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The effect of priming in a Bertrand competition game: An experimental study☆

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ABSTRACT

In a Bertrand competition experiment, we study the impact of two cognitive primes on strategic behaviour at first encounter and over time. With this aim, instructions are slightly modified to imprint one of the two incentive features present in a standard Bertrand duopoly: the winning rule (competition) and the winner's payoffs (cooperation). Therefore, under a between-subject design, we examine pricing behaviour in three treatments: a Competition Priming treatment, a Payoff Priming treatment and a non-priming Baseline. Taking the Baseline as benchmark, the results show that whereas priming for competition reduces significantly market prices from the beginning, priming for payoffs holds market prices at a significantly high level for a longer period. However, the effect of priming fades over time.

1. Introduction

While standard economic theory assumes that incentives are the sole motivators of human behaviour, people frequently make decisions using heuristic rules based on prior experience and intuition. These rules can be computationally efficient but are prone to psychological manipulations. That is, a particular incentive structure may be interpreted differently in the subjects' minds when it is described with distinct formats. Psychologists (for example, Kahneman and Tversky, 2000) have studied effects of priming in situations without economic incentives, and mainly one-shot, but economists emphasise that learning from experience and incentives mitigate priming effects. An interesting question is how long an unbalanced mental representation can survive the repeated interaction between players in a competitive context. This study is dedicated to explore this question.

With this aim, we design an experiment where participants act as firms competing repeatedly in a market and, at the beginning of the interaction, are primed for a particular competitive/cooperative behaviour.

The incentive structure we implement is the standard Bertrand competition. The reason we choose this model is because it is a kind of price competition where priming can be expected to affect behaviour. In a Bertrand game, players are subject to two opposite behavioural forces, derived from the incentive characteristics of the payoff function, that simultaneously shape their beliefs: on the one hand, the winner is the player whose price is the lowest (competition incentives) and, on the other hand, the winner's payoff depends positively on his/her chosen price (cooperation incentives). These characteristics allow us to compare different experimental conditions under the same incentive structure, that differ in which strategic feature is emphasised in the instructions. That is, we attempt to influence the mental interpretation that subjects construct internally of the characteristics of the payoff function.

In particular, we focus on three priming conditions:[1,2] (i) a pro-competitive priming, where we provide subjects with a hint which

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[1] Priming activates in subjects' minds a mental process which affects behaviour. This concept is closely related to framing, where a situation is described with a particular perspective (positive or negative in valence framing). In both cases, the experimenter modifies the way in which the same situation is presented to subjects (see Levin et al., 1998). Even though our design consists of a priming manipulation, both priming and framing have demonstrated to be relevant in economic decision making.

[2] Anchoring is also a cognitive manipulation where the order in which information is presented influences perceptions (see Furnham and Boo, 2011).

remarks upon the competition rule and, thereby, focuses attention on winning the game; (ii) a pro-cooperative priming, where we insert a hint mentioning the payoff variability of the game and guiding attention towards gaining high profits; and (iii) a neutral priming, where no additional information is provided.

Our hypotheses are as follows: first, we expect to find a significant priming effect at the beginning of the experiment. Taking the neutral priming as an intermediate baseline, initial prices are likely to be higher when subjects are primed towards cooperation than when they are primed for competition. Second, we also expect that those differences diminish steadily over time as subjects face repeatedly the competitive environment.

A branch of the cognitive literature has traditionally studied the effect of perceptual priming on information processing. McNamara and Holbrock (2003) summarises the theoretical and empirical literature. Framing has been also widely studied (see the surveys in Levin et al., 1998 and Kühberger, 1998). Anyhow, psychologists are still developing theories that attempt to explain consistently framing effects (Elliott and Hayward, 1998).

Focusing on the effect of psychological manipulations (both priming and framing) in economic games,[3] three games have received most of the attention: the trust game, the voluntary contribution mechanism (VCM) and the prisoner's dilemma.[4] In the trust game, Burnham et al. (2000) primes the cooperative/competitive concepts using a friend vs. foe imprint. These authors do not find an initial or final priming effect on trust levels, but a transitory one after some repetitions of the game.[5] In repeated public goods games, the standard manipulation frames a VCM as give to/take from a public pool or, in stronger terms, as a public good versus a public bad prevention (Andreoni, 1995; Sonnemans et al., 1998). The results show that while initial behaviour is similar between frames, differences appear with repetition. Lastly, framing has been also explored in prisoner's dilemma games, for example, describing it as a Community Game vs. a Wall Street Game (Kay and Ross, 2003; Liberman et al., 2004). Specifically, Liberman et al. (2004) finds a strong framing effect both in the first round and along the experiment. All in all, when players are primed in social dilemmas, the dynamics of behaviour seems to be important to characterise the salience and persistence of the mental manipulations.

From the viewpoint of firms, the Bertrand model can be considered a generalisation of the prisoner's dilemma. Therefore, our research may contribute to shed light on the role of priming in this kind of games as well. In a Bertrand duopoly, two symmetric firms with constant marginal costs simultaneously set prices in a market for homogeneous goods and with unitary demand. The equilibrium prediction is such that prices will be set at the marginal cost and profits will be zero, due to the firms' incentives to undercut each other. The fact that just two competitors are enough to converge towards the competitive outcome is called the Bertrand Paradox and it is one of the most remarkable points of disagreement between theory and empirical findings. Indeed, deviations from equilibrium are usually observed in experimental Bertrand duopoly games, even after subjects have gained experience doing repetitions (see, for example, Dufwenberg and Gneezy, 2000; Dufwenberg et al., 2007; Bruttel, 2009). It is our interest to investigate whether priming subjects for a particular strategic behaviour (competitive/cooperative) influences price dynamics.[6]

Our results show significant priming effects which lessen with repetition. Taking the non-priming baseline as benchmark, we obtain that priming for competition reduces market prices from the beginning. In contrast, priming for cooperation holds market prices at a high level for a relatively long period. At the end of the experiment, market prices end up being quite similar across priming conditions.

The remainder of this paper is structured as follows: Section 2 describes the experimental design and research hypotheses; Section 3 presents and discusses the results and Section 4 concludes.

2. Experimental design and hypotheses

We have three priming treatments under the same strategic environment. To get a neutral framework in terms of competition and information about the payoff function, we frame a Bertrand duopoly game with unitary demand and zero marginal cost as follows: two players have to choose simultaneously a number between 0 and 100, both included (up to two decimal places). The winner is the person whose number is closest to 2/3 of the average of those two numbers. The winner receives a payoff equal to the chosen number, the loser gains zero. In case of a tie, the payoff is split equally between winners.[7] This setting defines our control treatment (Baseline).[8]

In two additional treatments, we modify slightly the instructions given to the subjects by introducing a hint about some strategic features of the game. In the Competition Priming treatment we remind them about the competition rule: "Notice that the winner will always be the person who chooses the lowest number". Likewise, a cue about the payoff variability is inserted in the Payoff Priming treatment: "Notice that the winner will gain more points with higher choices".[9]

The cue we use in the Competition Priming treatment is quite similar to that introduced by Chou et al. (2009) in one of their treatments (Hint) of a one-shot two-person BCG. These authors vary the instructions to study the (in)ability of subjects to apprehend the strategic features of the game. While our price competition game and a standard two-person BCG share the frame used to describe the rules and the theoretical prediction, the incentive structure is completely different between both cases. Whereas the winner's prize is fixed in a BCG, in our Bertrand game the winner's payoff equals his/her choice

[3] Regarding individual decision making, the most widely studied aspect has been the effect of framing on decisions under risk. Since the classical study of the Asian disease problem (Tversky and Kahneman, 1981), psychologists (and economists) have argued about risk assessment (see the meta-analysis in Kühberger (1998) and the survey in DellaVigna (2009)). Another individual decision problem, the dictator game, has been used to investigate the impact of framing on the typical pro-social result (Brañas Garza, 2007; Hoffman et al., 1996).

[4] It is not coincidental that all of them represent social dilemmas. The duality between the individualistic incentives and the cooperation outcome is particularly prone to manipulations in this kind of games.

[5] Abbink and Hennig-Schmidt (2006) also finds that, using a bribery context, framing does not exert any significant effect on behaviour in trust games.

[6] Note that our aim here is not to test the standard theory of price competition. Instead, we study how some psychological manipulations can influence the Bertrand dynamics over time. To the best of our knowledge, no Bertrand price competition experiments with priming/framing have been done. In related environments, Cox and James (2012) finds effects of varying institutional format (clock/tree) and dynamic structure (simultaneous/sequential) of centipede games and Dutch auctions (these latter considered as isomorphic to first-price sealed-bid auctions). In other pricing environments, (Fehr and Tyran, 2001, 2007, 2008) address different research questions concerning nominal framing, more notably the ability of subjects to distinguish between nominal and real payoffs in a price competition with strategic complementarity (similar to a differentiated Bertrand game). Researchers have also found framing effects on trading behaviour in double auction markets (Kirchler et al., 2005; Weber et al., 2000) and in taxing decisions (Sausgruber and Tyran, 2011).

[7] Our winning rule is expressed as that used in a two-person beauty contest game (hereafter BCG), given that the number closest to 2/3 of any two numbers is always the minimum one (see, for example, (Grosskopf and Nagel, 2008)). Priming has been also studied in guessing games. Weber (2003) finds no impact of priming in a BCG without feedback.

[8] In this regard, we are following the advise of Zizzo (2010) that emphasises the importance of using a context-free language to avoid drawing attention towards one direction or another.

[9] Before undertaking this experiment, we checked the manipulation effect due to the use of a BCG frame instead of a Bertrand frame in our instructions. We run some independent sessions with a standard Bertrand frame (where we referred to firms, prices and a winning rule in terms of "the lowest price wins"), which is comparable to our Competition Priming treatment. We did not find significant differences in choices over time between the Bertrand frame and our Competition Priming frame.