Coarse Thinking and Collusion in Bertrand Duopoly with Increasing Marginal Costs

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Abstract

Mullainathan, Schwartzstein, & Shleifer [Quarterly Journal of Economics, May 2008] put forward a model of coarse thinking. The essential idea behind coarse thinking is that agents put situations into categories and then apply the same model of inference to all situations in a given category. We extend the argument to strategies in a game-theoretic setting and propose the following: Agents split the choice-space into categories in comparison with salient choices and then choose each option in a given category with equal probability. We provide an alternative explanation for the puzzling results obtained in a Bertrand competition experiment as reported in Abbink & Brandts [Games and Economic Behavior, 63, 2008]

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In an interesting paper, Mullainathan, Schwartzstein, & Shleifer (2008) put forward a model of coarse thinking. The essential idea behind coarse thinking is that people put situations into categories and then apply the same model of inference to all situations in the same category. In this paper, we show that an extension of the idea of coarse thinking to strategies can explain the collusive outcome in a Bertrand duopoly experiment with increasing marginal costs. The experiment is conducted by Abbink & Brandts (2008).

We propose the following. Consider a two-player setting. Each player sees the set of choices available to him or her as well as the other player in terms of categories. The categories are formed by spitting the choice-space into various categories around salient choices. That is, there are salient choices (choices that stand-out or are prominent for some inherent reason) and categories are formed in relation to them. Once grouped into categories, each option in a given category is chosen with equal probability.

Arguments for coarse thinking abound in the social science literature. Zaltman(1997), Lakoff (1987), Edelman (1992), Kahneman & Tversky (1982), and Gilovich (1981) are a few examples. In this paper, we study what happens when such thinking is allowed in the simplest (two-player) of strategic settings. We find that we are able to provide an alternative explanation for the collusive outcome in a Bertrand duopoly with increasing marginal costs.

This paper is organized as follows. In section 1, we present the relevant results from a Bertrand duopoly experiment as reported in Abbink & Brandts (2008). In section 2, we show how players engaged in coarse thinking give rise to the outcomes reported in section 1. Section 3 concludes.

1. Bertrand Competition with Increasing Marginal Costs

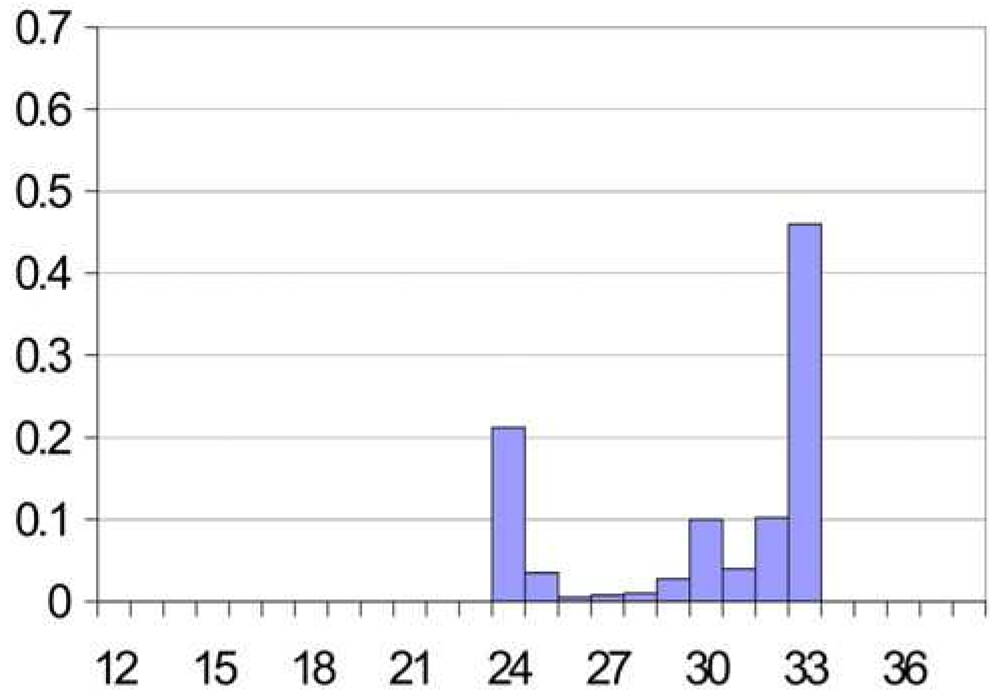
Abbink & Brandts (2008) conduct a series of experiments simulating Bertrand competition with increasing marginal costs and with two, three, and four firms in the industry. They presented participants with a table of choices. The relevant table is reproduced here as table 1. The table simulates a Bertrand duopoly competition with increasing marginal costs. Each of the two players is asked to choose a number between 1 and 39 simultaneously.[1] If the number (price) chosen by a player is the lowest, his or her payoff is shown in column two. If there is a tie (both players choose the same number), the payoff to each player is shown in column three. And, if the price chosen is not the lowest, the payoff is zero. This set-up simulates a Bertrand duopoly with increasing marginal costs in a controlled laboratory environment. It is easy to see that any choice between 13 and 30 (both numbers included) is a Nash equilibrium. The payoff dominant Nash equilibrium is 30. There were 50 trials in Abbink & Brandts (2008) implying that significant learning opportunities were present. Figure 1 shows the results from the experiment. As can be seen, 33 is the most frequent choice, even though it is not a Nash equilibrium. Furthermore, 24 is the second most frequent choice. Other choices range from 25 to 32. There is a whole set of Nash equilibria (13 to 23) which are never selected. How can the results be explained? Abbink and Brandts (2008) argue that there is a dynamic learning process leading to the observed outcomes. Here we provide an alternative explanation based on coarse thinking. In this paper, we only discuss the duopoly case. Extension to multi-players is a subject of future research.

[1] Since in this paper we are only focusing on a Bertrand duopoly, only a 2-player table is shown. A longer version of the paper considers the situation with three and four players. See Siddiqi (2009)

Table 1

Number chosen by you	**Profit if your choice is the lowest**	**Profit if this number is the lowest and chosen by you and the other player**	**Profit if this number is not the lowest**
39	784	489	0
38	783	503	0
37	777	514	0
36	763	522	0
35	743	528	0
34	716	532	0
33	683	533	0
32	642	532	0
31	596	528	0
30	542	522	0
29	482	514	0
28	415	503	0
27	341	489	0
26	261	473	0
25	174	455	0
24	81	434	0
23	-20	411	0
22	-126	385	0
21	-240	357	0
20	-360	326	0
19	-487	293	0
18	-621	257	0
17	-761	219	0
16	-908	179	0
15	-1062	136	0
14	-1222	90	0
13	-1389	42	0
12	-1563	-8	0
11	-1743	-61	0
10	-1930	-116	0
9	-2124	-173	0
8	-2340	-234	0
7	-2532	-296	0
6	-2745	-361	0
5	-2966	-429	0
4	-3193	-499	0
3	-3427	-571	0
2	-3667	-646	0
1	-3914	-723	0

Figure 1



2. Coarse Thinking about Strategies

We propose the following. 1) Agents split the choice space into categories with reference to salient choices. 2) All choices in a given category are chosen with equal probability.
A quick glance at table 1 reveals that there are two choices that stand out. Firstly, there is the choice of 24, which is clearly salient because it is the lowest price that guarantees a non-negative payoff. Secondly, there is 33 which is the price at which the collusive payoffs are maximized (highest payoff in column 2). That is, players eager to collude will pay special attention to this price.[2] Also, prices from 1 to 12 can be ignored since they guarantee a non-positive payoff. We have the following 5 categories: 13 to 23, 24, 25 to 32, 33, 34 to 39. Each player now sees a 5×5 matrix of payoffs rather than looking at a 39×39 (or 27×27) matrix of payoffs. Table 2 shows the payoff matrix.

[2] Price corresponding to the highest payoff in column 1 is not salient since a player targeting a column 1 outcome is looking to choose a price lower than his or her competitor. Obviously, that cannot happen with the highest payoff.

Table 2

Column Player						
		13-23	***24***	***25-32***	***33***	***34-39***
	13-23	-399.6, -399.6	-654.2, 0	-654.2, 0	-654.2, 0	-654.2, 0
	24	0, -654.2	434, 434	81, 0	81, 0	81, 0
Row Player	***25-32***	0, -654.2	0, 81	88.4, 88.4	431.6, 0	431.6, 0
	33	0, -654.2	0, 81	0, 431.6	533, 533	683, 0
	34-39	0, -654.2	0, 81	0, 431.6	0, 683	396.3, 396.3

The payoffs are calculated as follows. In each category, a player chooses a particular price with equal probability. For example, consider the category (13-23), the probability of choosing any price in this category is 1/11. For a given player, there are two possibilities; either both players choose the same price or the given player chooses a lower price. In the first case, the expected payoff to the player is 22.27 and in the second case the expected payoff to the player is (421.86). That gives an overall expected payoff of (399.6).

The Nash equilibria in the game with coarse thinking about strategies are: (24, 24), (25-32, 25-32) & (33, 33). This is a remarkable match with the results reported in Figure 1.

4. Discussion and Conclusions

Firstly, the coarse thinking model makes precise falsifiable predictions. For example, payoff structure can be altered to create additional equilibria or reduce the number of equilibria. The predictions can then be tested in controlled laboratory experiments. Secondly, further experiments are needed to guide theory in extending the coarse thinking approach to a multi-player setting. There are no *apriori* reasons to assume anything about how the presence of more than one competitor affects the formation of categories in the mind of a player. Are the competitors lumped together or are perceived separately? The answer to this question, which is essentially an empirical question, is crucial for further research in this area. However, from the experiment in Abbink & Brandts (2008), it appears that each player is considering the competitors together as one unit. Such lumping together reduces the attractiveness of the collusive outcome. Abbink and Brandts (2008) report weakening of the collusive outcome with three and four players.

There is also a need to extend this approach to other games such as ultimatum barginaing and Nash demand games. Researchers typically only report average outcomes in these experiments. However, the coarse thinking approach is aimed at explaining the entire distribution of observations (particularly, the mode of a distribution). All these issues are subjects of future research.

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