GOOP
Group of Oil Producers

Access files at davidbarrus.com and then click on “GOOP Economic Experiment 2023” link.

Outcomes of the Game

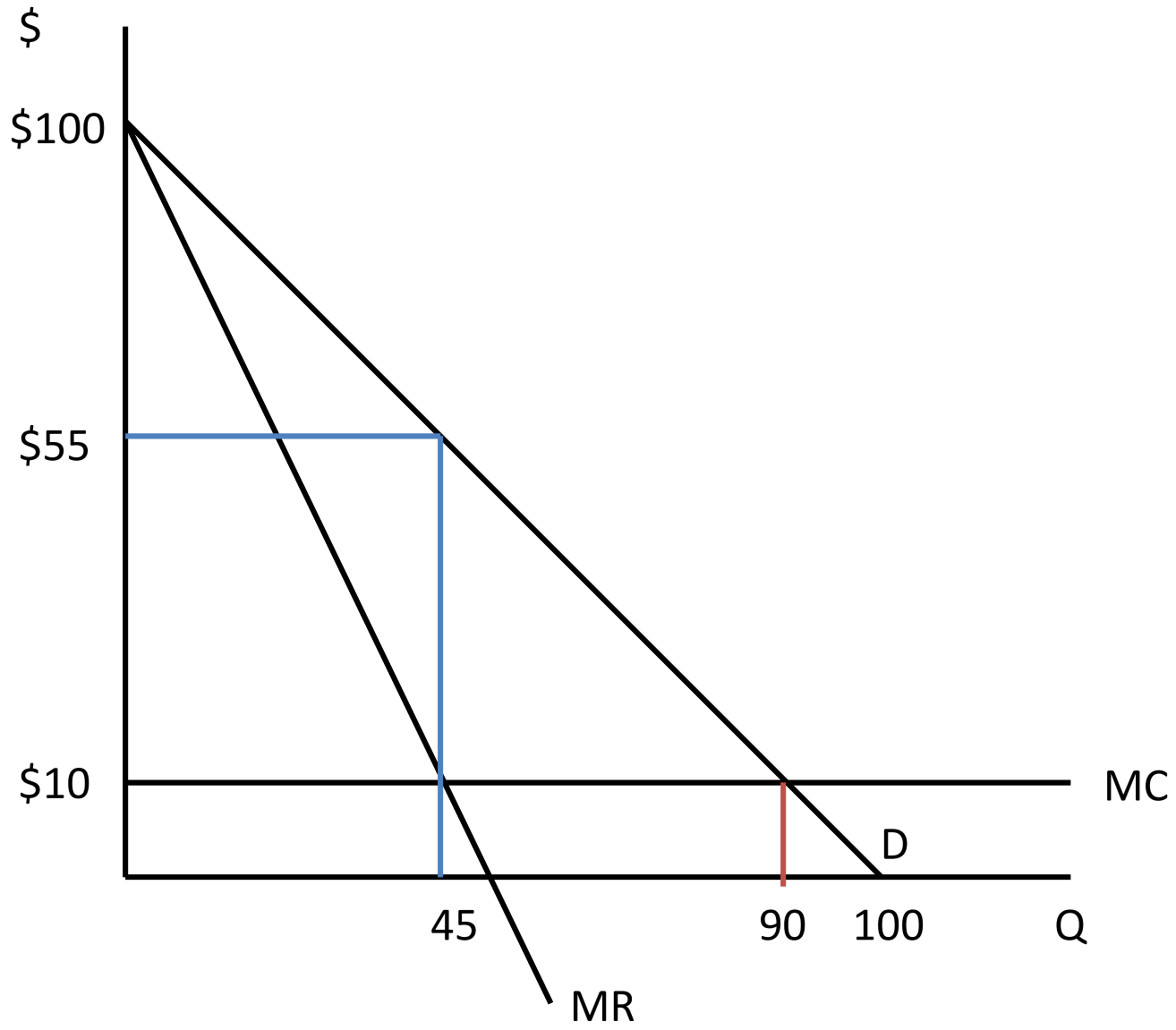
- A game theory experience for students
- Experience how interdependence impacts decision making
- Predict monopoly, Cournot, and competitive outcomes before the game mathematically (upper-division courses).
- Compare theory to classroom results

Basics of the Game

- Divide students into 10 groups (can be less)
- Create country name.
- Play 5 rounds – chance will determine if an additional 3 rounds are played
- Joint profit max – each country produces 4.5 million barrels per round
- Each country can produce 0 – 36.1 million barrels per round. (quantity choice)
- War / Limited Action

Demand & Costs (in millions)

- $Q_{Demanded} = 100 - Price_{oil}$ or $Price_{oil} = 100 - Q$.
- Each barrel cost $10
- Collectively:
  - Total Revenue = Q(100-Q)
  - Total Cost = 10Q
  - So MR = 100 – 2Q and MC = 10
- Setting MR = MC we find the optimal Q = 45 or 4.5 for each country per round (with 10 countries).


$
$100
$55
$10
MC
D
45
90
100
Q
MR

Running the Game

- Handouts
- Spreadsheet

- All handouts and spreadsheets can be found at davidbarrus.com. Click on “Goop Game Files” and then click the link “Goop Economic Experiment 2023” to access the files.

Predicted Results

- 10 firms
- Game: Simultaneous repeated game
- Monopoly outcome – Profit Max
  - Individual Quantity: 4.5 million barrels
  - Market Quantity: 45 million barrels
  - Market Price: $55
  - Extra Credit: 5 points on final exam

Predicted Results

- 10 firms
- Cournot outcome
  - Individual Quantity: 8.2 million barrels
  - Market Quantity: 82 million barrels
  - Market Price: $18
- Competitive outcome
  - Individual Quantity: 9.0 million barrels
  - Market Quantity: 90 million barrels
  - Market Price: $10

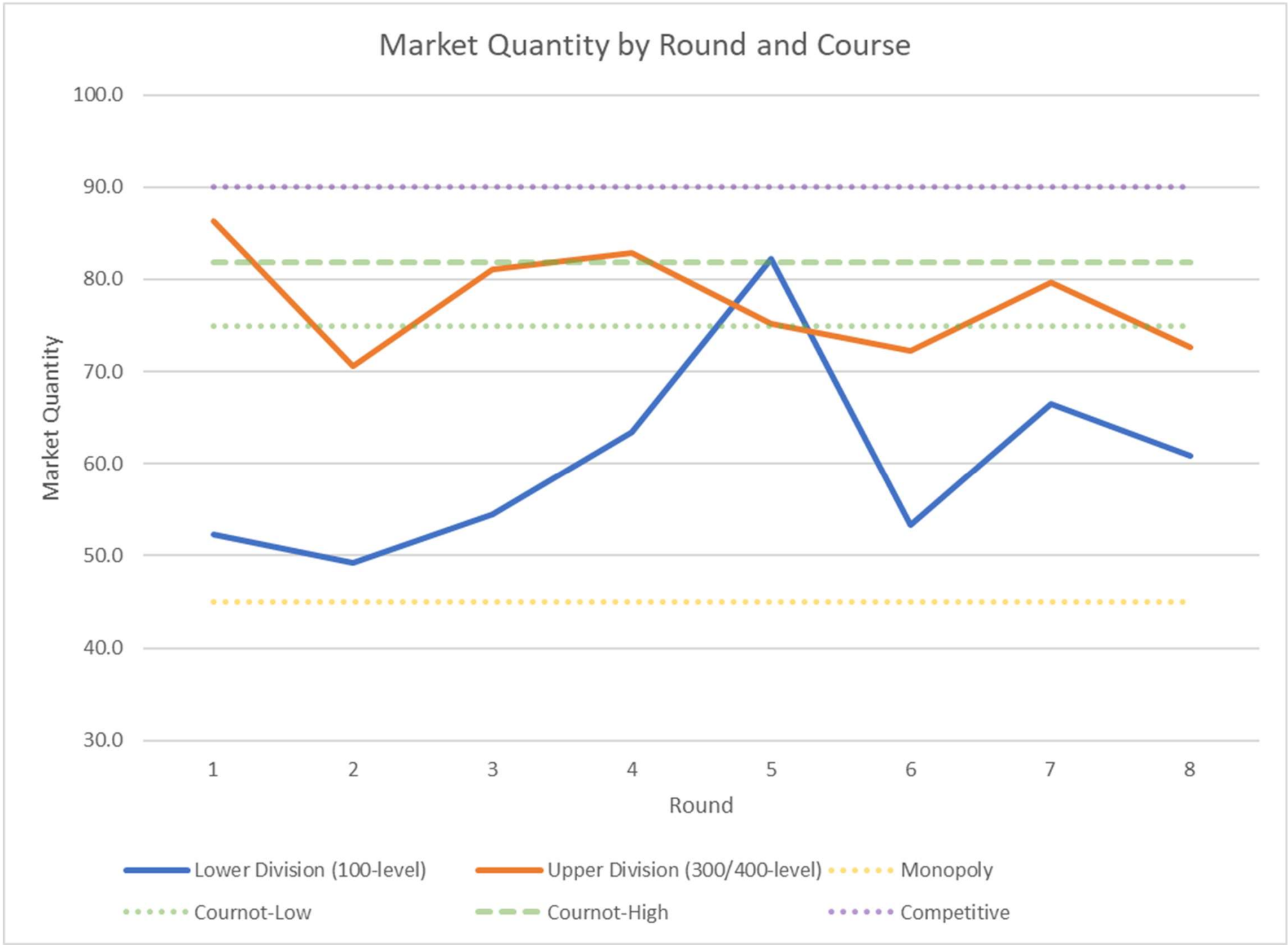
If all others produce 4.5

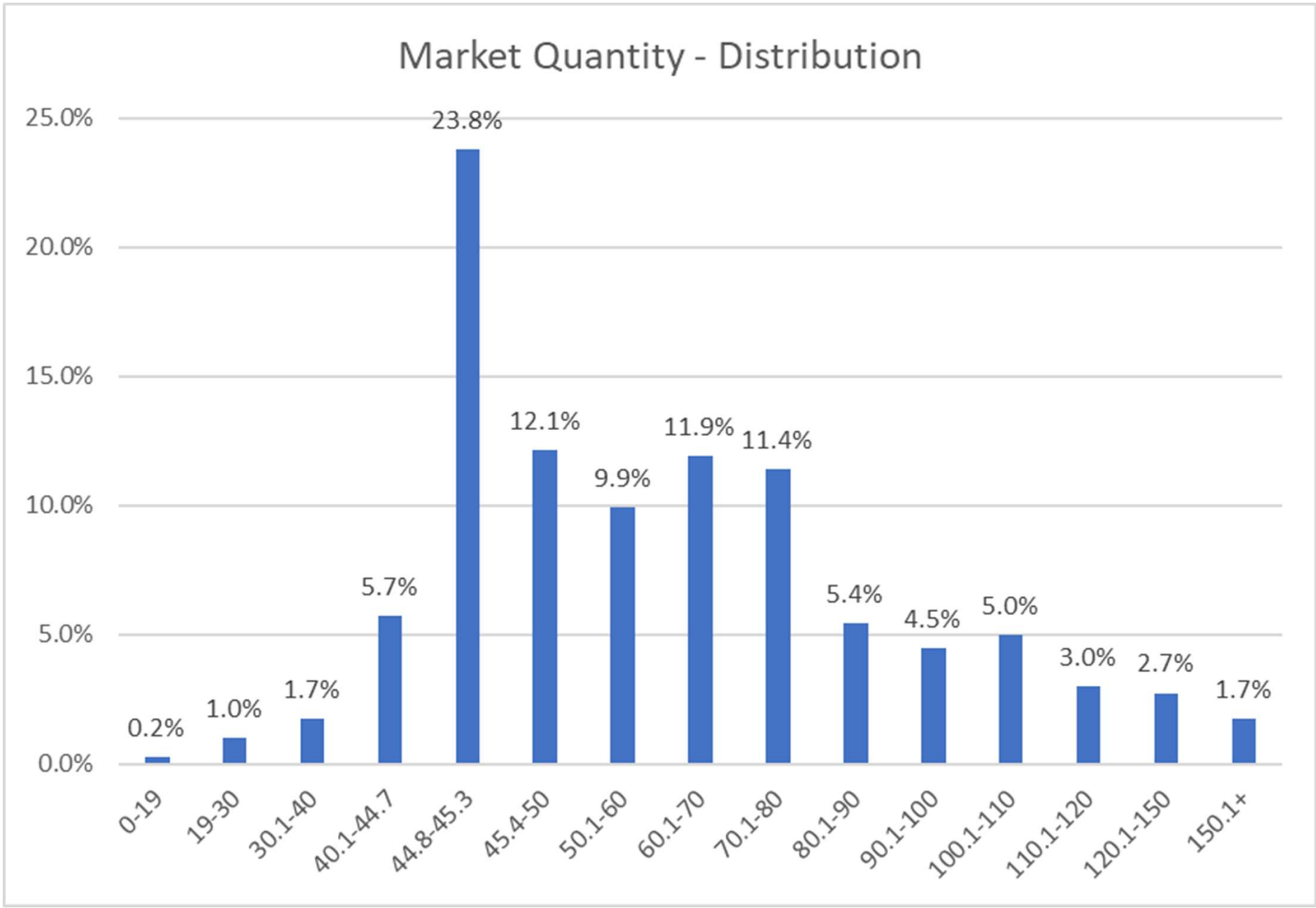
$$Profit\ (\pi) = (100 - Q_T)Q_i - 10Q_i$$
$$\pi = (100 - 40.5 - Q_i)Q_i - 10Q_i$$
$$\pi = 100Q_i - 40.5Q_i - {Q_i}^2 - 10Q_i$$
$$\pi = 49.5Q_i - {Q_i}^2$$

- First derivative: $49.5 - Q_i = 0$
- So your optimal $Q_i = 24.75$
- Your extra credit is 15.13
  Everyone else gets 2.75

Results

- Games played 2014-2023
- 43 games played in lower division courses
- 19 games played in upper division courses


Market Quantity by Round and Course
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
Market Quantity
1
2
3
4
5
6
7
8
Round
Lower Division (100-level)
Upper Division (300/400-level)
Monopoly
Cournot-Low
Cournot-High
Competitive


Market Quantity - Distribution
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.2%
1.0%
1.7%
5.7%
23.8%
12.1%
9.9%
11.9%
11.4%
5.4%
4.5%
5.0%
3.0%
2.7%
1.7%
0-19
19-30
30.1-40
40.1-44.7
44.8-45.3
45.4-50
50.1-60
60.1-70
70.1-80
80.1-90
90.1-100
100.1-110
110.1-120
120.1-150
150.1+

Enforcement

- War (MC+$35) and Limited Action (MC+$15)
- 70% votes to pass

Rounds	Number of Rounds (Total)	War (%)	Limited Action (%)	Resolution Passes (%)
1	62	0.0%	0.0%	0.0%
2	62	40.2%	4.3%	17.9%
3	62	16.9%	7.9%	2.6%
4	62	11.6%	16.9%	3.1%
5	62	9.7%	22.6%	5.6%
6	32	22.6%	13.2%	12.2%
7	31	3.4%	15.8%	3.1%
8	31	0.0%	13.1%	2.7%
Grand Total	**404**	**14.0%**	**11.1%**	**5.9%**

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Success of Enforcement

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IF WAR WAS DECLARED…			IF LIMITED ACTION WAS DECLARED…		
Rounds	Number of Rounds (Total)	Resolution Passes (%)	Rounds	Number of Rounds (Total)	Resolution Passes (%)
2	25	44%	2	3	0.0%
3	10	8%	3	5	15.2%
4	7	27%	4	10	0.0%
5	6	29%	5	14	12.3%
6	8	40%	6	4	23.1%
7	1	0%	7	5	19.6%
8	0	0%	8	4	21.1%
Grand Total	**57**	**33%**	**Grand Total**	**45**	**11.6%**

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Aftermath of War and LA

- War declared the most often in Round 2
- Limited action declared the most in Round 5

After War & LA	Number of Games	Number of Rounds (Total)	Market Q (Avg)	Market Q (SD)
Round of or Before LA/W	48.8	316	62.4	25.1
Round After LA Did Not Pass	4.6	31	90.7	43.9
Round After War Did Not Pass	4.9	34	86.1	30.6
Round After LA Passed	0.5	4	47.0	6.8
Round After War Passed	3.2	19	57.6	20.8
Grand Total	**62**	**404**	**66.4**	**29.1**

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Extra Credit

- Students (on average) would do better if they colluded
- A few groups get more than 5 points

Course	Total Games Played	Number of Rounds (Total)	Avg. Extra Credit	SD. Extra Credit	Max EC	Min EC
Lower Division (100-level)	43	267	3.17	1.59	6.99	-2.50
Upper Division (300/400-level)	19	137	1.49	1.84	8.10	-3.72
Grand Total	**62**	**404**	**2.59**	**1.86**	**8.10**	**-3.72**

Voting on War and LA – Extra Credit

- ALWAYS better to vote NO
  - Whether or not it passes
  - In terms of extra credit

Motion on War/Limited Action	Number of Rounds (Total)		Avg. Extra Credit		SD. Extra Credit	
Course/Votes on Motion	Motion-Failed	Motion-Passed	Motion-Failed	Motion-Passed	Motion-Failed	Motion-Passed
Voted NO on Motion	351	4	2.66*	3.28	1.87	1.37
Voted YES on Motion	26	23	1.44*	2.70	1.59	1.56
Grand Total	**377**	**27**	**2.58**	**2.79**	**1.88**	**1.54**

*Significantly different than motion-passed and significantly different between voted "no" and voted "yes" at 95% level.

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Access GOOP Files at **davidbarrus.com** then click on “Goop Game Files” or scan QR code.

Thank you!

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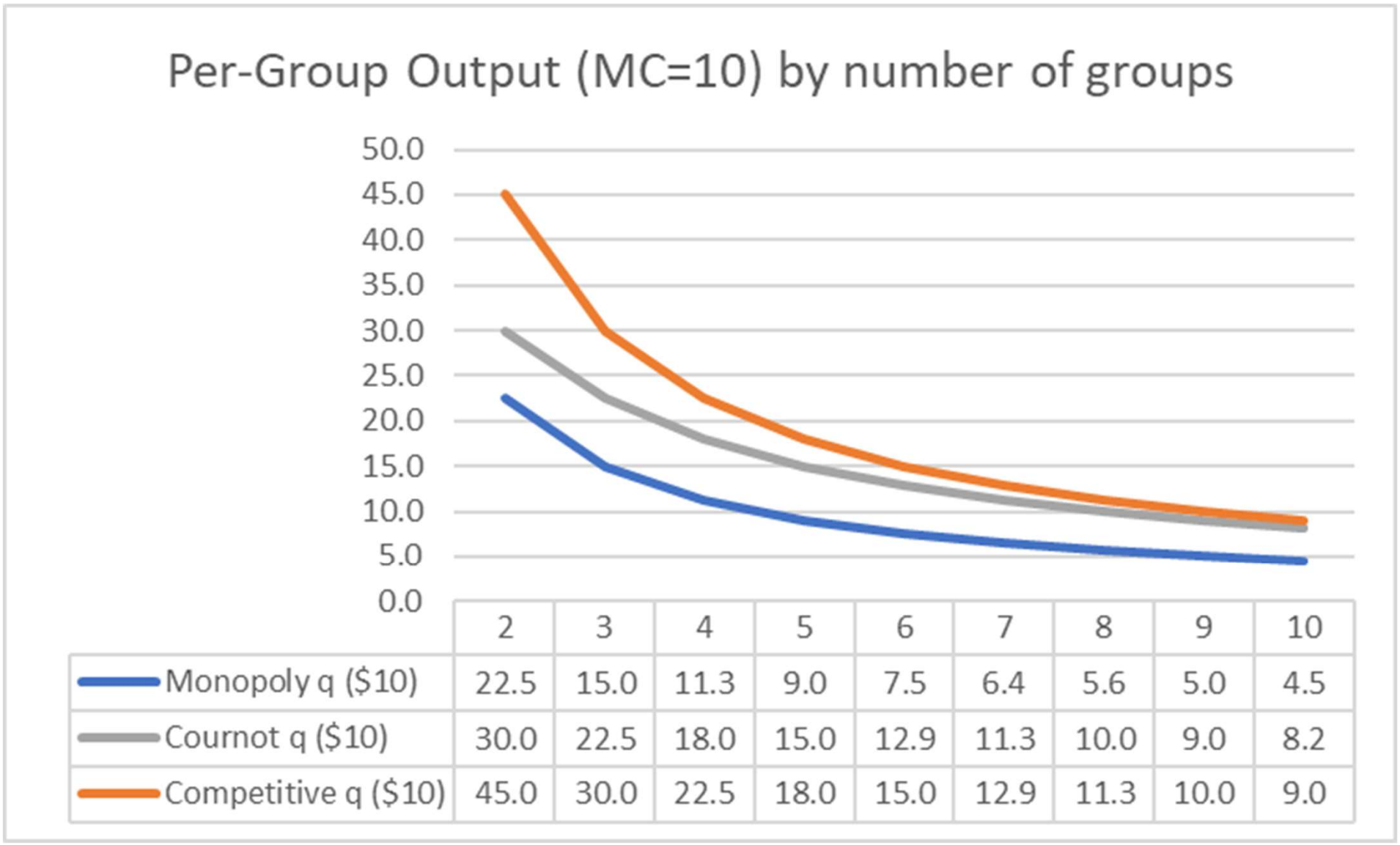

	2	3	4	5	6	7	8	9	10
Monopoly q ($10)	22.5	15.0	11.3	9.0	7.5	6.4	5.6	5.0	4.5
Cournot q ($10)	30.0	22.5	18.0	15.0	12.9	11.3	10.0	9.0	8.2
Competitive q ($10)	45.0	30.0	22.5	18.0	15.0	12.9	11.3	10.0	9.0

Summary Statistics

- 2014-2023
- 4 instructors
- Lower vs. Upper Division

Course	Number of Games	Number of Rounds (Avg)	Number of Rounds (Total)	Market Q (Avg)	Market Q (SD)	Market Q (Max)	Market Q (Min)
Lower Division (100-level)	43	6.6	267	60.2	27.4	218.5	14.0
Upper Division (300/400-level)	19	7.4	137	77.9	28.6	218.0	19.0
Grand Total	**62**	**6.9**	**404**	**66.4**	**29.1**	**218.5**	**14**

Summary Statistics
By Course and Instructor

Course/ Instructor	Number of Games	Number of Rounds (Avg)	Number of Rounds (Total)	Market Q (Avg)	Market Q (SD)	Market Q (Max)	Market Q (Min)
ECON 150	**35**	**6.7**	**221**	**59.5**	**26.9**	**218.5**	**14.0**
Anderson	19	6.1	111	56.2	24.3	188.8	27.5
Barrus	10	7.6	74	68.3	31.1	218.5	19.3
Ma	6	6.4	36	50.3	17.6	112.0	14.0
ECON 300/476	**19**	**7.4**	**137**	**77.9**	**28.6**	**218.0**	**19.0**
Barrus	7	7.7	53	65.3	25.8	152.7	19.0
Hirschi	12	7.3	84	85.1	27.6	218.0	45.8
FDAMF 101	**8**	**6.1**	**46**	**63.5**	**29.2**	**181.9**	**39.6**
Anderson	5	5.9	28	56.4	17.8	116.0	39.6
Barrus	3	6.3	18	74.0	38.3	181.9	42.0
Grand Total	**62**	**6.9**	**404**	**66.4**	**29.1**	**218.5**	**14.0**

Points	Total Profit	% of Ideal	Q1	Profit	Q2	Profit	Q3	Profit	Q4	Profit	Q5	Profit
15.13	$3,062.81	30%	24.75	612.56	24.75	612.56	24.75	612.6	24.75	612.6	24.75	612.5625
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
2.75	$ 556.88	6%	4.5	111.38	4.5	111.38	4.5	111.4	4.5	111.4	4.5	111.375
		Market Q	65.25		65.25		65.25		65.25		65.25	
		Market P	34.75		34.75		34.75		34.75		34.75	

Everyone goes 24.75

Points	Total Profit		% of Ideal	Q1	Profit	Q2	Profit	Q3	Profit	Q4	Profit	Q5	Profit
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
-6.11	$	(1,237.50)	-12%	24.75	-247.5	24.75	-247.5	24.75	-248	24.75	-248	24.75	-247.5
			Market Q	247.5		247.5		247.5		247.5		247.5	
			Market P	0		0		0		0		0	

Cournot

- P = 100 – Q and MC = $10
- With 10 producers: Equilibrium = 90/11 = 8.1818

Points	Total Profit	% of Ideal	Q1	Profit	Q2	Profit	Q3	Profit	Q4	Profit	Q5	Profit
1.65	$ 334.71	3%	8.182	66.942	8.1818	66.942	8.182	66.94	8.182	66.94	8.182	66.94215
1.65	$ 334.71	3%	8.182	66.942	8.1818	66.942	8.182	66.94	8.182	66.94	8.182	66.94215
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1.65	$ 334.71	3%	8.182	66.942	8.1818	66.942	8.182	66.94	8.182	66.94	8.182	66.94215
1.65	$ 334.71	3%	8.182	66.942	8.1818	66.942	8.182	66.94	8.182	66.94	8.182	66.94215
		Market Q	81.82		81.818		81.82		81.82		81.82	
		Market P	18.18		18.182		18.18		18.18		18.18	

No incentive to change production

- P = 100 – Q and MC = $10
- With 10 producers: Equilibrium = 90/11 = 8.1818

				Cournot						
	Q1	Profit	Q2	Profit	Q3	Profit	Q4	Profit	Q5	Profit
	4.5	202.5	24.75	612.56	8.182	66.94	8.3	66.93	8	66.91
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
	4.5	202.5	4.5	111.38	8.182	66.94	8.182	65.98	8.182	68.43
Market Q	45		65.25		81.82		81.94		81.64	
Market P	55		34.75		18.18		18.06		18.36	