Changing Preferences: An Experiment and Estimation of Market-Incentive Effects on Altruism

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Preferences

- Always assumed exogenous
  - as in Arrow-Debreu for example
- Shaped by things economists don't quite understand
  - Except perhaps until recently?
  - Decision theory, behavioral economics?
- Markets and incentives
- Usually studied under GIVEN preferences
- Can markets, incentives change preferences?
  - Compare with: Can culture and upbringing change preferences?

Challenges

- Behaviors observed; not preferences
- Behaviors change due to interaction between preferences and markets and incentives
- How to refute hypothesis that markets and incentives change preferences?
- Resolution:
  - Structural model
  - Game-theoretical model of preferences, markets, incentives
  - Experimental data
  - Structural nonparametric estimation of preferences

Typical experiments

- **Bartling, Weber, and Yao 2015, Quarterly Journal of Economics, "Do Markets Erode Social Responsibility"**
  - **Buyers; sellers, third parties; production externalities to harm third parties**
  - **Do sellers choose more costly production to avoid externality?**
  - **Do buyers pay more to get clean products?**
  - **Posted-price markets**
- **Falk and Szech 2013, Science, "Morals and Markets"**
  - **"Mouse paradigm"**

Preferences

- Common buzzwords: altruism, prosocial behavior, intrinsic motivation, honesty, other-regarding, etc.
- Identifying changes more likely if preferences are not all about profit or self-interest
- Medical context:
  - Ken Arrow 1963, American Economic Review, "The Welfare Economics of Medical Care"
    - His behavior is supposed to be governed by a concern for the customer's welfare which would not be expected of a salesman
  - Arrow's "His" refers to "The Doctor"
  - Altruism

Experiment and results

- Framing: health care quality
- Incentives: price, cost, patient benefit
- Markets: Monopoly, Duopoly, Quadropoly

- Preferences changed by incentives
- Preferences changed by markets
  - Markets have stronger effects than incentives
  - Subjects become less altruistic; preferences exhibit different variances

Theory: market and demand

- Monopoly; all patients must go to one physician
- Duopoly: two physicians, qualities q_1, q_2
  - Logistic market shares:

$$\frac{\exp(bq_1)}{\exp(bq_1) + \exp(bq')} \equiv S(q_1; q')$$

- Quadropoly: four physicians, qualities q_1, q_2, q_3, and q_4
  - Logistic market shares:

$$\frac{\exp(bq_1)}{\sum_{i=1}^{4} \exp(bq_i)} \quad \cdots \quad \cdots \quad \frac{\exp(bq_4)}{\sum_{i=1}^{4} \exp(bq_i)}$$

- Demand elasticities: duopoly $<$ quadropoly

Theory: incentives and preferences

- **Patient benefit b**
- **Price p, fixed revenue**
- **Cost parameter c; unit cost increasing and convex in quality q**
  - **Incentive configuration: (p, c, b)**
- **Utility: $\alpha bq + U(p - cq^2)$ per patient**
- **Altruism: α_i for physician i**
  - **distribution of α_i in each incentive configuration and in each market**

Monopoly optimal qualities

- **Quality:** $\max_q \alpha bq + U(p - cq^2)$
- **Simple tradeoff**
- **Benchmark**
  - **Giving up profit to benefit patient**

Duopoly Bayes Nash Equilibria

- **Let α be distributed on $[\underline{\alpha}, \overline{\alpha}]$, distribution F**

- **Stratregy: $q : [\underline{\alpha}, \overline{\alpha}] \to [0, 10]$**

- **Given rival's strategy q', player i's payoff:**

$$[\alpha_1 b q_1 + U(p - c q_1^2)] \times \int_{\underline{\alpha}}^{\overline{\alpha}} \left[\frac{100 \exp(b q_1)}{\exp(b q_1) + \exp(b q'(x))} \right] \mathrm{d}F(x)$$

- **Symmetric Bayes-Nash Equilibrium:**

$$q^*(\alpha) = \operatorname*{argmax}_q \, [\alpha b q + U(p - c q^2)] \times \int_{\underline{\alpha}}^{\overline{\alpha}} 100 S(q_1; q^*(x)) \mathrm{d}F(x)$$

Bayes Nash and monotonicity

Equilibrium strategy $q^* : [\underline{\alpha}, \overline{\alpha}] \rightarrow [0, 10]$ monotone increasing in α.

- From first-order condition for q^*
- Invert to get α as a function of q
  - Think first price auction: bid increasing in valuation
  - From Myerson symmetric equilibrium, invert bids to get valuations
- Identification by monotonicity!

Estimation

- **Goal: estimate α distribution from the Bayes-Nash equilibrium q**
- **Challenge: unknown α distribution, unknown q distribution**
- **Resolution: Guerre, Perrigne and Vuong "Optimal Nonparametric Estimation of First-Price Auctions" Econometrica 2000**
  - **Estimate unknown q distribution by empirical q distribution**
  - **Use first-order condition, invert, then estimate α from q**
  - **Stack up estimated α's to construct distribution**
- **GPV Nonparametric Estimation: consistent, asymptoticcally efficient, etc**
- **Are α distributions different across markets and incentive configurations?**

Estimating α by quality distribution

- **Replace altruism distribution F by the equilibrium quality distribution G:**

$$\boldsymbol{\alpha} = \frac{\begin{array}{c} 2cqU'(p-cq^2)\displaystyle\int_0^{10} S(q;x)\,\mathbf{d}G(x) - \\ U(p-cq^2)\times\displaystyle\int_0^{10} bS(q;x)[1-S(q;x)]\,\mathbf{d}G(x) \end{array}}{\begin{array}{c} b\displaystyle\int_0^{10} S(q;x)\,\mathbf{d}G(x) + \\ bq\displaystyle\int_0^{10} bS(q;x)[1-S(q;x)]\,\mathbf{d}G(x) \end{array}}$$

- **G estimated by empirical quality distribution—GPV**

The Experiment

- **Within-subject design**
  - **Monopoly, Duopoly, Quadropoly**
  - **Price, cost, benefit; each binary**
  - **total of $3 \times 2 \times 2 \times 2 = 24$ games for each subject**
- **When: sessions in October 2017, April 2018**
- **Where: University of Cologne**
- **Who: 361 subjects, most of them Cologne students**
  - **Average age, 24 years; 55% female. Subjects of study: 131 in law and social sciences, 22 in medicine, 42 in arts and humanities, 49 in mathematics and natural sciences, 35 in theology, and 82 others, non-students, unavailable**
- **What: played normal form games, exactly those above**

Time left [sec]:

Patient type 1

Capitation: 10

Quality	Costs	Profit	Patient benefit
0	0.00	10.00	0
1	0.10	9.90	1
2	0.40	9.60	2
3	0.90	9.10	3
4	1.60	8.40	4
5	2.50	7.50	5
6	3.60	6.40	6
7	4.90	5.10	7
8	6.40	3.60	8
9	8.10	1.90	9
10	10.00	0.00	10

Calculate

Your decision:

OK

Time left [sec]:

Patient type 1

Capitation: 10

Quality	Costs	Profit	Patient benefit
0	0.00	10.00	0
1	0.10	9.90	1
2	0.40	9.60	2
3	0.90	9.10	3
4	1.60	8.40	4
5	2.50	7.50	5
6	3.60	6.40	6
7	4.90	5.10	7
8	6.40	3.60	8
9	8.10	1.90	9
10	10.00	0.00	10

	My Quality	Quality 2nd physician
Quality		
Number of patients		
Profit		
Patient benefit		

Calculate

Your decision:

OK

Time left [sec]:

Patient type 1

Capitation: 10

Quality	Costs	Profit	Patient benefit
0	0.00	10.00	0
1	0.10	9.90	1
2	0.40	9.60	2
3	0.90	9.10	3
4	1.60	8.40	4
5	2.50	7.50	5
6	3.60	6.40	6
7	4.90	5.10	7
8	6.40	3.60	8
9	8.10	1.90	9
10	10.00	0.00	10

	My Quality	Quality second physician	Quality third physician	Quality fourth physician
Quality				
Number of patients				
Profit				
Patient benefit				

Calculate

OK

Remaining time [sec]:

Patient type 1

Capitation: **10**

Quality	Costs	Profit	Patient benefit
0	0.00	10.00	0
1	0.10	9.90	1
2	0.40	9.60	2
3	0.90	9.10	3
4	1.60	8.40	4
5	2.50	7.50	5
6	3.60	6.40	6
7	4.90	5.10	7
8	6.40	3.60	8
9	8.10	1.90	9
10	10.00	0.00	10

	My Quality	Quality second physician
Quality	5	4
Number of patients	73	27
Profit	547.50	226.80
Patient benefit	365.00	108.00

Calculate

Your Decision:

OK

Sessions

- Randomly assign subjects to 6 market sequences
  - (M-D-Q); (M-Q-D); (D-M-Q); (D-Q-M); (Q-M-D); (Q-D-M)
- Price-cost-benefit, or incentive, configurations order in all markets
  - 1st, $(p = 10,\ c = 0.1,\ b = 1)$
  - 2nd, $(p = 10,\ c = 0.075,\ b = 1)$
  - 3rd, $(p = 15,\ c = 0.1,\ b = 0.5)$
  - 4th, $(p = 15,\ c = 0.1,\ b = 1)$
  - 5th, $(p = 10,\ c = 0.1,\ b = 0.5)$
  - 6th, $(p = 10,\ c = 0.075,\ b = 0.5)$
  - 7th, $(p = 15,\ c = 0.075,\ b = 1)$
  - 8th, $(p = 15,\ c = 0.075,\ b = 0.5)$

Other details

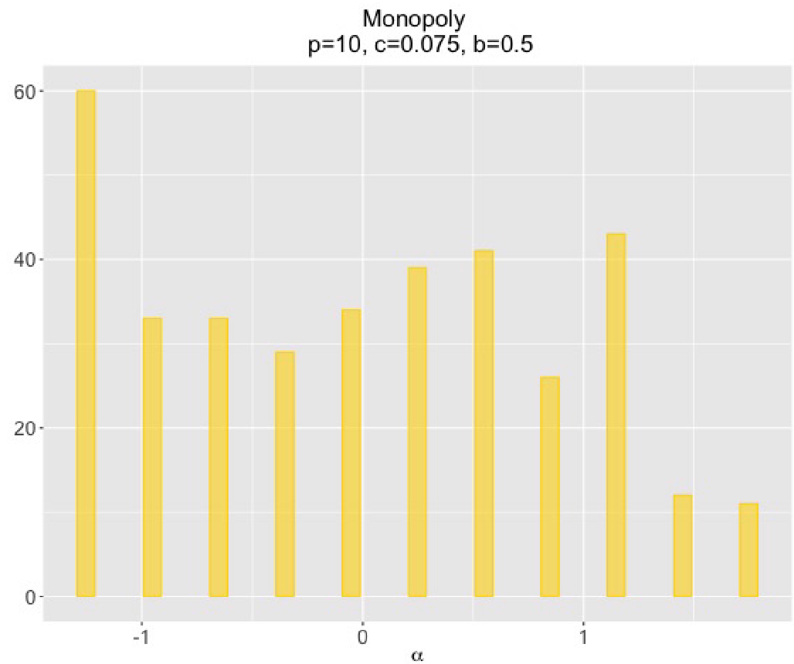
- No real patients; quality benefits translate to donation to charity
- Subjects only informed about market on a "need-to-know" basis
- Subjects get aggregated information of actual demands, profits, and patient benefits
- Subjects' profits and patient benefits: by "random choice" method in each market
- Control questions to test subjects' comprehension
- Sessions averaged 90 minutes; subjects earned €14.20 (€18.20 including show-up fee)
- €2,923.60 donated to the Christoffel Blindenmission, in Masvingo, Zimbabwe; enough for 97 cataract surgeries

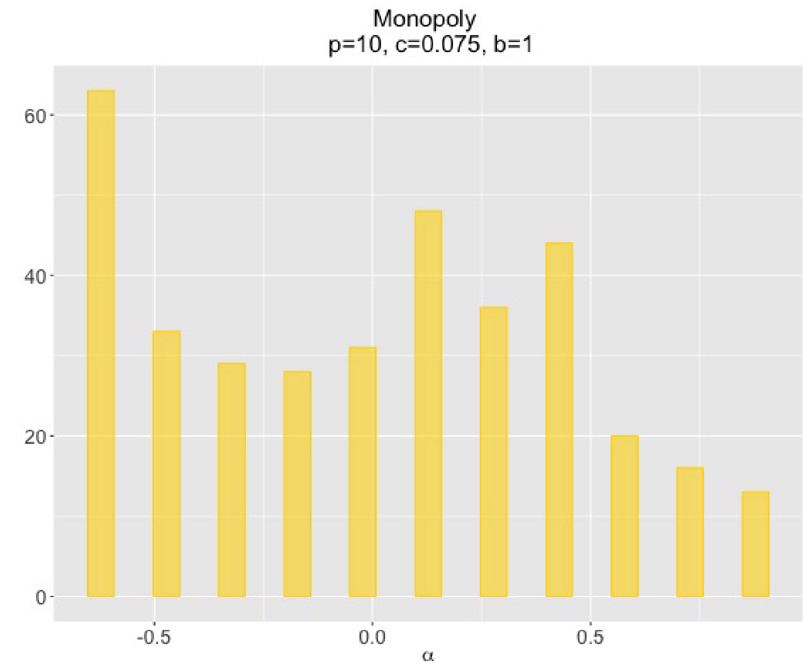
Estimation

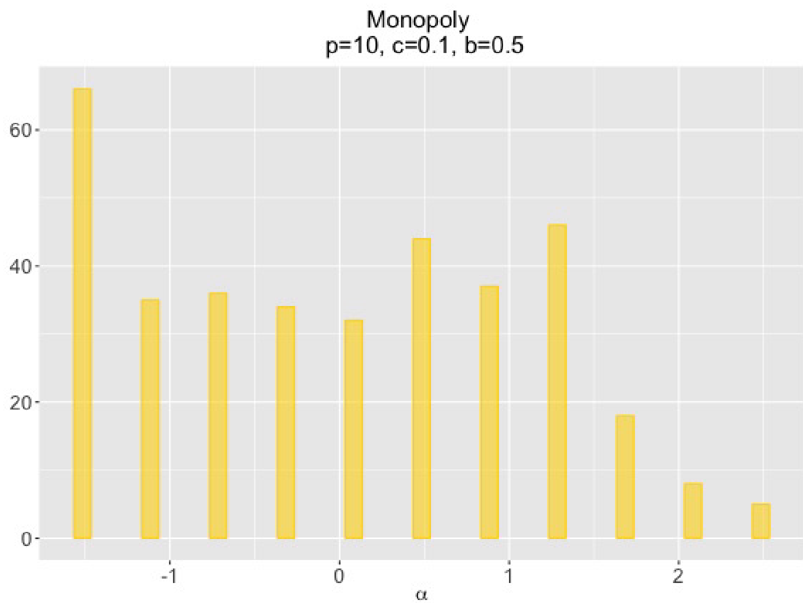
- Linear utility $U(x) = x$
  - α: marginal rate of substitution between profit and patient benefit
- CARA utility $U(x) = 1 - \exp(-rx)$, set $r = 0.1$(as robustness check)
- Normalization:
  - Recall 8 incentive configurations in 3 markets
  - For each incentive configuration, choose monopoly as origin
  - Find mean of estimated α, say α_i^M, $i =$ incentive configuration; M monopoly
  - Display $\alpha - \alpha_i^M$ for all i in all three markets
  - Measure α altruism as deviations from the monopoly mean

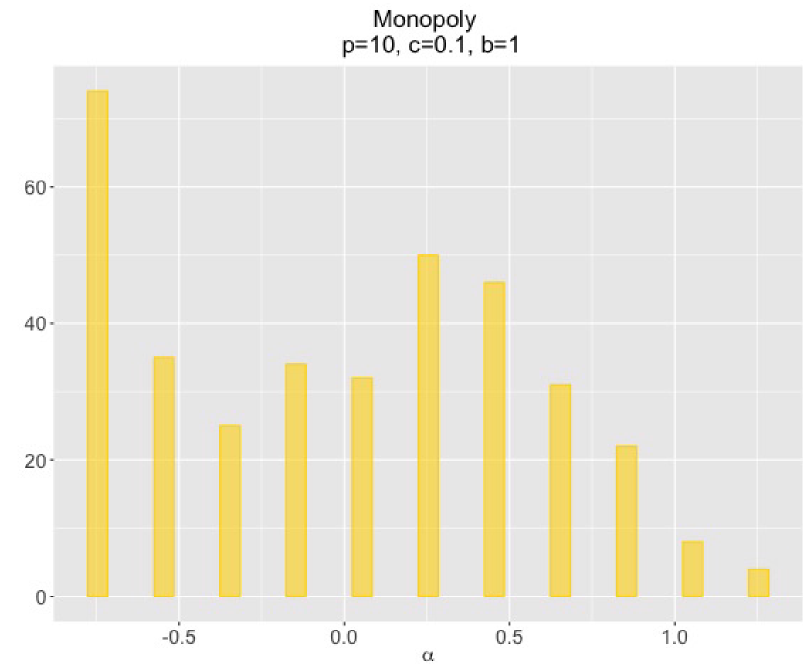
Linear Utility: means and standard deviations of normalized α

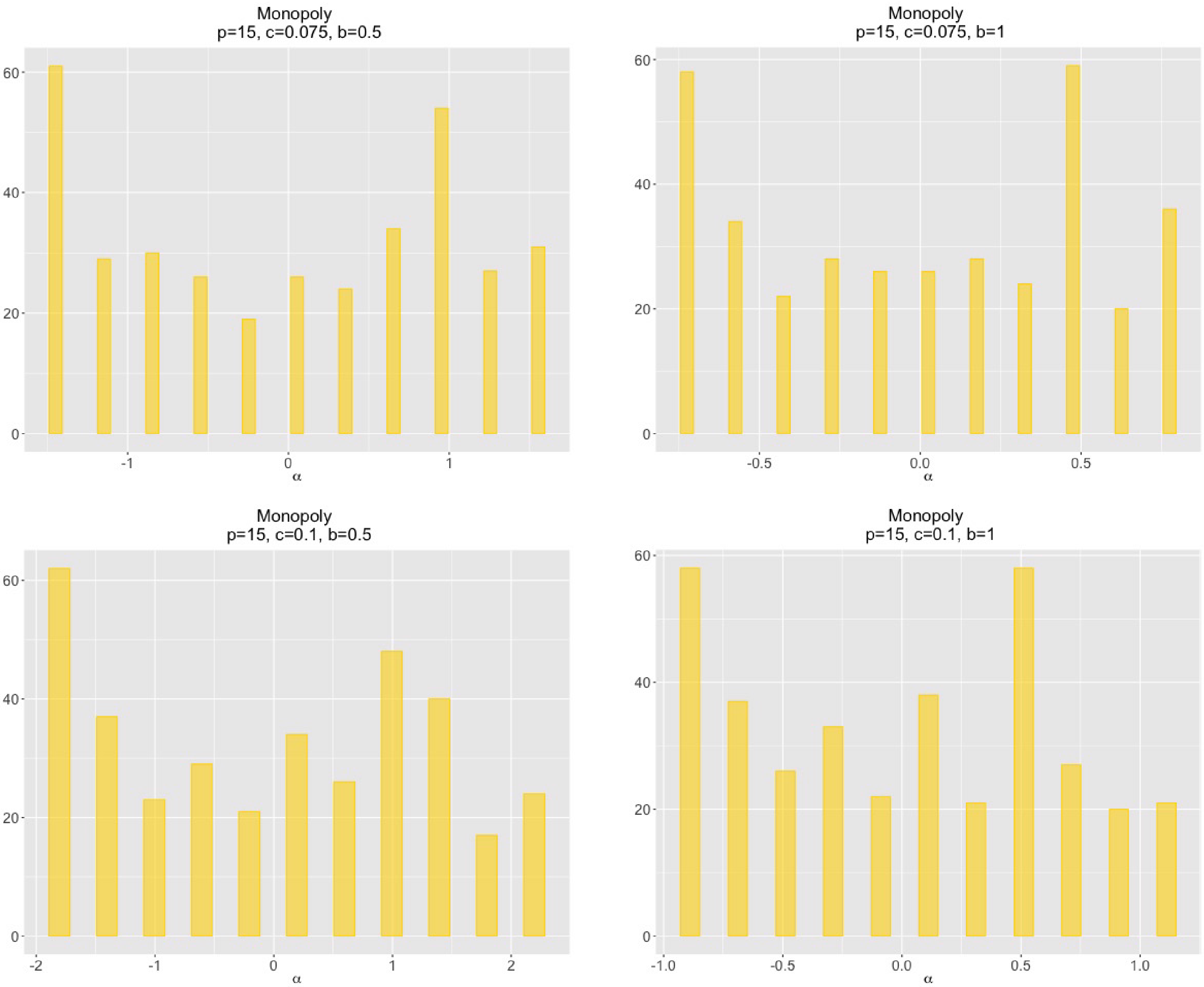
Incentive configurations	Monopoly		Duopoly		Quadropoly	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
$(\boldsymbol{p=10},\ \boldsymbol{c=0.075},\ \boldsymbol{b=0.5})$	0	0.898	-1.335	0.939	-1.579	0.766
$(\boldsymbol{p=10},\ \boldsymbol{c=0.075},\ \boldsymbol{b=1})$	0	0.448	-0.812	0.612	-0.985	0.657
$(\boldsymbol{p=10},\ \boldsymbol{c=0.1},\ \boldsymbol{b=0.5})$	0	1.117	-1.378	0.903	-2.233	1.710
$(\boldsymbol{p=10},\ \boldsymbol{c=0.1},\ \boldsymbol{b=1})$	0	0.559	-0.882	0.725	-1.069	0.822
$(\boldsymbol{p=15},\ \boldsymbol{c=0.075},\ \boldsymbol{b=0.5})$	0	1.028	-1.980	0.928	-2.382	0.980
$(\boldsymbol{p=15},\ \boldsymbol{c=0.075},\ \boldsymbol{b=1})$	0	0.512	-1.244	0.767	-1.471	1.138
$(\boldsymbol{p=15},\ \boldsymbol{c=0.1},\ \boldsymbol{b=0.5})$	0	1.308	-2.001	1.327	-2.428	1.147
$(\boldsymbol{p=15},\ \boldsymbol{c=0.1},\ \boldsymbol{b=1})$	0	0.638	-1.207	0.827	-1.485	1.016

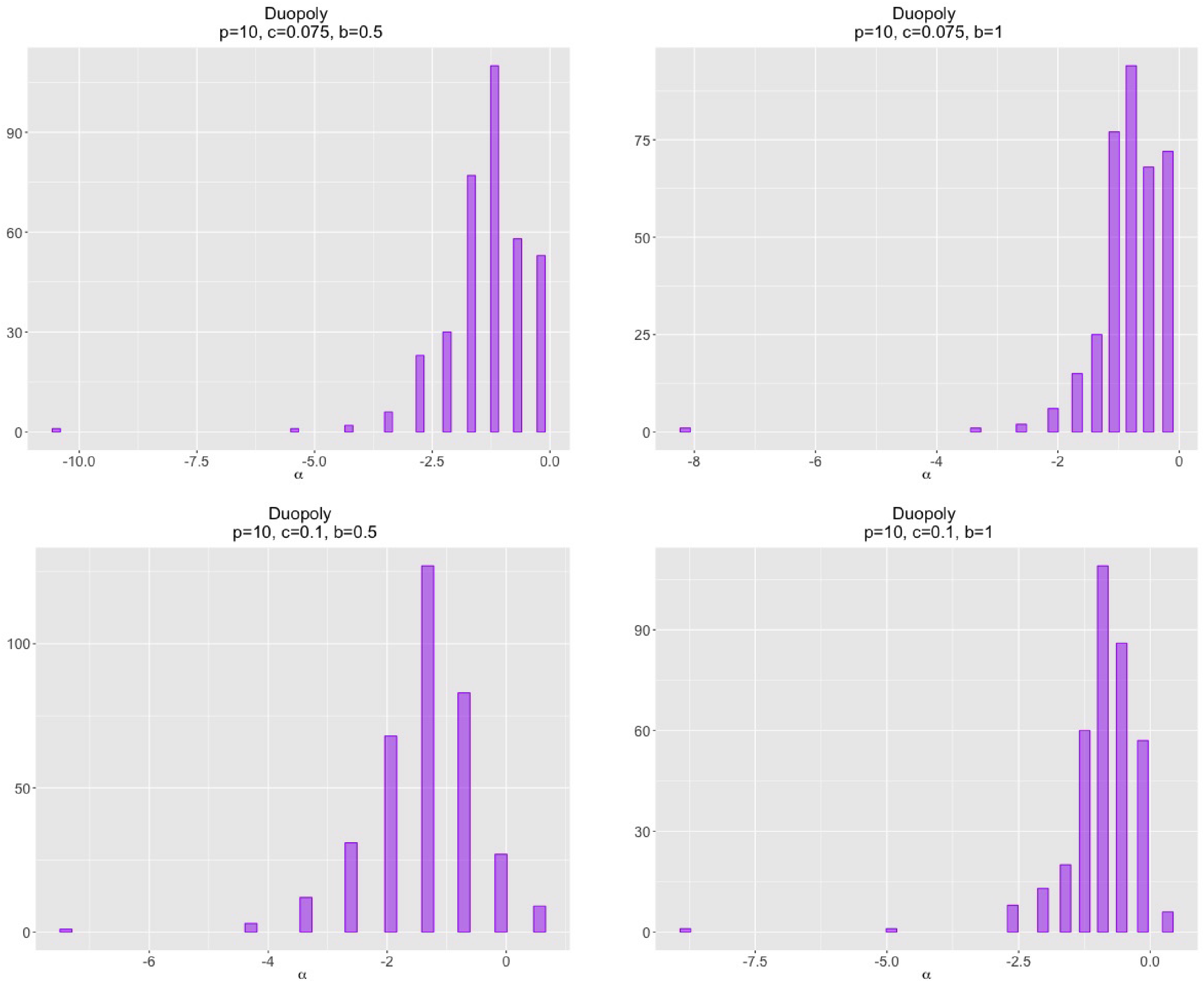

Monopoly
p=10, c=0.075, b=0.5
0
20
40
60
-1
0
1
α

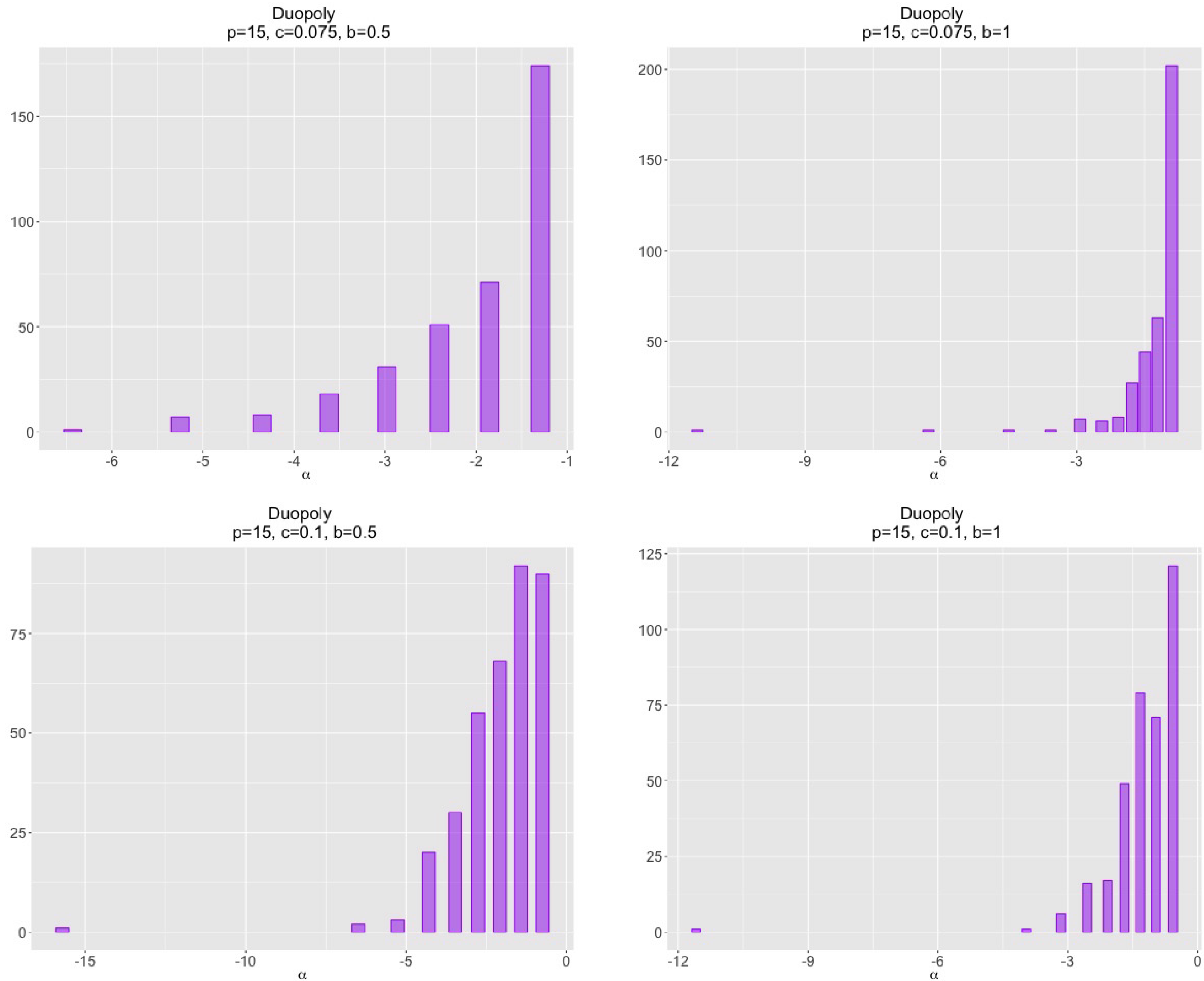

Monopoly
p=10, c=0.075, b=1
0
20
40
60
-0.5
0.0
0.5
α

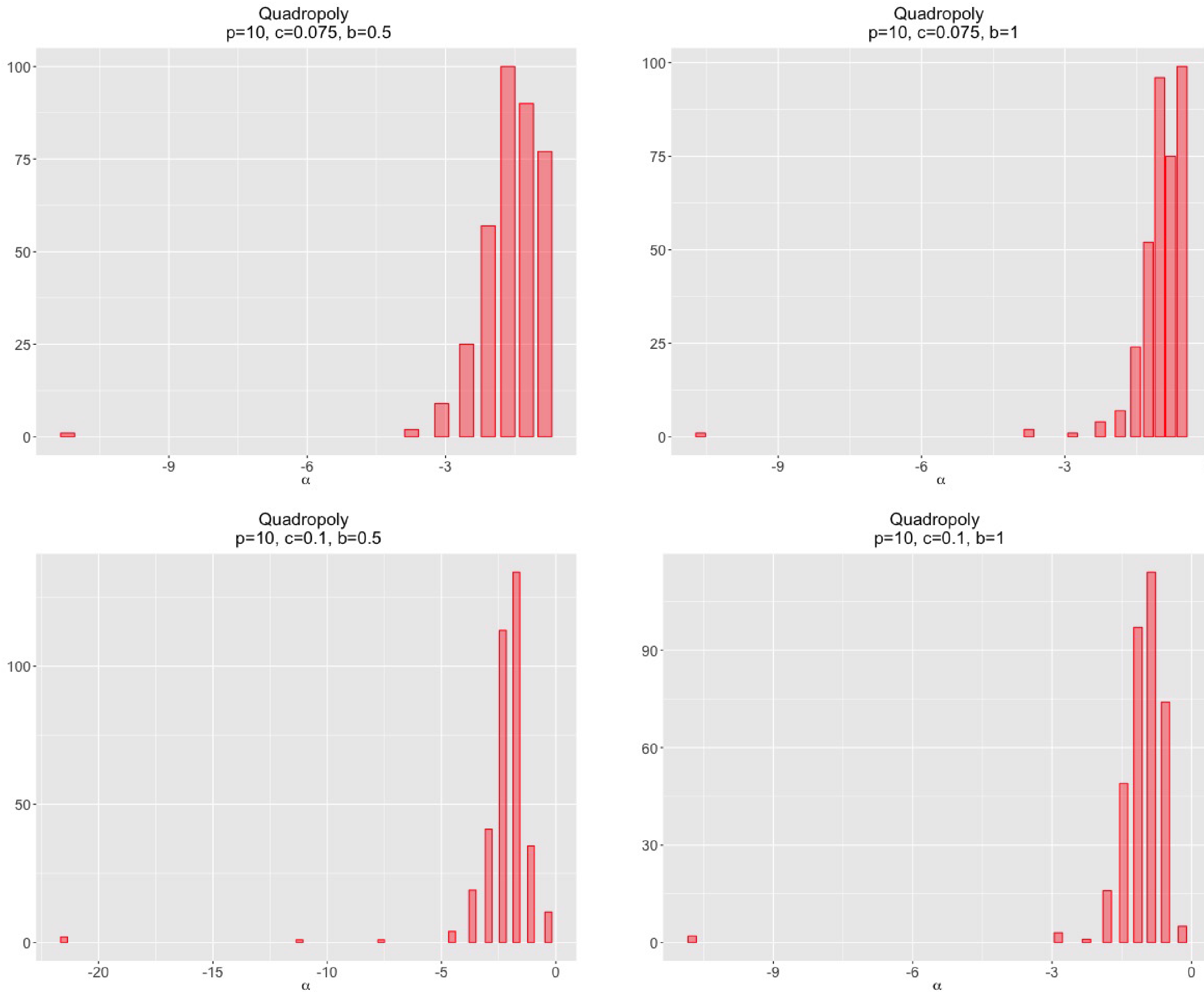

Monopoly
p=10, c=0.1, b=0.5
0
20
40
60
-1
0
1
2
α

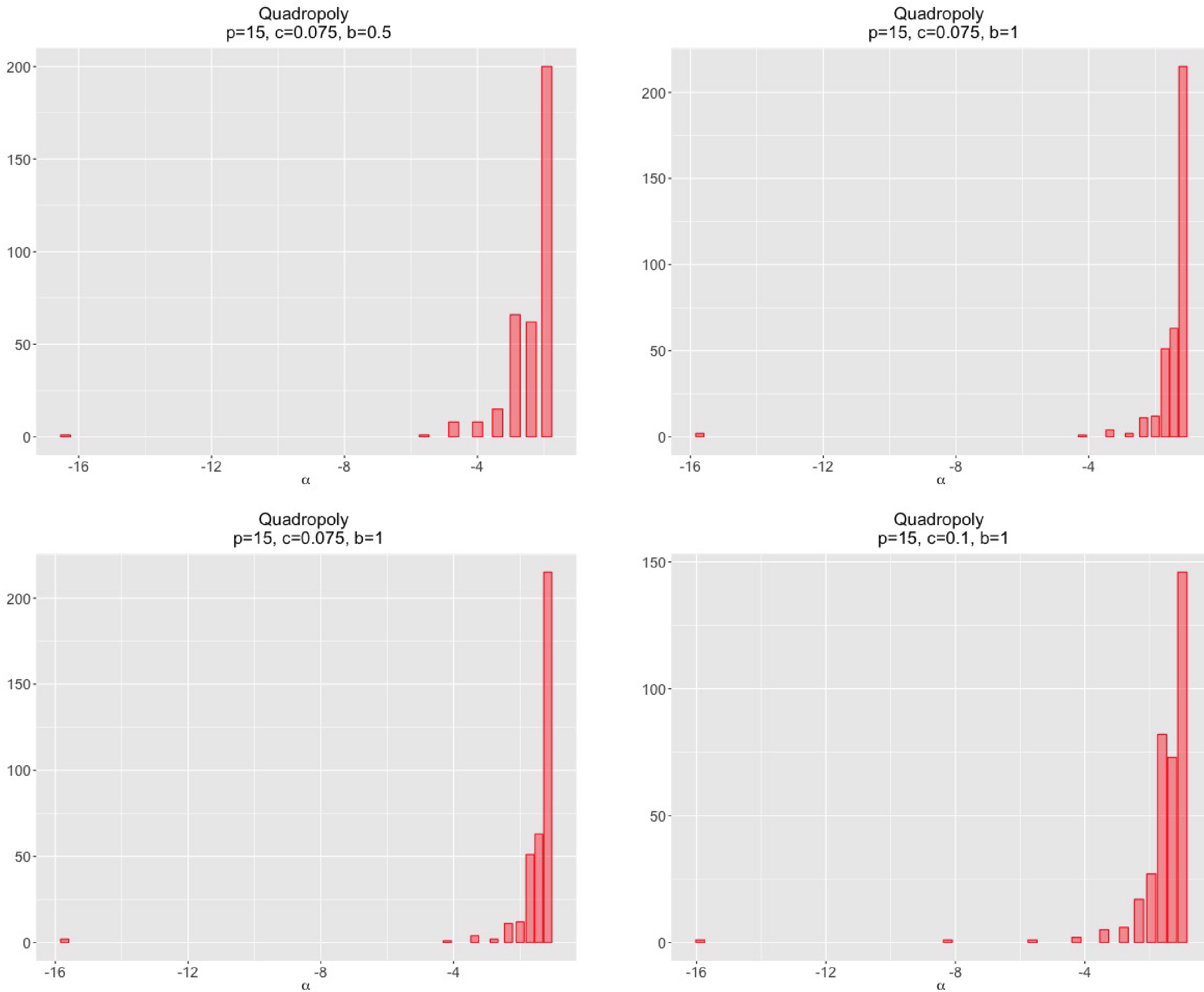

Monopoly
p=10, c=0.1, b=1
0
20
40
60
-0.5
0.0
0.5
1.0
α


Monopoly
p=15, c=0.075, b=0.5
α
Monopoly
p=15, c=0.075, b=1
α
Monopoly
p=15, c=0.1, b=0.5
α
Monopoly
p=15, c=0.1, b=1
α


Duopoly
p=10, c=0.075, b=0.5
α
Duopoly
p=10, c=0.075, b=1
α
Duopoly
p=10, c=0.1, b=0.5
α
Duopoly
p=10, c=0.1, b=1
α


Duopoly
p=15, c=0.075, b=0.5
α
Duopoly
p=15, c=0.075, b=1
α
Duopoly
p=15, c=0.1, b=0.5
α
Duopoly
p=15, c=0.1, b=1
α


Quadropoly
p=10, c=0.075, b=0.5
100
75
50
25
0
-9
-6
-3
α
Quadropoly
p=10, c=0.075, b=1
100
75
50
25
0
-9
-6
-3
0
α
Quadropoly
p=10, c=0.1, b=0.5
100
50
0
-20
-15
-10
-5
0
α
Quadropoly
p=10, c=0.1, b=1
90
60
30
0
-9
-6
-3
0
α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150
100
50
0
-16
-12
-8
-4
α
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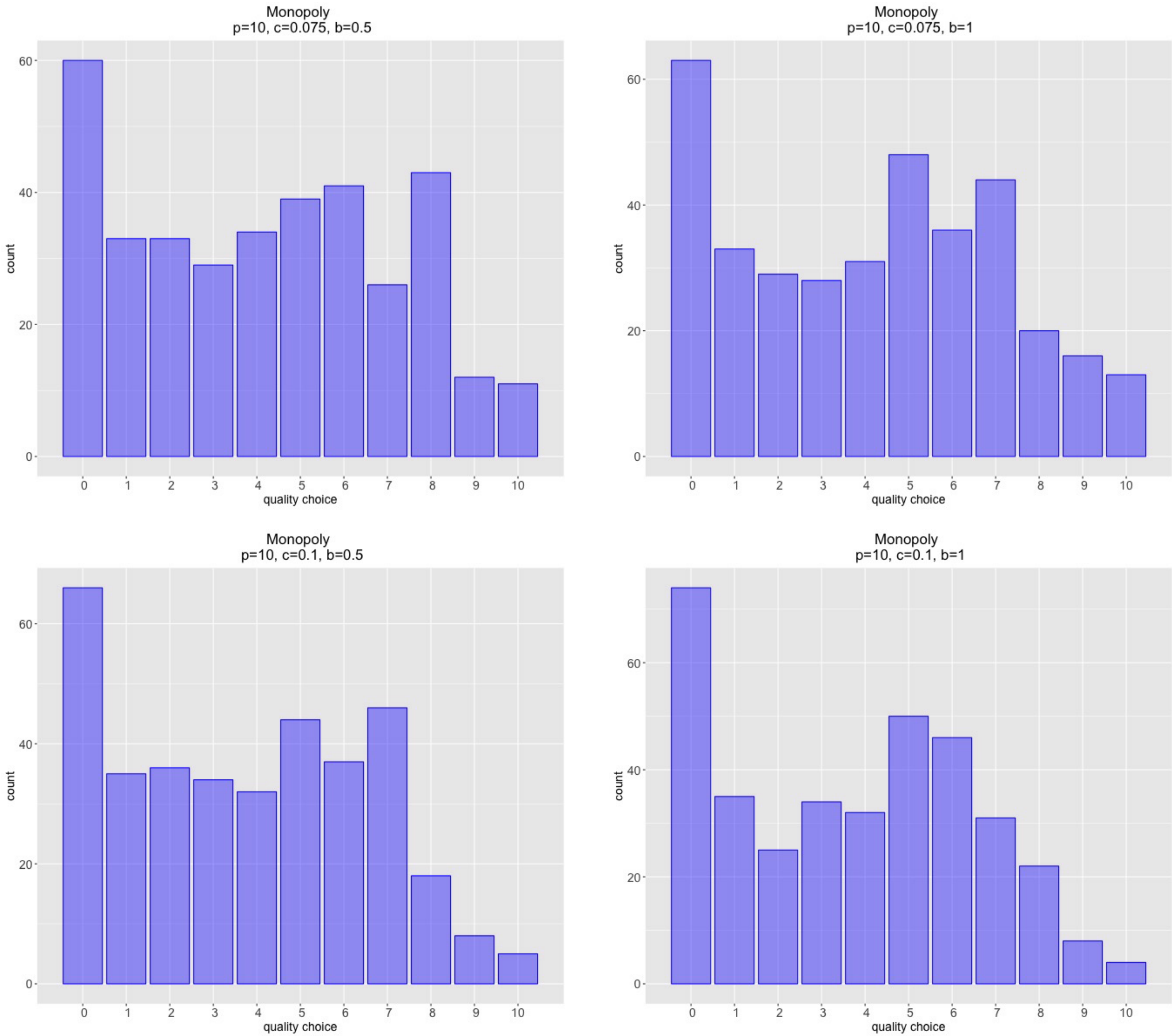
p=15, c=0.075, b=1
200
150
100
50
0
-16
-12
-8
-4
α
Quadropoly
p=15, c=0.075, b=1
200
150
100
50
0
-16
-12
-8
-4
α
Quadropoly
p=15, c=0.1, b=1
150
100
50
0
-16
-12
-8
-4
α

Equilibrium qualities

- **Three markets**
- **Eight incentive configurations**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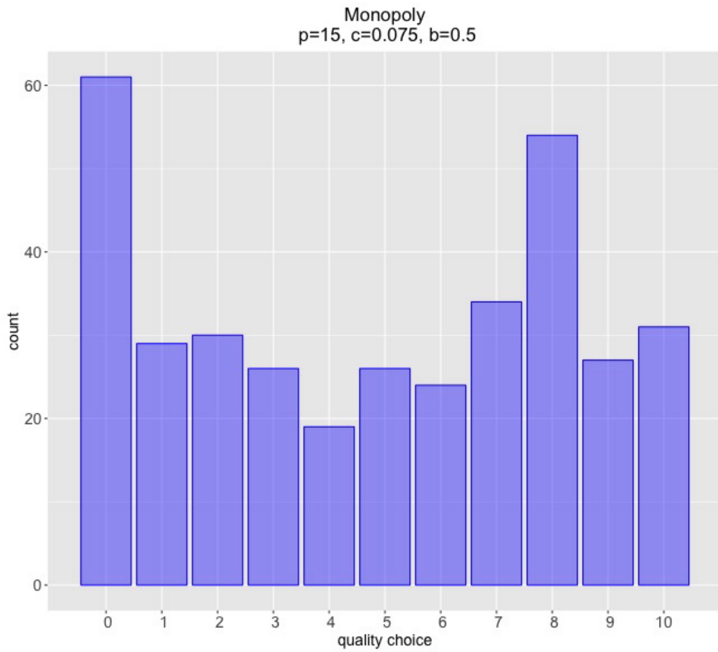
Monopoly
p=10, c=0.075, b=1
Monopoly
p=10, c=0.1, b=0.5
Monopoly
p=10, c=0.1, b=1
count
quality choice
0
20
40
60
0 1 2 3 4 5 6 7 8 9 10


Monopoly
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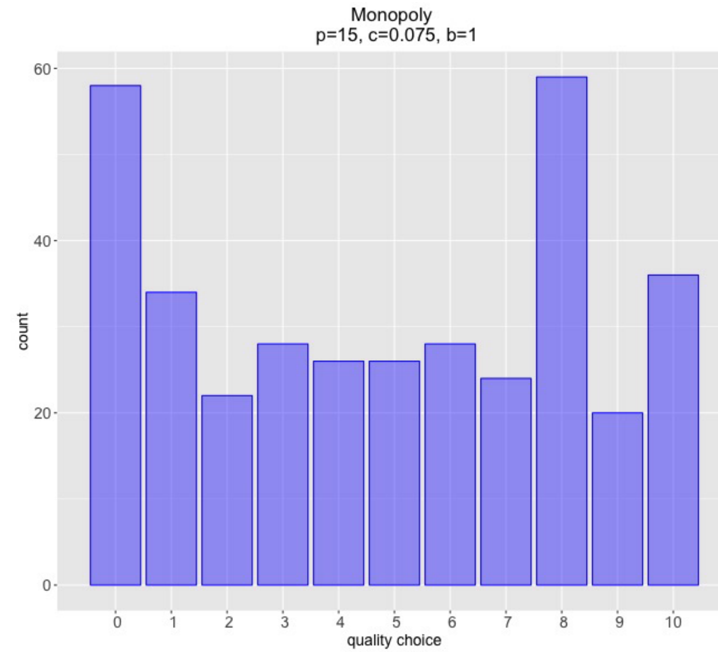
count
0
20
40
60
0 1 2 3 4 5 6 7 8 9 10
quality choice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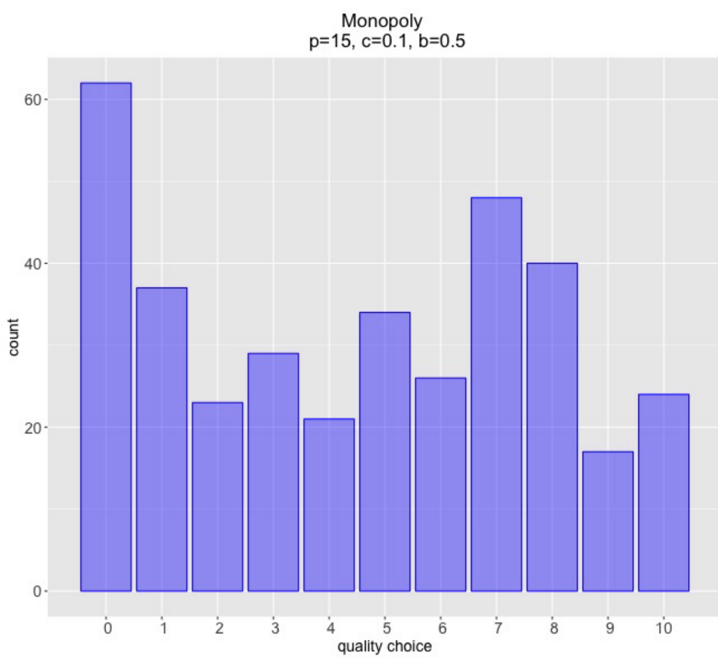
count
0
20
40
60
0 1 2 3 4 5 6 7 8 9 10
quality choice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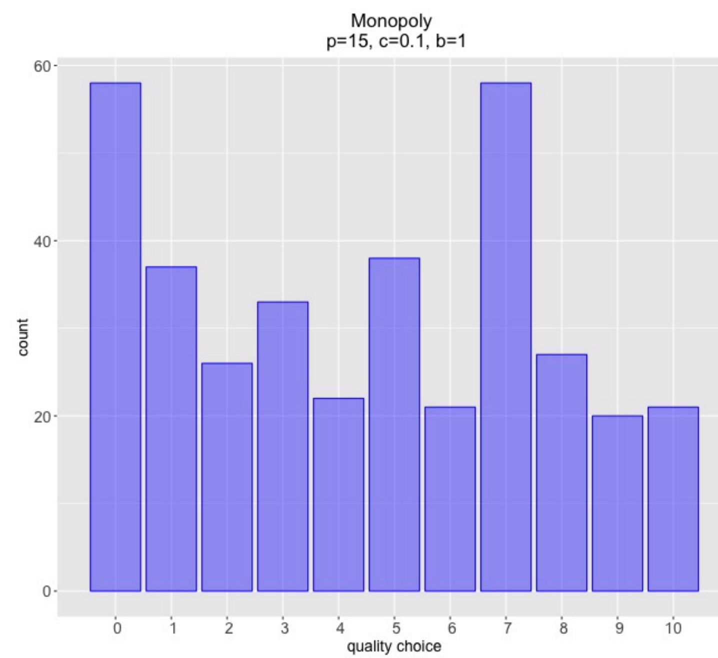
count
0
20
40
60
0 1 2 3 4 5 6 7 8 9 10
quality choice


Monopoly
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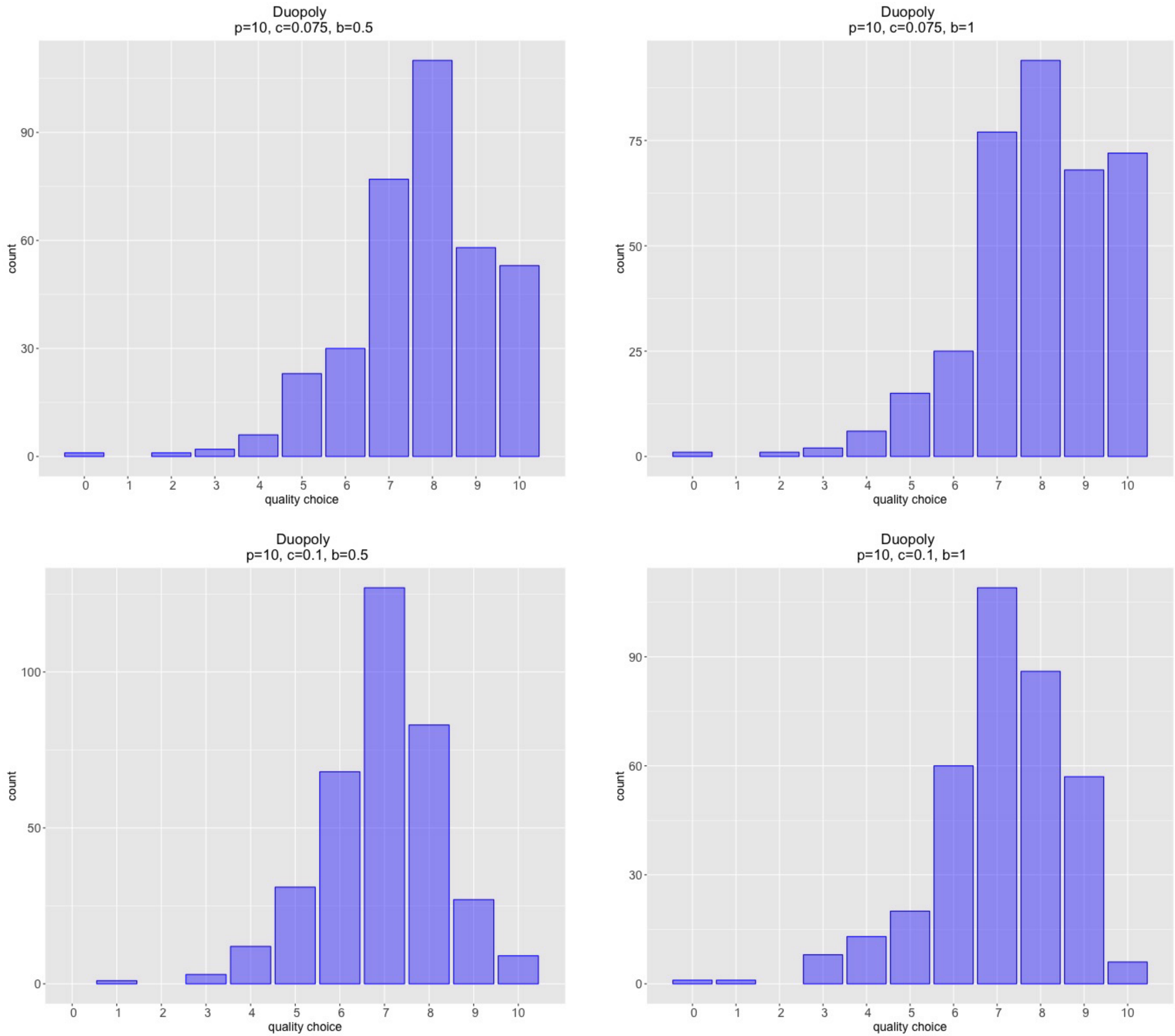
count
0
20
40
60
0 1 2 3 4 5 6 7 8 9 10
quality choice


Duopoly
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count
90
60
30
0
0 1 2 3 4 5 6 7 8 9 10
quality choice
Duopoly
p=10, c=0.075, b=1
count
75
50
25
0
0 1 2 3 4 5 6 7 8 9 10
quality choice
Duopoly
p=10, c=0.1, b=0.5
count
100
50
0
0 1 2 3 4 5 6 7 8 9 10
quality choice
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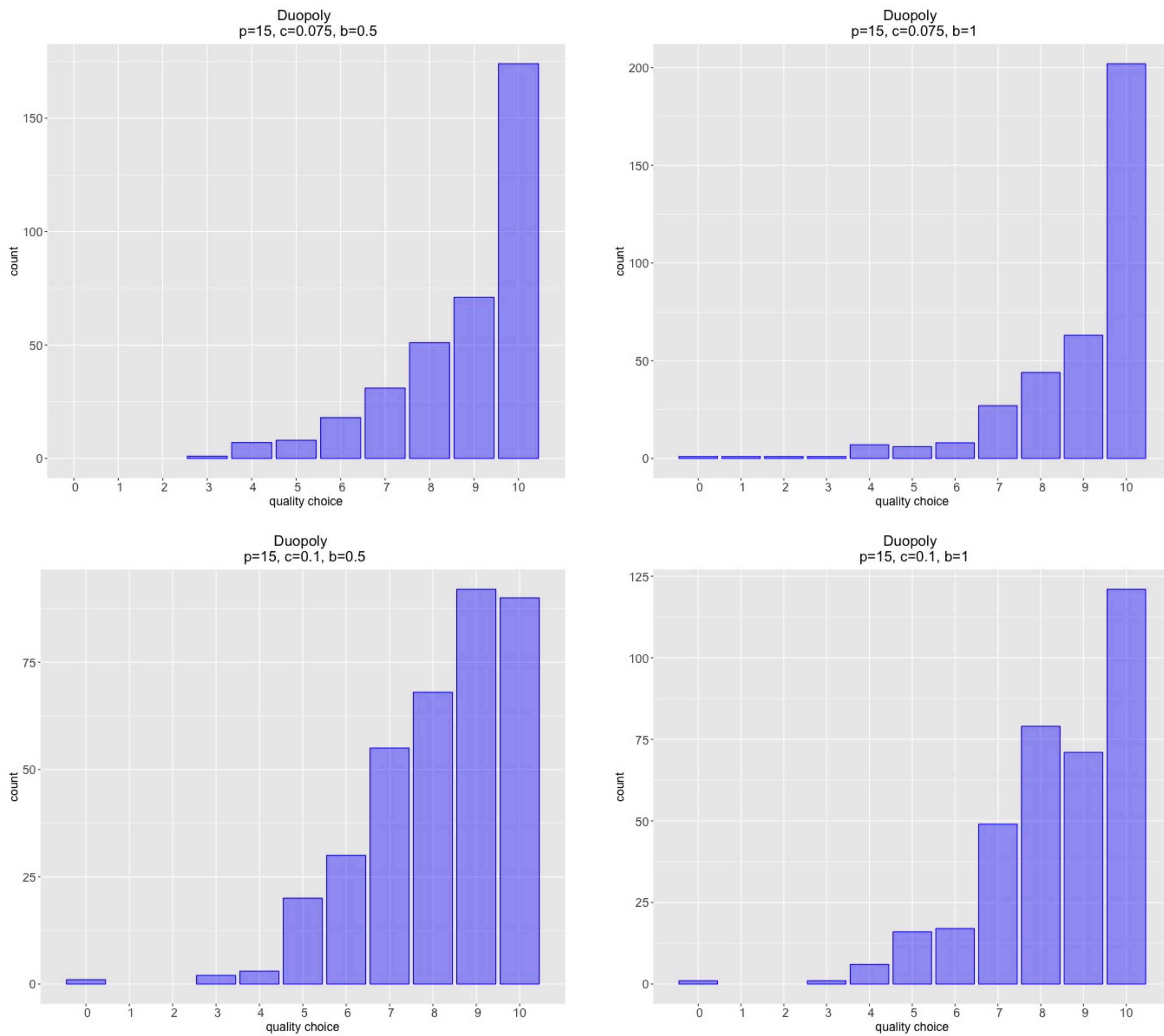
count
90
60
30
0
0 1 2 3 4 5 6 7 8 9 10
quality choice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count
quality choice
Duopoly
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count
quality choice
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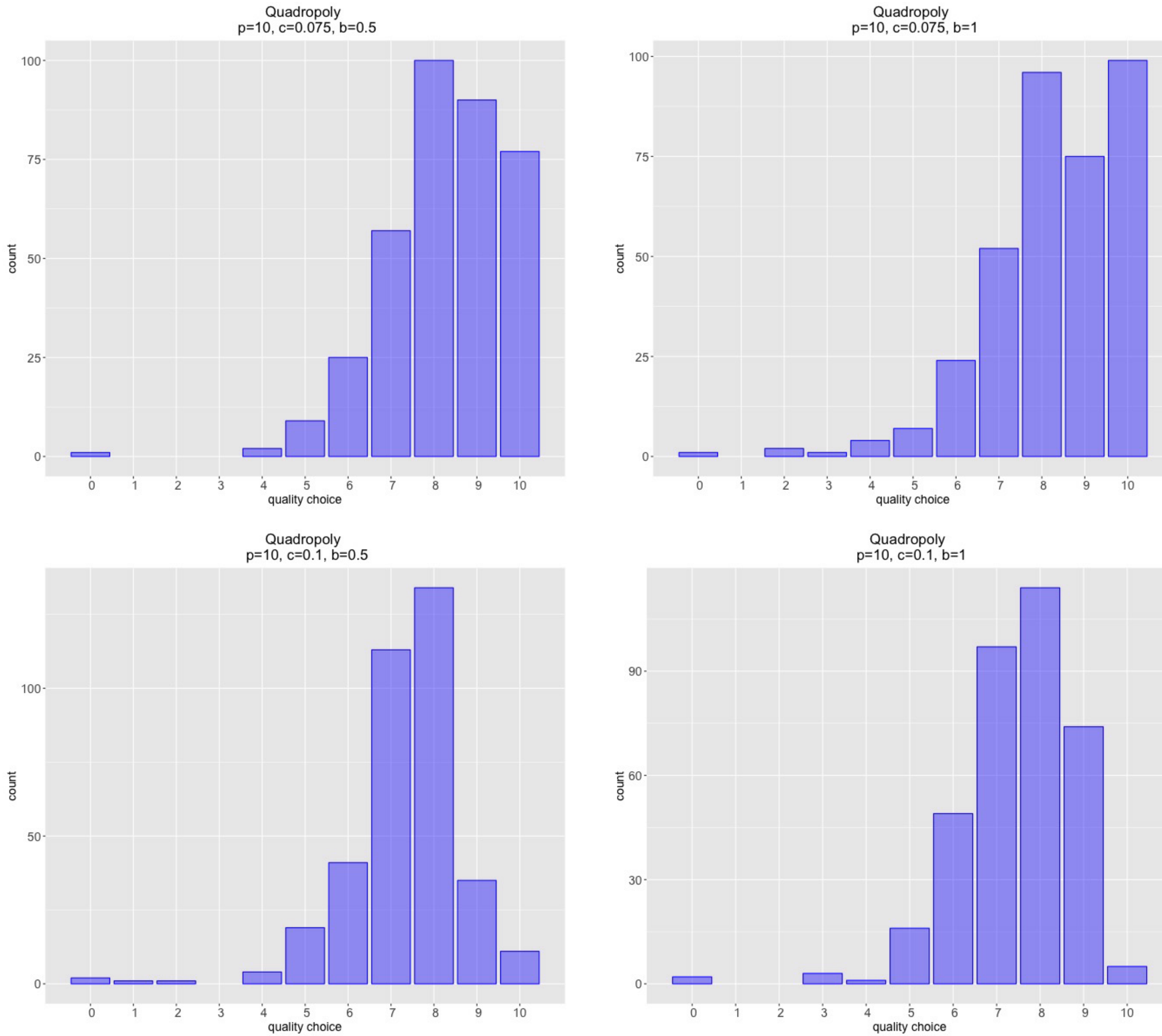
p=15, c=0.1, b=0.5
count
quality choice
Duopoly
p=15, c=0.1, b=1
count
quality choice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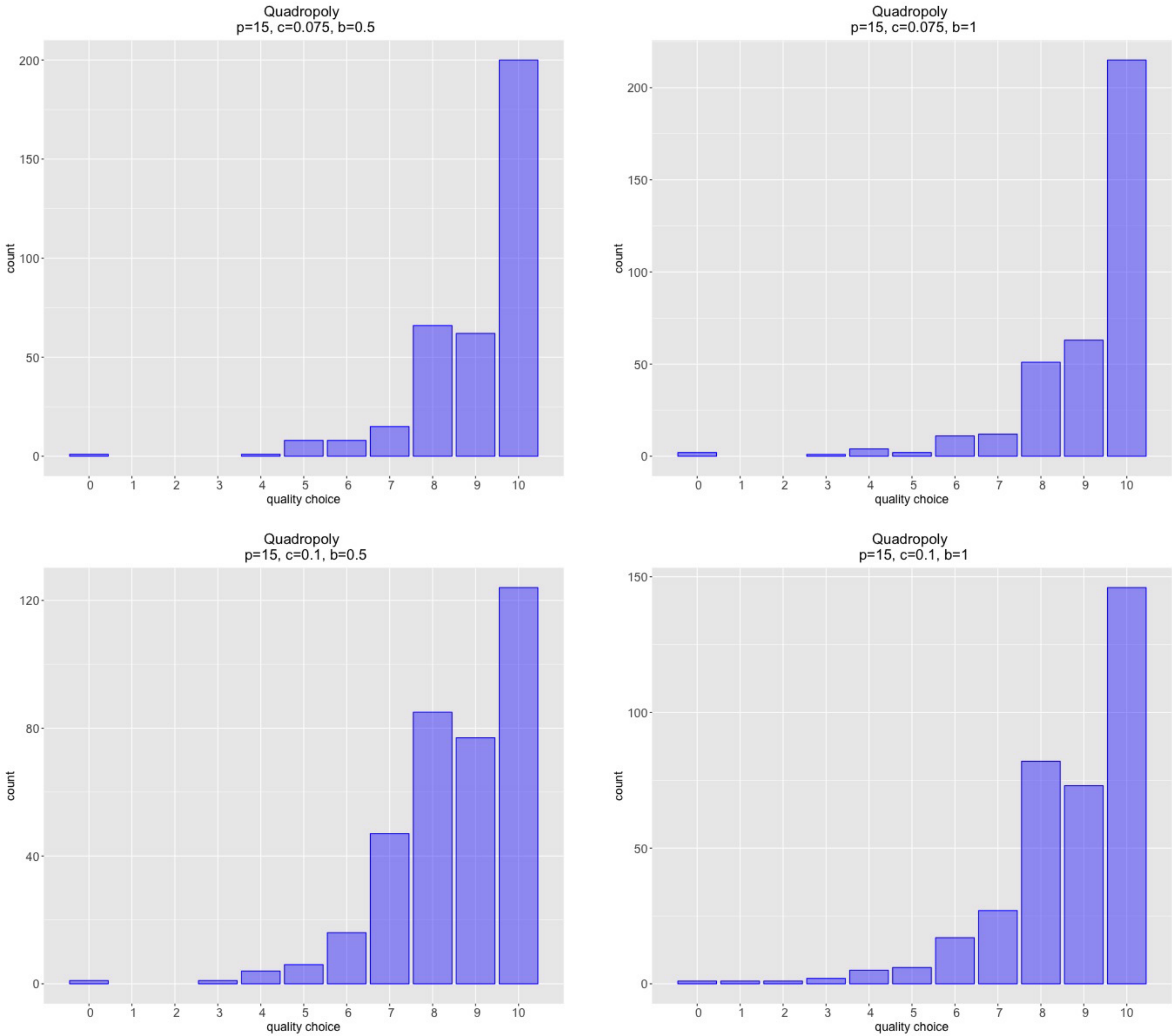
Quadropoly
p=10, c=0.1, b=1
count
quality choice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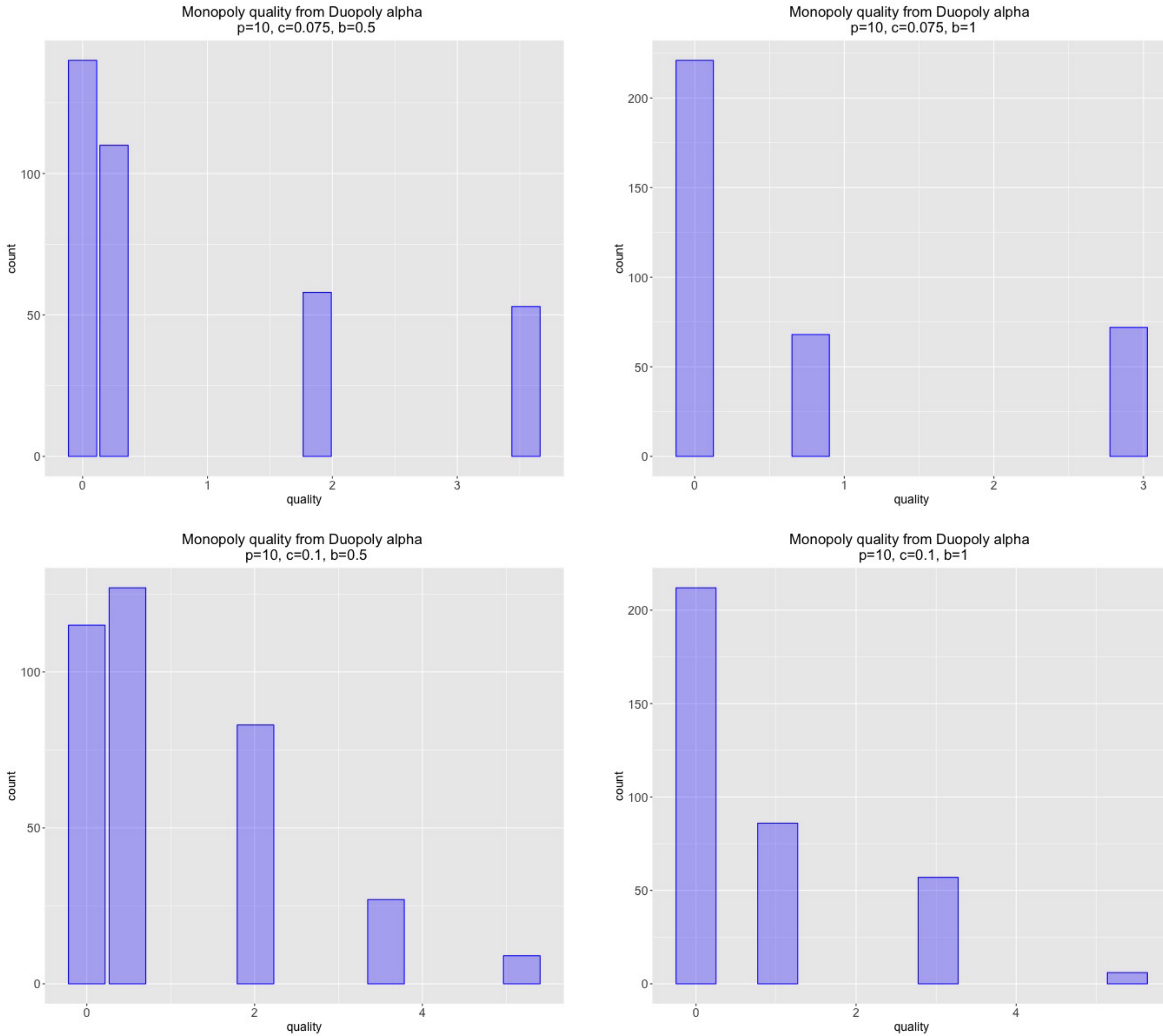
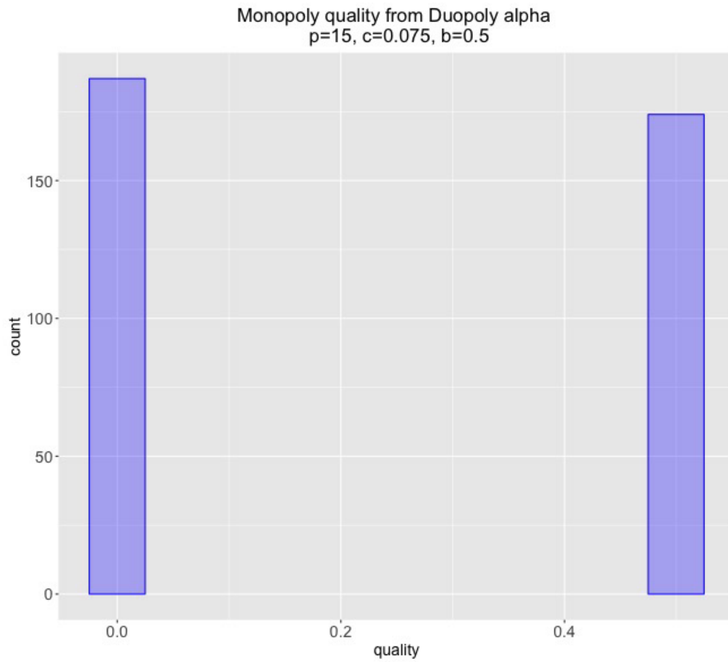
p=15, c=0.075, b=1
Quadropoly
p=15, c=0.1, b=0.5
Quadropoly
p=15, c=0.1, b=1
count
quality choice
0
1
2
3
4
5
6
7
8
9
10
50
100
150
200
40
80
120

Counterfactuals

- **What would qualities look like if there were no altruism change?**
- **Impossible to get analytical formulas for Bayes-Nash equilibrium qualities**
- **Take estimates of altruism parameters in duopoly and quadropoly**
  - **Feed them into formulas for optimal qualities in monopoly**
  - **Counterfact qualities**


Monopoly quality from Duopoly alpha
p=10, c=0.075, b=0.5
count
quality
0
50
100
0
1
2
3
Monopoly quality from Duopoly alpha
p=10, c=0.075, b=1
count
quality
0
50
100
150
200
0
1
2
3
Monopoly quality from Duopoly alpha
p=10, c=0.1, b=0.5
count
quality
0
50
100
0
2
4
Monopoly quality from Duopoly alpha
p=10, c=0.1, b=1
count
quality
0
50
100
150
200
0
2
4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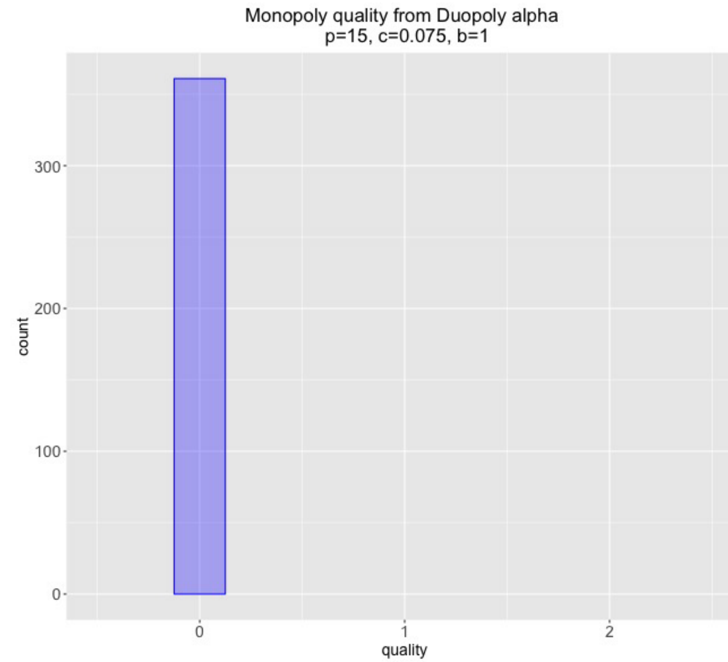
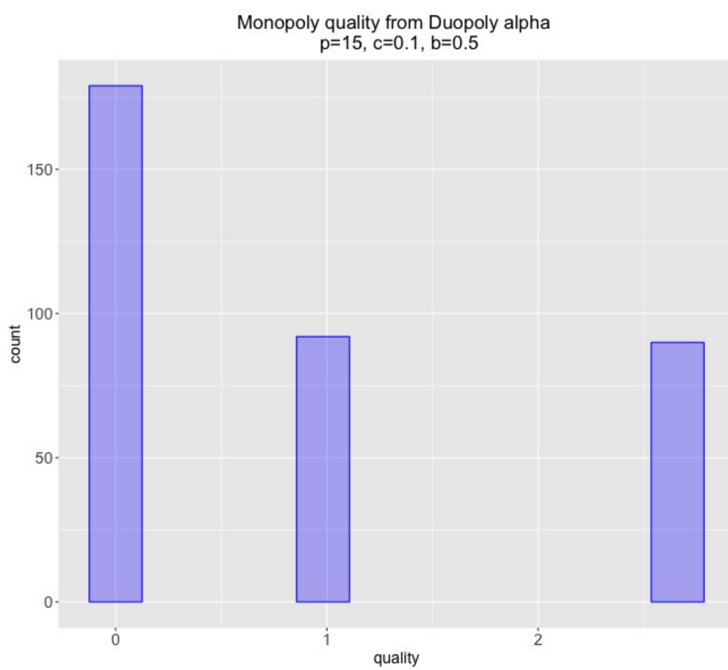
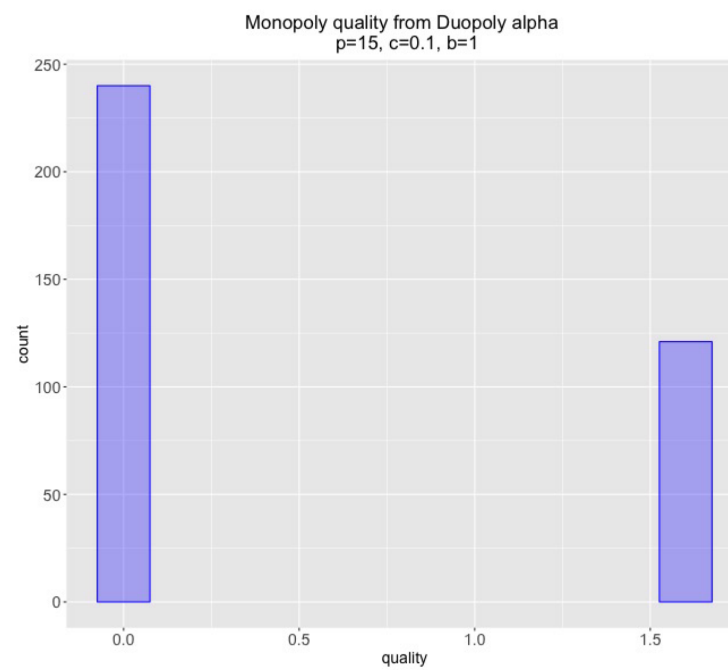
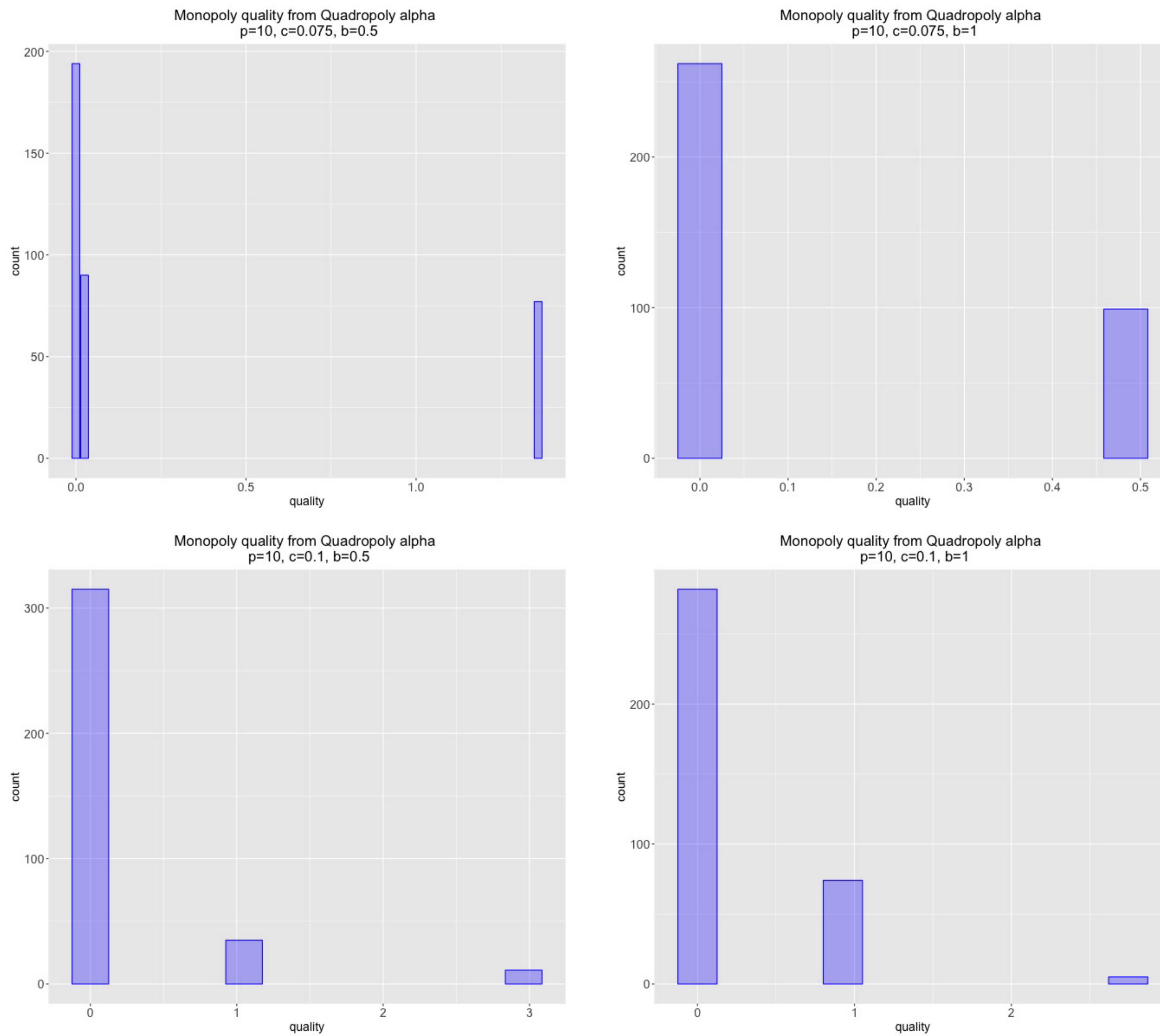
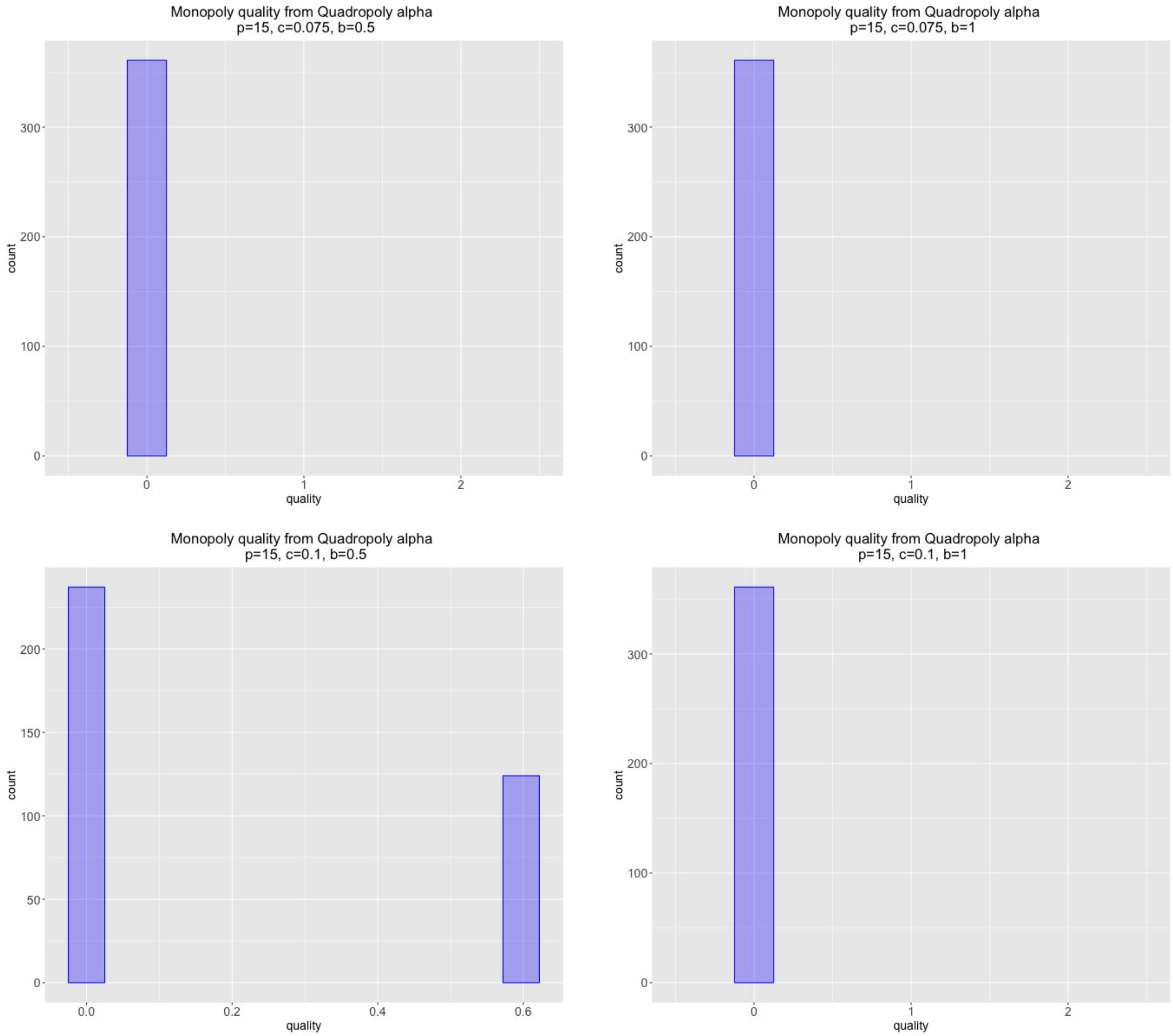
count
0
50
100
150
0.0
0.2
0.4
quality


Monopoly quality from Duopoly alpha
p=15, c=0.075, b=1
count
0
100
200
300
0
1
2
quality


Monopoly quality from Duopoly alpha
p=15, c=0.1, b=0.5
count
0
50
100
150
0
1
2
quality


Monopoly quality from Duopoly alpha
p=15, c=0.1, b=1
count
0
50
100
150
200
250
0.0
0.5
1.0
1.5
quality


Monopoly quality from Quadropoly alpha
p=10, c=0.075, b=0.5
count
quality
Monopoly quality from Quadropoly alpha
p=10, c=0.075, b=1
count
quality
Monopoly quality from Quadropoly alpha
p=10, c=0.1, b=0.5
count
quality
Monopoly quality from Quadropoly alpha
p=10, c=0.1, b=1
count
quality


Monopoly quality from Quadropoly alpha
p=15, c=0.075, b=0.5
count
quality
Monopoly quality from Quadropoly alpha
p=15, c=0.075, b=1
count
quality
Monopoly quality from Quadropoly alpha
p=15, c=0.1, b=0.5
count
quality
Monopoly quality from Quadropoly alpha
p=15, c=0.1, b=1
count
quality

Means and standard deviations of qualities

Incentive configurations	Monopoly		Duopoly		Quadropoly	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
$(\boldsymbol{p} = \mathbf{10},\ \boldsymbol{c} = \mathbf{0.075},\ \boldsymbol{b} = \mathbf{0.5})$	4.17	2.99	7.75	1.58	8.26	1.40
$(\boldsymbol{p} = \mathbf{10},\ \boldsymbol{c} = \mathbf{0.075},\ \boldsymbol{b} = \mathbf{1})$	4.15	2.99	7.98	1.59	8.31	1.56
$(\boldsymbol{p} = \mathbf{10},\ \boldsymbol{c} = \mathbf{0.1},\ \boldsymbol{b} = \mathbf{0.5})$	3.79	2.79	6.94	1.35	7.34	1.34
$(\boldsymbol{p} = \mathbf{10},\ \boldsymbol{c} = \mathbf{0.1},\ \boldsymbol{b} = \mathbf{1})$	3.73	2.80	7.09	1.52	7.46	1.34
$(\boldsymbol{p} = \mathbf{15},\ \boldsymbol{c} = \mathbf{0.075},\ \boldsymbol{b} = \mathbf{0.5})$	4.82	3.43	8.82	1.53	9.09	1.32
$(\boldsymbol{p} = \mathbf{15},\ \boldsymbol{c} = \mathbf{0.075},\ \boldsymbol{b} = \mathbf{1})$	4.83	3.41	8.98	1.60	9.15	1.43
$(\boldsymbol{p} = \mathbf{15},\ \boldsymbol{c} = \mathbf{0.1},\ \boldsymbol{b} = \mathbf{0.5})$	4.51	3.27	8.19	1.63	8.55	1.47
$(\boldsymbol{p} = \mathbf{15},\ \boldsymbol{c} = \mathbf{0.1},\ \boldsymbol{b} = \mathbf{1})$	4.44	3.19	8.40	1.62	8.65	1.61

Parameter	Low parameter level (N=1,444, per market) Mean	st. dev.	High parameter level (N=1,444, per market) Mean	st. dev.	Relative difference
Price ($\boldsymbol{p} = \mathbf{10}$ and $\boldsymbol{p} = \mathbf{15}$)					
Monopoly	3.959	2.900	4.652	3.327	0.175
Duopoly	7.442	1.573	8.595	1.625	0.155
Quadropoly	7.841	1.479	8.862	1.484	0.130
Cost ($\boldsymbol{c} = \mathbf{0.075}$ and $\boldsymbol{c} = \mathbf{0.1}$)					
Monopoly	4.493	3.227	4.118	3.038	-0.083
Duopoly	8.380	1.660	7.657	1.662	-0.086
Quadropoly	8.704	1.489	8.000	1.564	-0.081
Patient benefit ($\boldsymbol{b} = \mathbf{0.5}$ and $\boldsymbol{b} = \mathbf{1}$)					
Monopoly	4.323	3.150	4.287	3.128	-0.008
Duopoly	7.925	1.668	8.112	1.726	0.024
Quadropoly	8.310	1.523	8.393	1.608	0.010

Duopoly	3.713***	3.713***		3.713***	3.545***
	(0.158)	(0.158)		(0.158)	(0.157)
Quadropoly	4.046***	4.046***		4.046***	3.987***
	(0.157)	(0.157)		(0.157)	(0.156)
High price (= **1** if $p_H = 15$)			0.955***	0.955***	0.693***
			(0.0292)	(0.0292)	(0.0504)
High cost (= **1** if $c_H = 0.1$)			-0.601***	-0.601***	-0.375***
			(0.0235)	(0.0235)	(0.0456)
High benefit (= **1** if $b_H = 1$)			0.0783***	0.0783***	-0.0360
			(0.0238)	(0.0238)	(0.0429)
Duopoly × High price					0.461***
					(0.0659)
Quadropoly × High price					0.328***
					(0.0608)
Duopoly × High cost					-0.348***
					(0.0558)
Quadropoly × High cost					-0.328***
					(0.0545)
Duopoly × High benefit					0.224***
					(0.0560)
Quadropoly × High benefit					0.119**
					(0.0551)
Market order and session dummies	No	Yes	Yes	Yes	Yes
Constant	4.305***	4.188***	6.558***	3.971***	4.047***
	(0.155)	(0.400)	(0.378)	(0.400)	(0.399)
Observations	8,664	8,664	8,664	8,664	8,664
Subjects	361	361	361	361	361
R^2	0.399	0.407	0.046	0.445	0.447

Market orders and between-subject subsample

- **Does it matter if subjects experience monopoly before duopoly, etc?**
  - **Results similar**
- **Use 1/3 of data to construct between-subject design**
  - **Take subjects' first market experience**
  - **Results similar**

BMW (Byambadalai, Ma, and Wiesen) questioning the basics

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- Preferences-Markets-Incentives altogether, not independent
- Competition and incentives are like switches
- Why? Or should it be what or how?
- Cognitive demands?
- Reductionism: "Equity theory and fair inequality: A neuroeconomic study" by Cappelen, Proceedings of the National Academy of Science, 2014