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Endogenous price expectations as reference points in auctions☆,☆☆

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ABSTRACT

The paper models auctions with bidders who have reference dependent preferences and who may be loss averse. The endogenous reference point is defined as either the ex-ante or the interim expected price of the good, depending on whether bidders are naive or sophisticated. Equilibria with *consistent* reference points are shown to exist and are fully characterised. The model predicts that in equilibrium bidders both overbid and underbid in comparison to the standard risk neutral Nash equilibrium strategies.

1. Introduction

In the standard model of individual behaviour, utility is a function of only the final consumption bundle. Tversky and Kahneman (1974) and Kahneman and Tversky (1979) propose an alternate specification of individual utility where total utility is a function of both the final consumption bundle and its relation to some reference point or anchor. This behavioural model has received much attention in both economics and psychology under different names: reference dependence and anchor adjustment, respectively. In this paper, we apply the model of reference dependence to first and second price auctions, and study the effects of an endogenous reference point on bidder behaviour. We use the auction setting and rational expectations to endogenise the reference point, which is defined as the expected price of the good in equilibrium.

As a motivating example, consider Anne who wishes to purchase a new television. Under the standard model of preferences, Anne would gain some utility from buying (or consuming) the television. Upon purchasing the television, Anne's overall

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utility would then be the positive utility gained from the purchase of the television, less what it cost to buy it. A transaction would then take place if the price of the television is less than its value to Anne.

While intuitive, the above story is incomplete. It can be argued that Anne additionally has expectations over the price of the television. This price may act as a reference point, and Anne would experience additional utility if she pays less than she expected, as she experiences the joy of "saving money." Similarly, "over paying," i.e. paying more than the reference point would result in disutility in addition to her standard utility. This additional gain–loss element in Anne's utility, would lead to different predictions from the standard model. Indeed, Anne may refuse to buy the television, even when the price is less than her value, if the price is higher than what she expected to pay.

The choice of reference point is not trivial, as the predictions of the model rely on the particular reference point chosen.[1] It is therefore important to identify an appropriate reference point. In this paper, we argue that the game theoretic structure of an auction allows us to calculate the expected price of the good for sale. Therefore, if Anne were to instead buy the television at an auction, she could form rational expectations over the expected price, which in turn would act as her reference point in the auction.

Such an endogenous reference point would then be determined by the behaviour of bidders in the auction and would need to be *consistent* with equilibrium play. We show that such a consistent reference point exists in first and second price auctions, and characterise equilibrium behaviour when bidders have reference dependent preferences and endogenous reference points.

We model first and second price auctions in the independent private values setting, where bidder values are drawn independently from a continuous distribution. Unlike the standard risk neutral model, bidders are assumed to have reference dependent preferences. Reference dependent preferences capture two important inter-related features of human behaviour: gain–loss utility with respect to a reference point, and loss aversion. Gain–loss utility is captured by our example above, where Anne gains additional utility (or disutility) from paying less (more) than her reference point. Loss aversion in addition, implies that losses relative to the reference point yield higher disutility compared to the utility derived from gains of equal magnitude. We model reference dependent preferences both with and without loss aversion.

The reference point is endogenised as the expected price of the good in equilibrium. Endogenising the reference point removes a major degree of freedom from the model of reference dependent preferences. Defining the reference point as the expected price of the good is consistent with the motivation of past literature. Such a definition is motivated by bidders experiencing gains in utility when they pay less than what they expected (saving money) and disutility when they pay more than the reference point (over paying).

Bidder expectations can be incorporated into the model in two ways and we define two types of reference points. Naive reference points are modelled as the ex-ante expected price of the good. Naive bidders do not incorporate the effect of their own bid on the expected price of the good and therefore set their reference points equal to the ex-ante expected price. In contrast, the interim or sophisticated reference point, incorporates the effect of a player's own private information on her reference point. Sophisticated bidders understand the effects their own bids have on the expected price of the good and so take expectations once they observe their private information.

In Section 3, we consider the case of naive bidders who have reference dependent preferences but are not loss averse. For naive bidders with endogenous reference points, we define a *naive consistent equilibrium*. We characterise the unique symmetric consistent equilibrium, where bidders bid according to increasing bid functions and the reference point is consistent with equilibrium strategies. As the reference point affects bidder behaviour, it determines the expected price in equilibrium. A reference point is said to be consistent when given the reference point, bidder behaviour yields an expected price equal to the reference point.

We find that the introduction of reference dependence alters bidder behaviour in both first and second price auctions. In equilibrium, depending on their values, bidders either overbid or underbid relative to the predictions of the standard model.[2] There exists in both first and second price auctions a cut-off value, where bidders whose values lie below the cut-off overbid, while those above it underbid. The cut-off value is a function of the endogenous reference point and this allows us to predict whether, in expectation, more bidders overbid or underbid in equilibrium. In particular when values are distributed uniformly, we find that in expectation more bidders overbid than underbid in first price auctions and in second price auctions with three or more bidders. We also find that this cut-off is increasing in the number of bidders, so as the auction gets larger more people are predicted to overbid. Given how the size of an auction can be seen as a sign of the objects popularity and desirability, the prediction is intuitive, but it does not conform with laboratory data.[3]

In Section 4 we analyse the case of sophisticated bidders. Sophisticated bidders incorporate the effect of their own bid on the expected price of the auction and so the reference point is defined as the interim expected price of the good. Unlike the naive case, where the ex-ante formulation implied that the reference point was a real number, for sophisticated bidders the reference point is a function of their value. We modify the definition of a consistent equilibrium to account for this change and

[1] If for example Anne's reference point is set to infinity, we get the outrageous prediction that Anne would buy a TV at any price, regardless of her value.

[2] The terms overbid and underbid, are common in the literature, especially in the case of second price auctions where standard theory predicts that rational bidders should bid their value, which is a weakly dominant strategy. In first price auctions we set our base as the symmetric Nash equilibrium strategy.

[3] For example Kagel and Levin (1993) find that fewer bidders overbid when the size of the auction changes from five to ten bidders.