



Sequential auctions, price trends, and risk preferences

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Received 6 November 2014; final version received 7 May 2015; accepted 15 May 2015

Available online 18 May 2015

Abstract

We analyze sequential auctions in a general environment where bidders are heterogeneous in risk exposures and exhibit non-quasilinear utilities. We derive a pure strategy symmetric equilibrium for the sequential Dutch and Vickrey auctions respectively, with an arbitrary number of identical objects for sale. When bidders are risk averse (preferring), the equilibrium price sequences must be downward (upward) drifting. The “declining price anomaly” is thus evidence of bidder risk aversion in this general environment. These results derive from a key assumption that bidders’ marginal utilities are *log-supermodular* in payment and type.

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JEL classification: D44; D82

Keywords: Sequential auction; Background risk; Risk preference; Declining price; Log-supermodularity; Ex-post efficiency

1. Introduction

Sequential auctions frequently take place to sell multiple units of similar objects. Examples range from fine wine, cut flowers, live cattle, licenses, mineral rights to blocks of shares of IPO firms or the like. Bidders at these auctions are typically businesspersons to whom both winning and losing can have risky consequences. For example, it can be a firm bidding for an asset to

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diversify its ongoing risk, or a wholesaler for roses to supply foreign demand and so on. In these situations, a bidder's willingness-to-pay can be directly related to the severity of the undesirable consequences should he lose, as well as the added values should he win. We construe these situations as bidders having exposures to *background risk*.¹

In this paper, we investigate how background risks and bidders' risk preferences would affect competitive bidding strategies, price patterns, and ex-post efficiency in sequential auctions. We focus on a sequence of Dutch or Vickrey auctions² selling m identical objects to n ($> m$) competing bidders, each having a unit demand and i.i.d. private type t . It is well known from McAfee and Vincent (1993) that a pure strategy equilibrium may fail to exist when bidders' preferences can be represented by a concave utility function $U(t - p)$ such that t is the bidder's type, and p is the price he pays upon winning. Using a two-round example where bidders exhibit decreasing absolute risk aversion (DARA), McAfee and Vincent show that only a mixed strategy equilibrium exists, which is inefficient ex post with positive probability. It is also known from Mezzetti (2011) that an equilibrium exists when bidders' preferences can be represented by an additive function of *value minus cost of payment*, where the cost function is convex. Therefore in Mezzetti's model bidders are averse solely to price risk. For the more general cases, many issues remain open because of the lack of clear characterizations of equilibria.

An important insight from the present study is that the existence of a pure strategy equilibrium hinges on the key assumption that bidders' marginal utilities of income are *log-supermodular* in payment and type.³ This condition is fairly general, and it provides an effective tool for simplifying, clarifying, and generalizing the analysis of sequential auctions. We derive a unique pure strategy symmetric equilibrium under this condition for the sequential Dutch and Vickrey auctions respectively, in a general environment nesting McAfee and Vincent (1993) and Mezzetti (2011) for his private values case as special instances (Propositions 1 and 2).

Much of the literature on sequential auctions has been motivated by the so-called "declining price anomaly," popularized by Ashenfelter's (1989) study of the "afternoon effect" at fine wine auctions.⁴ The anomaly refers to the empirical observations of downward-drifting price patterns for similar objects sold in sequential auctions. It contradicts the standard theoretical predictions in the risk neutral paradigm that the expected prices should be the same when bidders have private values or increasing when bidders have affiliated values (e.g., Weber, 1983; Milgrom and Weber, 2000). Indeed, risk aversion offers an intuitive explanation for the declining prices because risk averse bidders are willing to pay a premium to win earlier, given that winning later involves more uncertainty. However, this logic has been either just argued informally (e.g., Ashenfelter, 1989; Milgrom and Weber, 2000) or shown under somewhat special assumptions on bidders' risk preferences (e.g., McAfee and Vincent, 1993; Mezzetti, 2011).⁵

¹ Some studies allow bidders to have exposures to *ex-post risk*, or *ensuing risk*, upon winning where the true value of the object remains uncertain after the auction. See, e.g., Maskin and Riley (1984), Eso and White (2004), Hu et al. (2014), and Hu et al. (2015). Our notion of background risk incorporates ensuing risk and, in general, allows losing bidders to face undesirable risky consequences as well.

² In the present context, the Dutch auction is strategically equivalent to the first-price sealed-bid auction in which the winning price of each round is announced, and the Vickrey auction to the second-price sealed-bid auction without price announcements. We use the "Dutch" and "Vickrey" terms for simplicity.

³ See, e.g., Athey (2001, 2002) and the references therein.

⁴ See, e.g., Ashenfelter and Genesove (1992), McAfee and Vincent (1993, 1997), Mezzetti (2011) and the references therein.

⁵ Mezzetti (2011) obtained the declining price result for the case of private values. He also considered affiliated values and a non-standard formulation of English auctions, with mixed results on price trends. See also Mezzetti et al. (2008).

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