*Chapter 3*

# EXOGENOUS UNCERTAINTY INCREASES THE BID–ASK SPREAD IN THE CONTINUOUS DOUBLE AUCTION

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Traditional theories of the bid–ask spread are of two kinds: (1) the bid–ask spread is a transactions cost of the dealer or a specialist for providing the services of immediacy (see Demsetz, 1968), and (2) the bid–ask spread is due to the existence of traders with superior information to that of the specialist (see Copeland and Galai, 1983; Glosten and Milgrom, 1985). One should be aware that these models provide sufficient – not necessary – conditions for the existence of a positive bid–ask spread. That these conditions are not necessary is shown by the hundreds of experimental double auction markets and our experiments reported here, in which a positive bid–ask spread persists; yet these are principals markets, without intermediate dealers or specialists, and transactions costs are minuscule. In many of these experiments, all individuals have identical (although uncertain) information on the value of the securities traded (see Smith, Suchanek, and Williams, 1988), so asymmetric information is not necessary for observing a bid–ask spread. A third theory is based on establishing that "... the probability of a limit order executing does not rise to unity as the price at which the order is placed gets infinitesimally close to a counterpart (bid or ask) market quote" (see Cohen et al., 1981, p. 300). In terms of this theory, the success reported below in inducing a wider bid–ask spread by increasing uncertainty in the environment may be attributed to the fact that we shifted the probability distribution of executing a limit order.

## 1. Experimental Design

Our experimental design uses the supply and demand schedules shown in Figure 1. These schedules are known to the experimenter but are not known by any subject. Price is measured in deviations from the center of the set of competitive equilibrium prices. There are five buyers and five sellers. Three of the buyers ($B_1$, $B_3$, $B_5$) each have a capacity to buy up to 6 units, while two of the buyers ($B_2$, $B_4$) have a capacity to buy up to 3 units in any single trading period. Symmetrically, three sellers ($S_1$, $S_3$, $S_5$) can sell up to 6 units and two ($S_2$, $S_4$) can sell up to 3 units. Any particular buyer or seller subject was assigned randomly to one of the step positions (1, 2, 3, 4, 5) at the beginning of each of the three weeks (5 day trading periods) in an experiment.

In experiments 4 and 5 (Table 1) subjects were not only assigned randomly by 5-day weeks to the steps shown in Figure 1, but in addition a random constant (positive or negative) was added each period to all buyer values and all seller costs. Consequently,

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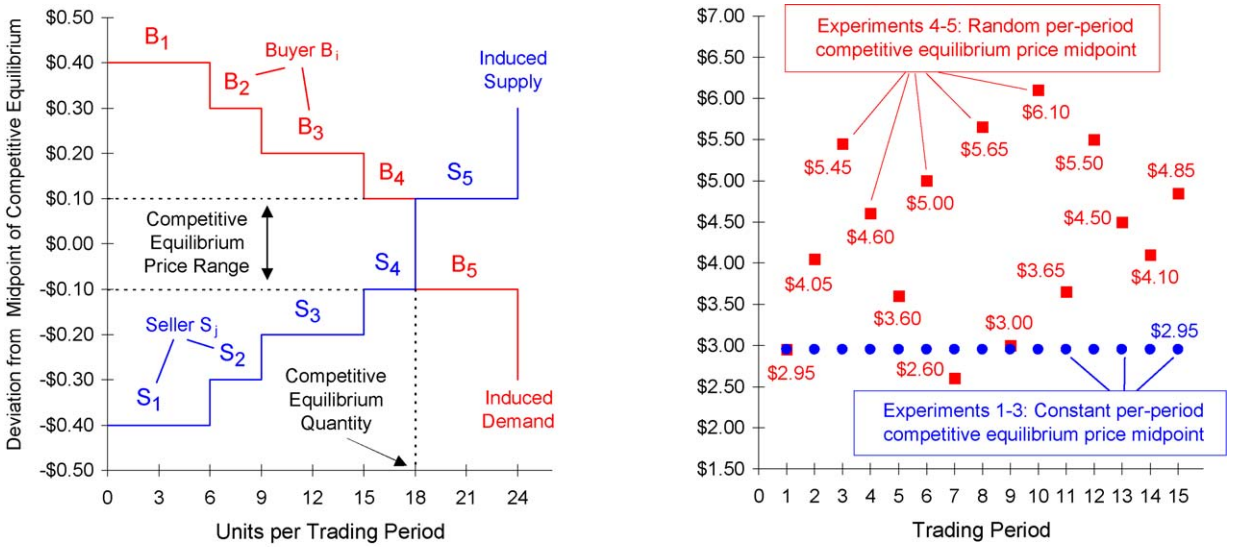



The competitive equilibrium (CE) price range is ± $0.10 from the CE midpoint, and the CE quantity is 18 units (left panel). In experiments 1-3, the midpoint of the CE price range is constant at $2.95 each period, while in experiments 4 and 5 the CE midpoint is randomly shifted each period (right panel).

Source: Campbell et al. (1991); see Tables 1 and 2, Baseline 2 experiments 2-4 (constant) and 7-8 (random).

Figure 1. Experimental per period induced supply and demand schedules.

Table 1
Experimental design

| Experiment number | Market size | Competitive equilibrium price per period | Value/cost assignment per period | Number of periods |
|---|---|---|---|---|
| 1, 2, 3 | 5 buyers<br>5 sellers | Constant | Random | 15 |
| 4, 5 | 5 buyers<br>5 sellers | Random | Random | 15 |

in these experiments, the competitive equilibrium price was shifted randomly each period. This provided greatly increased price and transaction uncertainty relative to those experiments (1–3) in which only the step assignments were randomized.

## 2. Exogenous Uncertainty and the Bid/Ask Spread

In experiments 1–3 the competitive equilibrium price and quantity were constant over all periods, while in experiments 4 and 5 the competitive equilibrium price level shifted at random each period. Our a priori prediction was that the second condition would yield a greater bid–ask spread than the first. We define the spread as the difference between the "standing (lowest) bid" and the "standing (highest) ask" at the time of a contract. Here, we evaluate our prediction by comparing the per-period mean and median spreads of experiments 1–3 with those of experiments 4 and 5, and by comparing the distribution of spreads in 1–3 with those in 4 and 5.

A measurement problem associated with our prediction is that contracts may and often do occur without a defined bid–ask spread or before that spread has a chance to narrow. Thus, a bid may be entered and accepted before an ask price is established. We measure the spread two ways. First, we exclude any observations where there is either no bid or no ask at the time of contract, and compute the mean spread using the remaining observations (this is the measure of central tendency reported in Campbell et al., 1991). Second, we define the spread as follows. Where a bid is accepted to form a contract but no ask is entered, we define the standing offer as \$9.99; if there is an offer price being accepted, but no bid, we define the standing bid as \$0.01. In this way we are able to utilize all the information content in our data; it requires only the weak assumption that any seller would be willing to sell for \$9.99 (the maximum allowable) and any buyer would be willing to buy for \$0.01 (the minimum allowable). Defining the spread in this way leads to some large erratic observations under all treatment conditions. In order not to weight such observations unduly, we use the median as the measure of central tendency.

Figure 2 shows the mean and median spreads per period across the constant (experiments 1–3) and randomly shifting (experiments 4 and 5) per period supply and demand

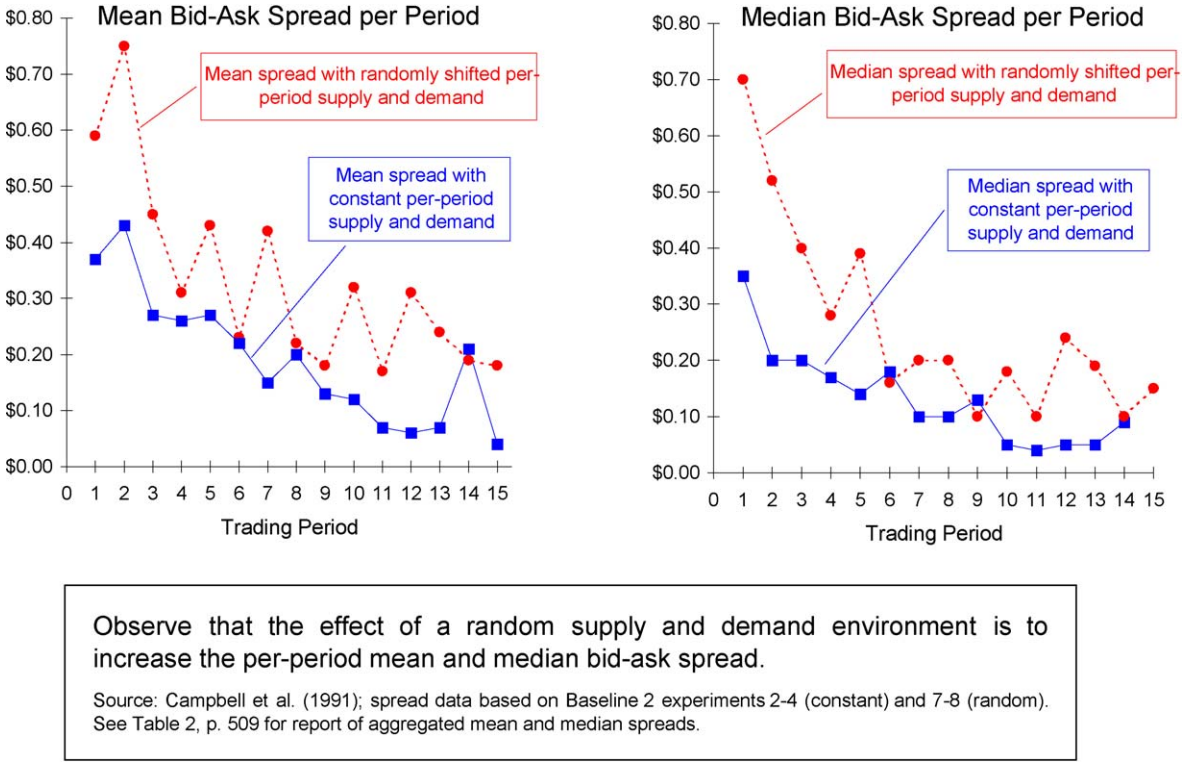
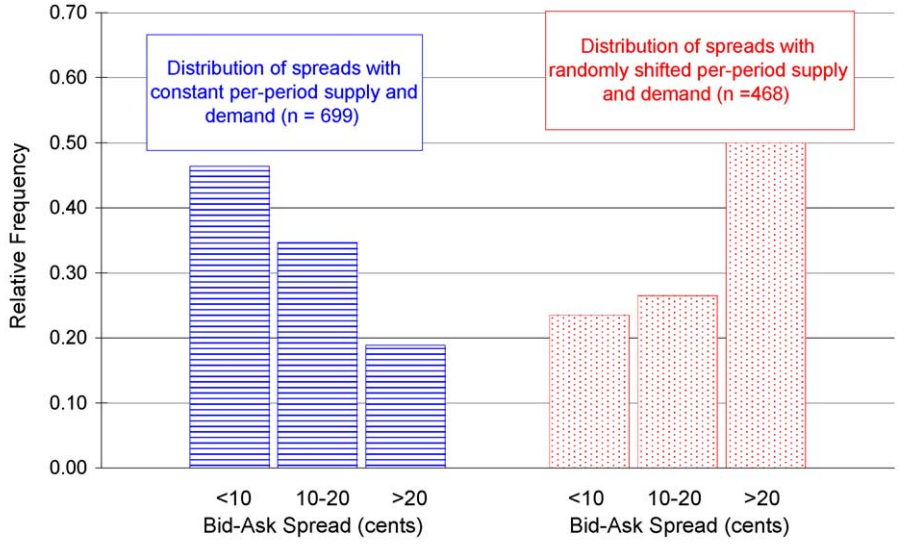



Figure 2. Mean and median bid–ask spreads for constant and randomly shifted per-period supply and demand.




Observe that the effect of a random supply and demand environment is to decrease the frequency of small spreads (< 10 cents), and increase the frequency of large spreads (> 20 cents).

Source: Campbell et al. (1991). Spread data based on experiments 2-4 (constant) and 7-8 (random) See Table 2, p. 509 for report of aggregated mean and median spreads.

Figure 3. Distribution of bid–ask spreads for constant and randomly shifted per period supply and demand.

conditions. The upper panel shows that in 14 of the 15 trading periods, the mean spread with randomly shifting supply and demand is greater than the mean spread with constant supply and demand. The lower panel shows that in 13 of the 15 trading periods, the median spread with randomly shifting supply and demand is greater than when the supply and demand are constant. These data suggest that the effect of increased uncertainty in the supply and demand environment is to increase the per-period mean and median bid–ask spread.

Figure 3 shows our observed distributions of bid–ask spreads for the two treatment conditions. The data are shown for spreads less than 10 cents, spreads in the 10–20 cent range, and spreads greater than 20 cents. There is clearly a difference in the two empirical distributions: smaller spreads are much more likely in the constant supply and demand treatment. Closer comparison reveals that under constant per period supply and demand, about 45% of the spreads are less than 10 cents, whereas under the randomly shifting supply and demand, the amount is less than 25%. Furthermore, with constant supply and demand, less than 20% of the spreads are greater than 20 cents, while half (50%) of all spreads in the random environment fall in this interval. The data indicate that relative to a constant supply and demand, the effect of a random supply and demand environment is to decrease the frequency of small spreads and increase the frequency of large spreads.

## 3. Conclusion

These experiments demonstrate that exogenous uncertainty can increase the bid–ask spread in the continuous double auction. We observed greater mean and median spreads, and a greater probability of a large spread in double auctions with randomly shifting per-period supply and demand than in double auctions with constant supply and demand. These results, and many others, demonstrate that even in the absence of transaction cost or information asymmetry, positive bid–ask spreads are observed and wider spreads are observed when there is greater uncertainty in the environment.

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