \overline{c}_g]$ drawn from a distribution G
- Key features:
  - Merger neutrality of investment opportunities (at market level)
  - Complex investment choices (can acquire multiple units)
  - Incremental cost of capital acquisition for a firm is decreasing in its current size, and increasing in the number of units it adds
- Given capital stocks, production and sales are short-run Cournot
- Stochastic, unit-by-unit capital depreciation at rate $d \in (0, 1)$
- Cash flows discounted with discount factor $\delta \in (0, 1)$

The Model: Mergers

- Bargaining over mergers:
  - A problem of bargaining with externalities
  - Here we restrict attention to two active firms and use widely accepted and easily interpreted 50/50 Nash bargaining
- Entry:
  - Following a merger, entrant appears immediately with zero capital and same investment process as incumbent
  - Get similar results if the entrant is the owner-manager of the acquired firm (justifying restriction to two active firms)
- Merging firms' gain from merger is

$$\Delta \equiv \overline{V}(K_1 + K_2, 0) - \left[\overline{V}(K_1, K_2) + \overline{V}(K_2, K_1)\right] - \phi$$

where $\phi \sim \Phi$ is a random proposal cost

The Model: Merger Policy

- Merger Policy:
  - Randomly drawn merger blocking cost $b \sim H$
  - Consider both commitment and no commitment ("Markov perfect") policies
    - Can think of policy equivalently as a state-contingent cut-off value of the blocking cost $\widehat{b}(K_1, K_2)$ or as a probability of approval $a(K_1, K_2)$
  - Consider both consumer and aggregate value as objectives

The Model: Timing

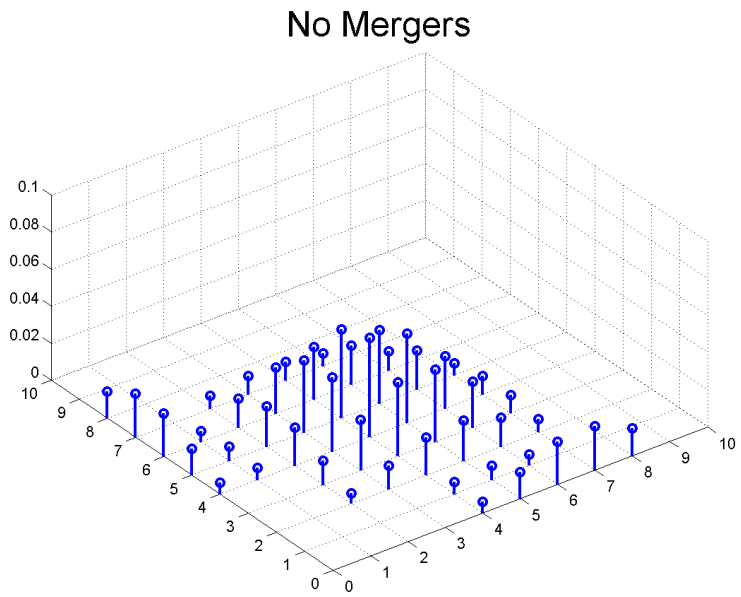
Each period, starting in state (K_1, K_2):

1. Firms observe each others' capital stocks
2. The firms observe their proposal cost ϕ and bargain over whether to propose a merger
3. If a merger is proposed, the antitrust agency observes its blocking cost b and decides whether to block it. If a merger is approved, it is consummated immediately, and the merged firm's capital stock is $K_1 + K_2$.
4. If a merger occurred, an entrant enters with no capital
5. Firms choose their output levels simultaneously and the market price is determined
6. Firms privately observe their capital augmentation and greenfield cost draws and decide on their investments
7. Stochastic depreciation occurs, resulting in the capital levels at which firms begin the next period

Three Markets

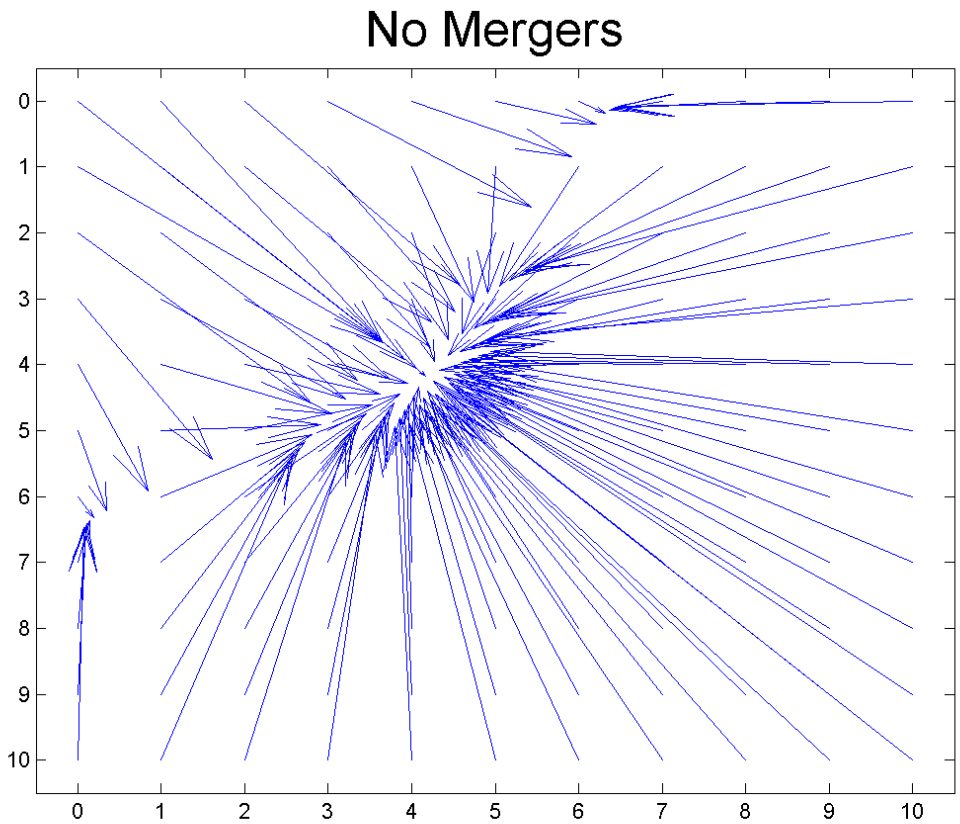
- Focus on three markets: Large (natural duopoly), Small (verges on natural monopoly), and Intermediate
- Parameters:
  - Demand: $Q(p) = B(A-p)^{\gamma} \Rightarrow A = 3, \gamma = 1, B \in \{22, 26, 30\}$
  - Production function: $F(K,L) = \left(K^{\beta} L^{1-\beta}\right)^{\theta} \Rightarrow \beta = 1/3, \theta = 1.1$
  - Investment costs: $\underline{c} = 3, \overline{c} = 6, \overline{c}_g = 7$ uniformly distributed
  - Depreciation & discounting: $d = 0.2, \delta = 0.8$ (5-year periods)
  - State space: $S^2 = \{0, 1, ..., 20\}^2$
- Nearly all action in these markets takes place in $\{0, 1, 2, ..., 10\}^2$, the upper-left quadrant of the state space. Need full state space to calculate values for mergers and avoid edge effects.

Steady State for Intermediate Market No Mergers



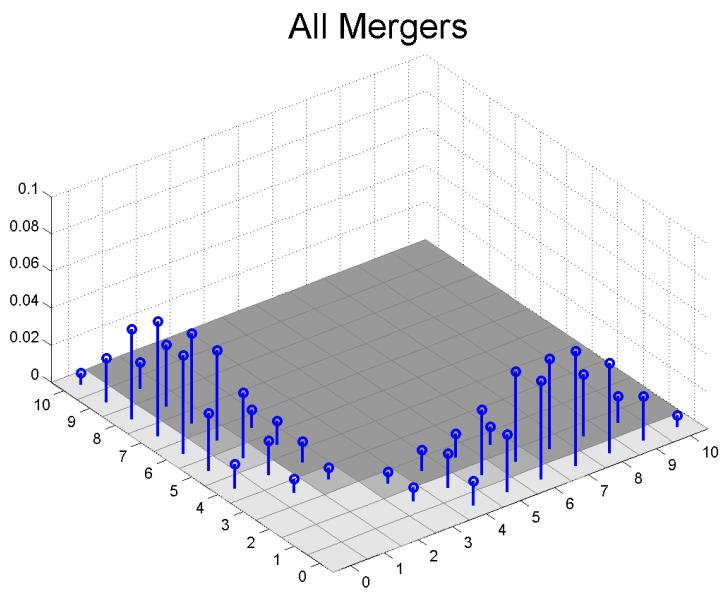
- Monopoly relatively rare: 18.6% of the time. States (K_1, K_2) with $\min\{K_1, K_2\} \geq 2$: 75.7% of the time
- If at monopoly position, likely to be at monopoly for some time: From state $(5, 0)$, there is a 96% chance it is still a monopoly next period because firm with zero capital doesn't invest
  - Entrant faces more efficient rival
  - Entrant can use only greenfield investment

Five Period Expected Transition for Intermediate Market No Mergers



The arrow originating in a state (K_1, K_2) points to the expected state the industry will be in after five full periods.

Steady State for Intermediate Market All Mergers



Shading indicates probability of merger happening with darker shading corresponding to higher probability of merger

- In monopoly state 86.0% (pre-merger: 48.3%) of the time
- Mergers occur about 37.7% of the time
- Large (small) market spends less (more) time in monopoly state

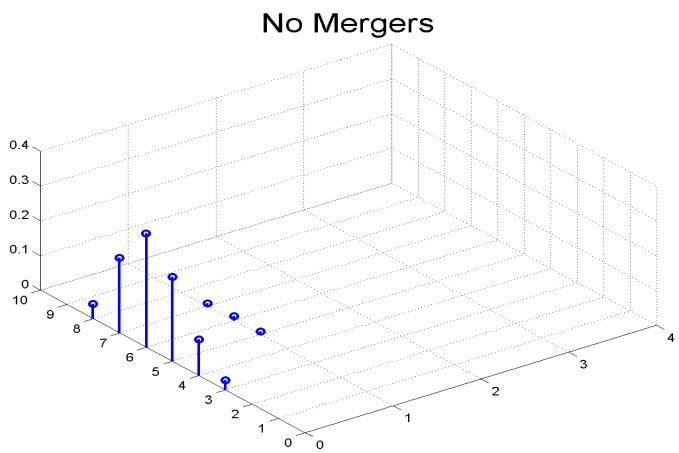
All Mergers Compared to No Mergers

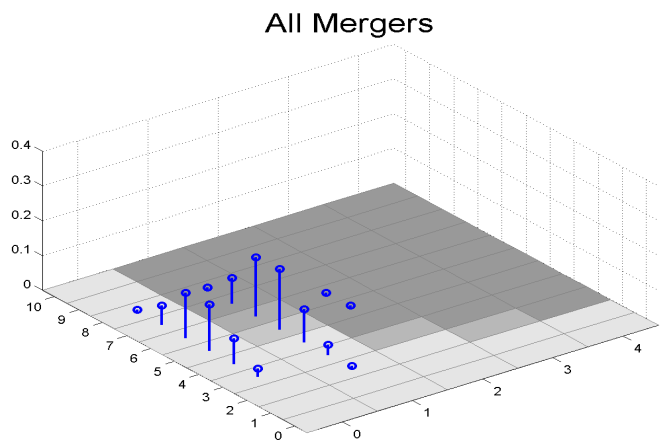
Steady State Averages	No Mergers	All Mergers
Consumer Value	48.1	35.8
Incumbent Value	69.4	68.7
Aggregate Value	117.5	106
Price	2.15	2.26
Quantity	22.2	19.2
Total K	7.98	7.01

- Mergers make the market more monopolistic and cause total capital to fall from 7.98 to 7.01
- Decomposition of the reduction in capital:
  - Change in distribution over states from no merger to all mergers allowed, holding fixed the investment behavior reduces average capital additions from 1.994 to 1.462
  - Change in investment policies, holding fixed distribution over states when all mergers allowed increases average capital additions from 1.462 to 1.763

Entry for Buyout

- We saw that there is a decrease in incumbent value when all mergers are allowed. Why?
- "Entry for buyout" effect: e.g., in state $(5, 0)$ entrant probability of investing goes from 0.04 with no mergers to 0.71 with all mergers allowed





One period transition probabilites from state (5,0)

Distortions in Investment Incentives

All Mergers	0	1	2	3	4	5	6	7	8	9	10
0	(0.6)	(0.2)	0.5	1.2	2.2	3.0	3.5	3.9	4.2	4.4	4.6
1	(1.2)	(1.3)	0.3	0.9	1.4	1.6	1.9	2.1	2.2	2.3	2.3
2	(1.7)	(1.3)	(0.4)	0.1	0.4	0.7	0.9	1.0	1.2	1.3	1.3
3	(1.4)	(1.2)	(0.6)	(0.2)	0.0	0.2	0.4	0.5	0.6	0.7	0.8
4	(1.3)	(1.1)	(0.7)	(0.4)	(0.2)	0.0	0.1	0.3	0.3	0.4	0.4
5	(1.3)	(1.0)	(0.7)	(0.4)	(0.3)	(0.1)	(0.0)	0.1	0.2	0.2	0.3
6	(1.2)	(0.9)	(0.7)	(0.5)	(0.3)	(0.2)	(0.1)	(0.0)	0.1	0.1	0.1
7	(1.1)	(0.9)	(0.6)	(0.5)	(0.4)	(0.3)	(0.2)	(0.1)	(0.0)	0.0	0.1
8	(1.0)	(0.8)	(0.6)	(0.5)	(0.4)	(0.3)	(0.2)	(0.1)	(0.1)	(0.0)	0.0
9	(0.9)	(0.8)	(0.7)	(0.6)	(0.5)	(0.4)	(0.3)	(0.2)	(0.2)	(0.1)	(0.0)
10											

(Benefit to row firm - Social benefit) resulting from row firm adding one unit of capital

- Small firms have an over incentive to invest compared to social welfare
- The fact that they invest more in the All Mergers equilibrium is a major reason why AV (and IV) is lower than in No Mergers

Merger Policy: Static Benchmark

Cons Surp	0	1	2	3	4	5	6	7	8	9	10
0	-	0.6	1.9	3.2	4.4	5.5	6.4	7.2	7.9	8.6	9.1
1	0.6	1.9	3.4	4.8	6.0	7.0	7.9	8.7	9.4	10.1	10.6
2	1.9	3.4	5.1	6.5	7.7	8.7	9.6	10.4	11.1	11.7	12.3
3	3.2	4.8	6.5	7.9	9.1	10.2	11.1	11.8	12.5	13.1	13.7
4	4.4	6.0	7.7	9.1	10.3	11.4	12.2	13.0	13.7	14.3	14.9
5	5.5	7.0	8.7	10.2	11.4	12.4	13.3	14.0	14.7	15.3	15.8
6	6.4	7.9	9.6	11.1	12.2	13.3	14.1	14.9	15.6	16.2	16.7
7	7.2	8.7	10.4	11.8	13.0	14.0	14.9	15.6	16.3	16.9	17.4
8	7.9	9.4	11.1	12.5	13.7	14.7	15.6	16.3	17.0	17.6	18.1
9	8.6	10.1	11.7	13.1	14.3	15.3	16.2	16.9	17.6	18.2	18.7
10	9.1	10.6	12.3	13.7	14.9	15.8	16.7	17.4	18.1	18.7	19.2

Agg Surp	0	1	2	3	4	5	6	7	8	9	10
0	-	5.7	11.7	16.7	20.7	24.0	26.9	29.4	**31.5**	33.4	35.1
1	5.7	10.1	15.0	19.3	22.9	25.9	28.5	**30.7**	32.7	34.5	36.1
2	11.7	15.0	19.0	22.6	25.7	28.4	**30.7**	32.8	34.6	36.2	37.7
3	16.7	19.3	22.6	25.8	28.5	**30.9**	33.0	34.9	36.5	38.1	39.4
4	20.7	22.9	25.7	28.5	**31.0**	33.1	35.1	36.8	38.4	39.8	41.0
5	24.0	25.9	28.4	**30.9**	33.1	35.2	37.0	38.6	40.0	41.3	42.5
6	26.9	28.5	**30.7**	33.0	35.1	37.0	38.6	40.2	41.5	42.8	43.9
7	29.4	**30.7**	32.8	34.9	36.8	38.6	40.2	41.6	42.9	44.1	45.2
8	**31.5**	32.7	34.6	36.5	38.4	40.0	41.5	42.9	44.1	45.3	46.3
9	33.4	34.5	36.2	38.1	39.8	41.3	42.8	44.1	45.3	46.4	47.4
10	35.1	36.1	37.7	39.4	41.0	42.5	43.9	45.2	46.3	47.4	48.3

- A static Consumer Surplus standard leads to almost no mergers being allowed
- A static Aggregate Surplus standard leads to almost all mergers being allowed considering the resulting steady state distribution

No Commitment: First Iteration for AV Objective

	0	1	2	3	4	5	6	7	8	9	10
0	-	(0.0)	0.0	0.0	(0.0)	(0.0)	0.0	(0.0)	(0.0)	(0.0)	(0.0)
1	-	1.8	2.3	3.0	3.4	3.2	3.0	2.8	2.6	2.4	2.5
2	-	2.3	2.9	3.1	2.8	2.5	2.2	1.9	1.7	1.8	1.8
3	-	3.0	3.1	2.6	2.0	1.5	1.1	0.8	0.8	0.8	0.8
4	-	3.4	2.8	2.0	1.2	0.7	0.2	0.0	(0.0)	(0.1)	(0.2)
5	-	3.2	2.5	1.5	0.7	(0.1)	(0.4)	(0.6)	(0.7)	(0.9)	(1.0)
6	-	3.0	2.2	1.1	0.2	(0.4)	(0.7)	(1.0)	(1.3)	(1.5)	(1.8)
7	-	2.8	1.9	0.8	0.0	(0.6)	(1.0)	(1.4)	(1.8)	(2.1)	(2.4)
8	-	2.6	1.7	0.8	(0.0)	(0.7)	(1.3)	(1.8)	(2.2)	(2.7)	(3.0)
9	-	2.4	1.8	0.8	(0.1)	(0.9)	(1.5)	(2.1)	(2.7)	(3.1)	(3.6)
10	-	2.5	1.8	0.8	(0.2)	(1.0)	(1.8)	(2.4)	(3.0)	(3.6)	(4.1)

AV benefit from merger given no merger equilibrium, positive benefits in green

- If no mergers approved in the future, the set of AV-increasing mergers is almost the same as the set of statically AS-increasing mergers
- Because of blocking costs, some AV-decreasing mergers will also be approved with positive probability

No Commitment: Second iteration for AV Objective

	0	1	2	3	4	5	6	7	8	9	10
0	-	(0.0)	(0.0)	(0.0)	0.0	0.0	(0.0)	0.0	0.0	0.0	(0.0)
1	-	1.1	0.1	(0.0)	0.1	0.2	0.2	0.3	0.3	0.3	0.5
2	-	0.1	0.1	0.1	(0.0)	(0.1)	(0.2)	(0.2)	(0.2)	(0.0)	0.2
3	-	(0.0)	0.1	(0.2)	(0.4)	(0.6)	(0.7)	(0.8)	(0.7)	(0.5)	(0.4)
4	-	0.1	(0.0)	(0.4)	(0.7)	(1.0)	(1.2)	(1.3)	(1.2)	(1.1)	(1.0)
5	-	0.2	(0.1)	(0.6)	(1.0)	(1.4)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)
6	-	0.2	(0.2)	(0.7)	(1.2)	(1.6)	(1.8)	(1.9)	(2.0)	(2.2)	(2.3)
7	-	0.3	(0.2)	(0.8)	(1.3)	(1.6)	(1.9)	(2.2)	(2.5)	(2.9)	(3.1)
8	-	0.3	(0.2)	(0.7)	(1.2)	(1.6)	(2.0)	(2.5)	(3.1)	(3.5)	(3.8)
9	-	0.3	(0.0)	(0.5)	(1.1)	(1.6)	(2.2)	(2.9)	(3.5)	(4.0)	(4.4)
10	-	0.5	0.2	(0.4)	(1.0)	(1.6)	(2.3)	(3.1)	(3.8)	(4.4)	(4.8)

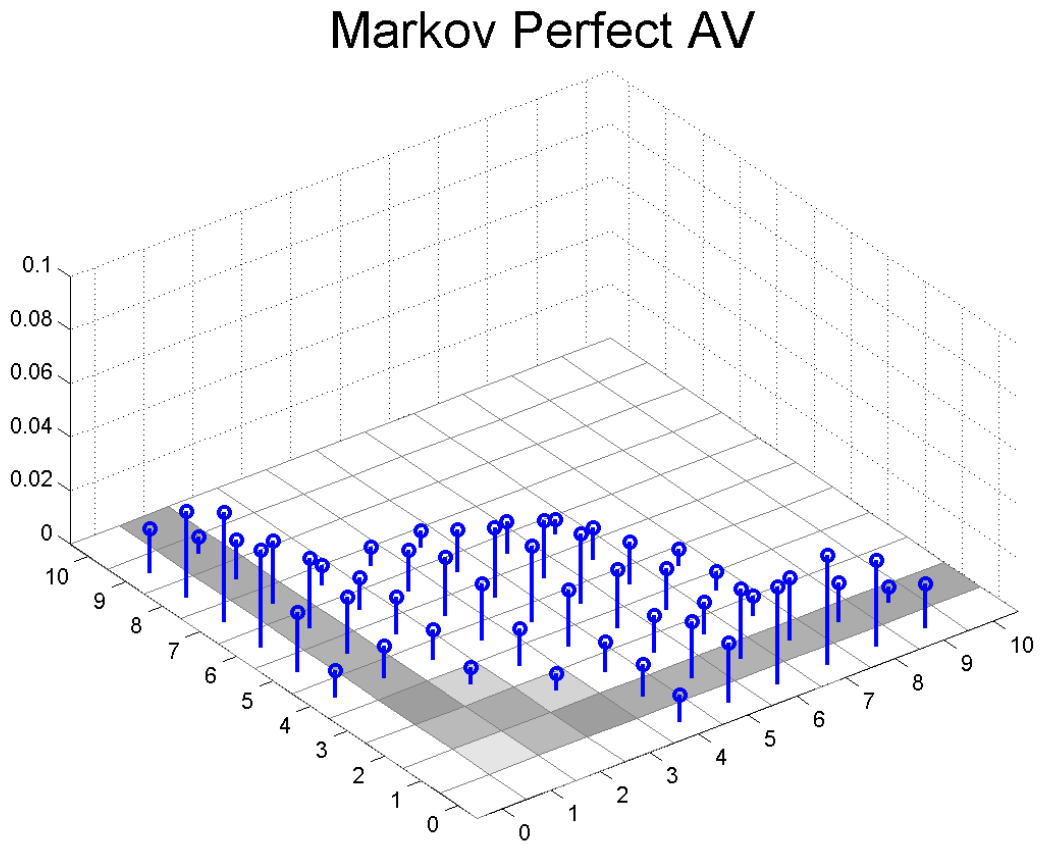
AV benefit from merger given 1st iteration equilibrium, positive benefits in green

No Commitment: Markov Perfect Policy for AV Objective

Mergers Happen	0	1	2	3	4	5	6	7	8	9	10
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1	0.0%	0.0%	56.5%	92.7%	72.7%	66.6%	66.3%	69.4%	74.5%	80.4%	80.0%
2	0.0%	56.5%	76.0%	22.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0.0%	92.7%	22.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	0.0%	72.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	0.0%	66.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	0.0%	66.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	0.0%	69.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	0.0%	74.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	0.0%	80.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	0.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Probability that a merger happens in Markov Perfect Policy equilibrium

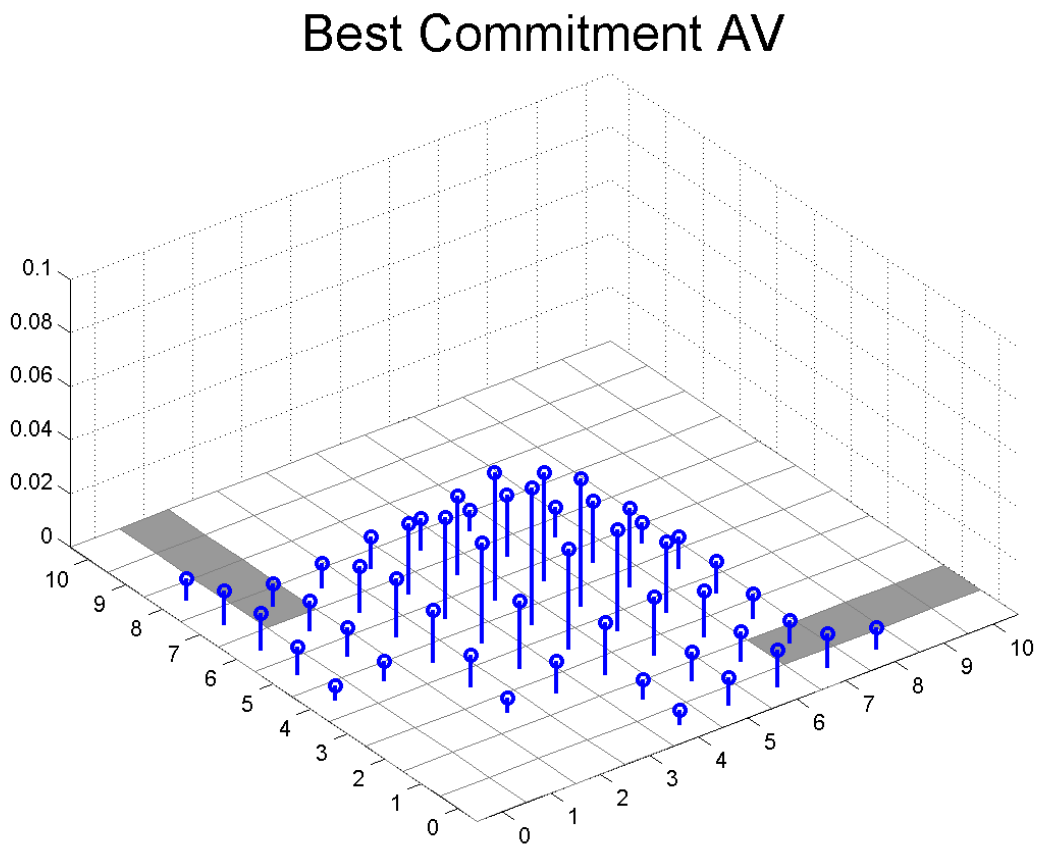
Steady State for Intermediate Market MPP



Comparing Markov Perfect Policy to No and All Mergers

	No Mergers	All Mergers	Markov Perfect
Ave Aggregate Value	117.5	105.8	113.6
Ave Consumer Value	48.1	35.8	43.3
Ave Incumbent Value	69.4	68.1	69.9
Merger Happen %	0.0	37.7	16.1
Post Merger % Monop	18.6	86.0	49.4
Post Each K$\geq$ 2 %	75.7	0.9	44.2
Ave Total Capital	7.98	7.01	7.65
Ave Price	2.15	2.26	2.19

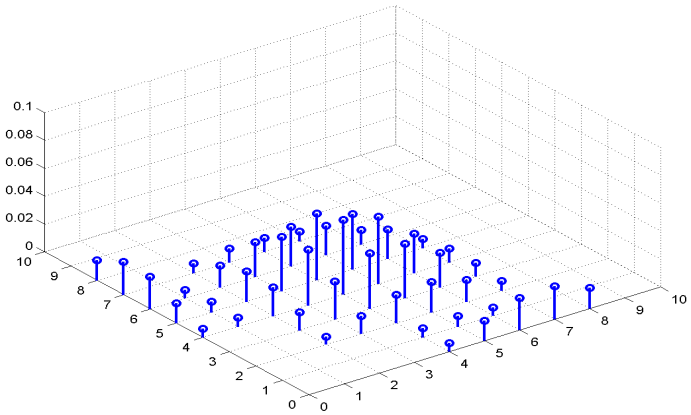
Optimal Commitment Policy for AV/CV Objectives



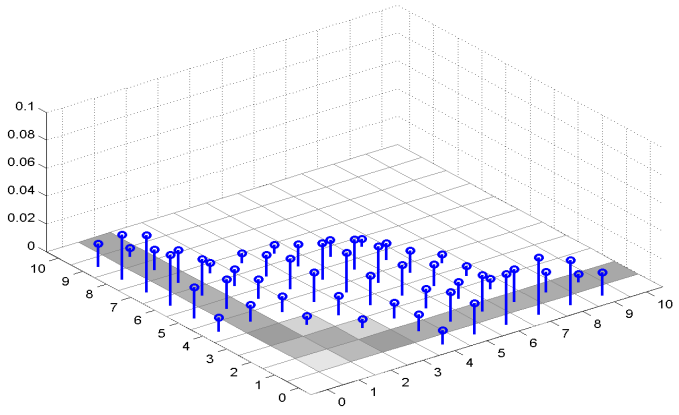
- Optimal commitment policy for AV objective: $\underline{H} = 0.775$
- This is also the optimal commitment policy for CV objective

Review: Steady State Equilibrium Distributions

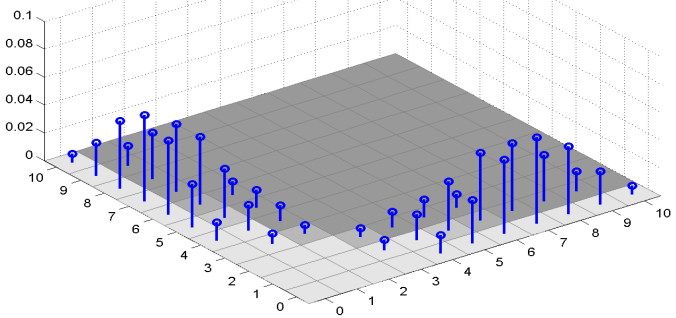
No Mergers



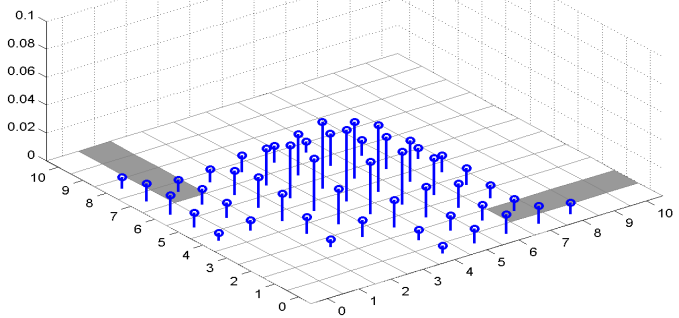
Markov Perfect AV



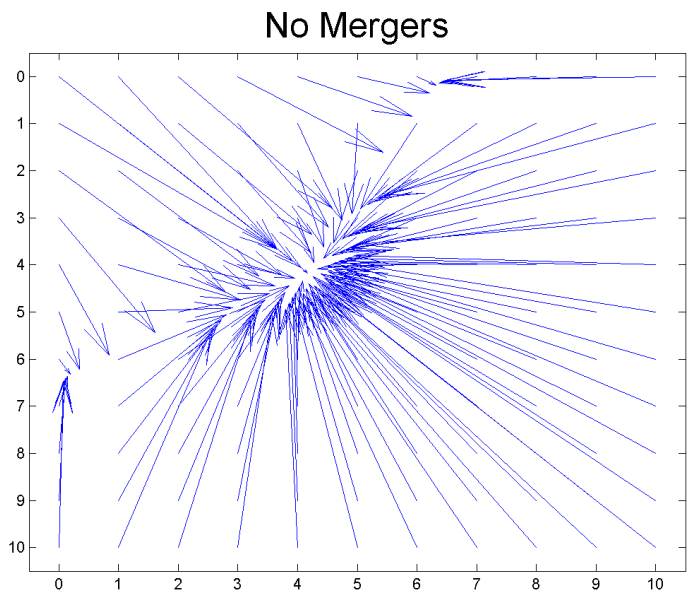
All Mergers

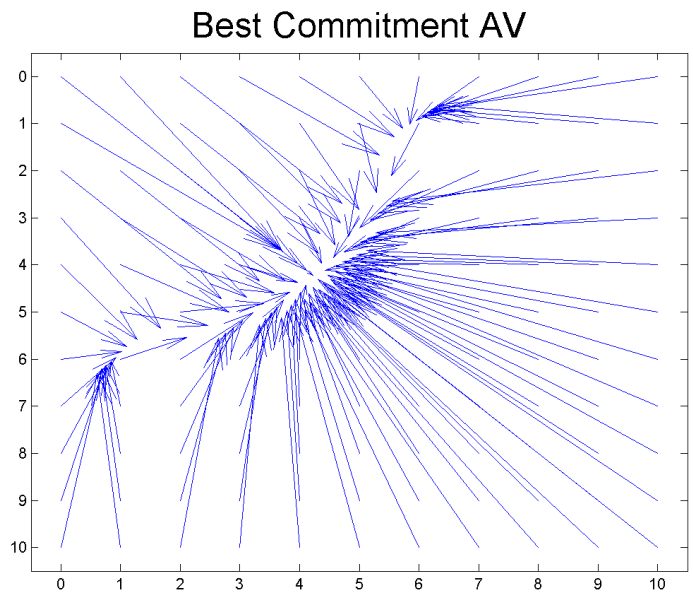


Best Commitment AV



Five Period Expected Transitions





Comparing Optimal Commitment Policy and Other Policies

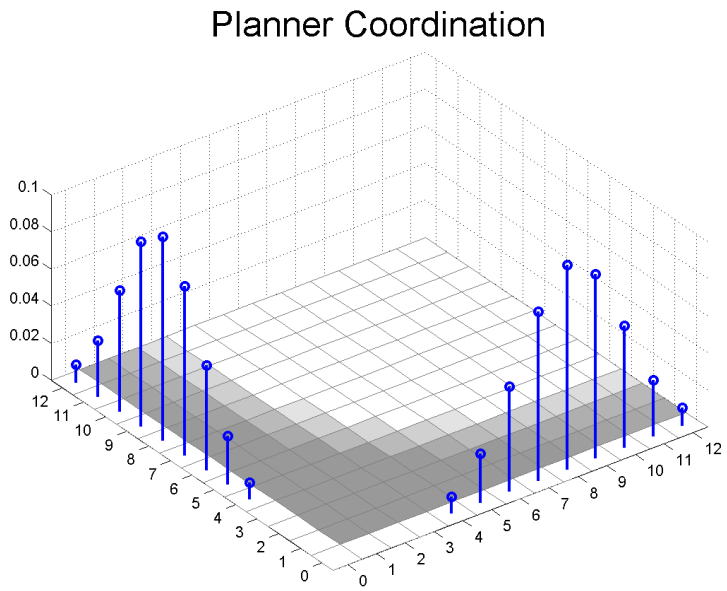
Steady State Ave	Opt Comm	MPP AV	No Mergers	All Mergers
Consumer Value	49.3	43.3	48.1	35.8
Incumbent Value	68.8	69.9	69.4	68.1
Aggregate Value	118.1	113.6	117.5	105.8
Price	2.14	2.19	2.15	2.26
Quantity	22.5	21.0	22.2	19.2
Total K	8.17	7.65	7.98	7.01
Merger Prob.	0.030	0.161	0.000	0.377
Prob. Monopoly	0.143	0.494	0.186	0.860

- By allowing mergers iff one firm is large and the other small, optimal commitment policy leads to higher capital levels
- Although optimal commitment policy allows some mergers, less time is spent in monopoly than when no mergers are allowed

Robustness to Narrower Cost Ranges

- We saw the phenomenon of entry for buyout causing inefficient investment resulting in lower AV in the All Mergers and MPP policies than in the No Mergers policy
- What happens when cost ranges are smaller?
- We make the cost ranges smaller while trying to keep a similar steady state in the No Mergers case
- Entry for buyout still occurs, but it is not as inefficient
- AV is similar in No Mergers, All Mergers, and MPP policies. In the small market, AV is higher in All Mergers and MPP than in No Mergers.

Merger Policy vs. Regulation: The Planner's Solution



- Suppose the social planner could, in each state, determine firms' investment and merger choices, subject to Cournot competition ("second-best" AV solution)
- The set of states in which a merger is approved is almost the same as that in which a merger is statically AS-increasing

Comparing Planner Solution To Merger Policies

Steady State Ave	Planner AV	Opt Comm	MPP AV	No Mergers
Consumer Value	39.2	49.3	43.3	48.1
Incumbent Value	82.1	68.8	69.9	69.4
Aggregate Value	121.3	118.1	113.6	117.5
Price	2.23	2.14	2.19	2.15
Quantity	20.1	22.5	21.0	22.2
Total K	8.08	8.17	7.65	7.98
Merger Prob.	0.000	0.030	0.161	0.000
Prob. Monopoly	1.000	0.143	0.494	0.186

- Second-best solution for AV objective results in monopoly with high capital level even though the intermediate market with No Mergers Allowed appears "workably competitive"
- The planner solution is not good for consumers

Comparing Franchised Monopoly To Merger Policies

Steady State Ave	Monopoly	Opt Comm	MPP AV	No Mergers
Consumer Value	28.0	49.3	43.3	48.1
Incumbent Value	90.5	68.8	69.9	69.4
Aggregate Value	118.6	118.1	113.6	117.5
Price	2.35	2.14	2.19	2.15
Quantity	16.9	22.5	21.0	22.2
Total K	5.28	8.17	7.65	7.98
Merger Prob.	0.000	0.030	0.161	0.000
Prob. Monopoly	1.000	0.143	0.494	0.186

- Franchised monopoly does slightly better than best merger policy for AV objective (by exploiting scale economies and avoiding miscoordination of investment). However, it induces a very low CV.
- If we can't control investment and care about CV, a merger policy that allows very few mergers turns out to be better

Conclusion

- Examined optimal merger policy when scale economies give rise to a trade-off between internal and external growth
- Computational model with rich, merger-neutral investment technology
- Main findings so far:
  - Firms' investment behavior greatly affected by merger policy, and optimal policy greatly affected by firms' investment behavior
  - Optimal policy can differ substantially from what would be optimal if only welfare in current period is considered
  - Ability to commit can lead to significant welfare improvement
  - Absent commitment, endowing authority with a CV-standard may be good for AV maximization
  - Because of scale economies and miscoordination of investment under duopoly, franchised monopoly can do very well for AV objective (but serves consumers very poorly)