Chapter 5

EFFECT OF NON-BINDING PRICE CONTROLS IN DOUBLE AUCTION TRADING

VERNON L. SMITH and ARLINGTON W. WILLIAMS

1. Introduction

There are two primary reasons for examining the effect of non-binding price controls (floors or ceilings) on experimental double auctions (DA) trading.

1. The DA institution yields convergence to a competitive equilibrium at least as rapidly, and in most cases distinctly more rapidly, with fewer participating agents, than any other institution to which it has been compared. (See Smith, 1982; for an exception; see McCabe, Rassenti and Smith, 1993 for a version of the real time uniform price DA with open display). As a vehicle to better understand this important characteristic, it is desirable to explore conditions that might interfere with, or otherwise modify, this convergence process. The pathbreaking work of Isaac and Plott (1981) set the stage for expecting that non-binding price controls, contrary to static competitive equilibrium theory, would extensively modify the convergence properties of DA trading. (See Smith and Williams, 1981 for a more detailed treatment of the results reported here.)

2. Commodity trading often occurs at prices just below ceilings and just above floors set by the exchanges who ". . . often set limits on price fluctuations during any single day . . . (and when such limits are achieved) . . . no further trading for the day is permitted" (Labys, 1976, p. 162). Consequently, ceilings and floors routinely have application to DA exchange.

2. Experimental Design

The research task is to isolate the treatment effect of non-binding price controls on competitive market outcomes including market dynamics. The design used for this exercise has the following key features.

1. All experiments use an electronic (computerized) DA mechanism characterized by a bid/ask continuous market in which bids (asks) were required to improve; i.e., once a standing bid (ask) was entered any new bid (ask) must be higher (lower) to become standing. When the standing bid (ask) is accepted, the resulting contract ends the auction, and the computer awaits a new bid (ask), and so on. There is also an electronic "specialist's" book. Any new bid (ask) that is lower (higher) than the standing bid (ask) cannot replace it, but is entered into an electronic queue, lexicographically ordered with higher bids (lower asks) having priority, and tied bids (asks) ordered chronologically – the first in having priority over a second at the same price.

Table 1

Incentives for subjects units. Listed are the typical unit values (costs) in dollars for each subject buyer (seller), with the competitive equilibrium (CE) surplus for each subject shown in the last column. In addition to the surplus realized in a trading period, a commission of $0.10 is paid for each trade as a means of providing a minimal incentive for a unit to trade at its value (cost). The market CE price in this example is $ 4.65 with 15 units trading since all buyer (seller) units are predicted to trade whose value (cost) is equal to or above (below) the CE price

Subject	1	2	3	4	5	6	Individual competitive equilibrium surplus
Buyer 1	5.35	5.10	4.70	4.60	4.50	–	1.20
Buyer 2	5.60	4.90	4.80	4.65	4.55	–	1.35
Buyer 3	5.60	4.90	4.80	4.65	4.60	4.50	1.35
Buyer 4	5.35	5.10	4.70	4.65	4.55	–	1.20
Seller 1	3.95	4.20	4.60	4.65	4.75	–	1.20
Seller 2	3.70	4.40	4.50	4.65	4.75	–	1.35
Seller 3	3.95	4.20	4.60	4.70	4.80	–	1.20
Seller 4	3.70	4.40	4.50	4.65	4.70	4.80	1.35
Total market surplus							10.20

2. All subjects in these experiments had participated in at least one previous DA market experiment without price controls in which the induced supply and demand were characterized by parameters distinct from those reported below.

3. The induced values and costs for a typical experiment are shown in Table 1 for each of four buyers and four sellers. Also listed is the competitive equilibrium (CE) surplus that would be earned by each subject, where the CE price is $4.65 and exchange volume is 15 units. To provide incentives for units to trade at their value (cost) a 10 cent commission is paid to the buyer (seller) on each trade. This provides a minimum, or normal, profit to be made on the marginal values and costs at the CE price.

4. Each experiment consisted of three five-day "weeks" of trading. Week 1 provided the baseline set of observations without a price control. If any particular subject sample is characterized by strong bargaining buyers (sellers) this is measured in the baseline by the difference between the surplus earned by buyers and that earned by the sellers. Since the design is symmetrical in the sense that at the CE differential surplus is zero, this measure reflects only the relative bargaining strength of buyers (sellers if negative) in a particular experiment.

5. Following the first five periods (week 1) of trading, a prespecified constant is added algebraically to all values and costs to yield a uniform shift up or down. (A trading period, or "day," is 6.5 minutes). Also, the assignment of unit values (costs) to individual buyers (sellers) in Table 1 is rerandomized. Trading is resumed in week 2, periods 6 to 10 (or 9 in some cases). In eight experiments a price ceiling is imposed, in four experiments a price floor is imposed, and in four others no price control is used. This allows any effect of the shift in supply and demand to be separated from the effect of the ceiling or floor.

Table 2
Experiments and conditions price control variable. Listed are the number of markets conducted under each experimental condition. The unit values (costs) are shifted up (down) or down (up) in week 2 (3). In the baseline control experiments there are no price controls in any week. In week 2 either a price ceiling or floor is imposed at 5 cents above or below the CE price; in week 3 the price controls are reversed, yielding a symmetric treatment design

Supply and demand shift in week 2 (3)	No price control in week 2 or week 3	Week 2 price ceiling 5 cents above CE week 3 price floor 5 cents below CE	Week 2 price floor 5 cents below CE week 3 price ceiling 5 cents above CE
Up (up)	1	2	1
Up (down)	1	2	1
Down (up)	1	2	1
Down (down)	1	2	1

6. After five periods of trading in week 2, the values (costs) are again shifted and rerandomized among the subjects. Trading resumes in week 3, period 11–15, with a price floor in eight experiments, a ceiling in four, and with no price control in four experiments. The number of experiments concluded under each week 2 (or week 3) shift condition with or without a ceiling or floor is shown in Table 2.

The price hypotheses were that, after correcting for shifts in supply and demand and group specific differential bargaining ability, a price ceiling 5 cents above the CE benefits buyers at the expense of sellers,

3. Experimental Results

Define: $B(\tau) - S(\tau) \equiv D(\tau) \equiv$ differential DA bargaining strength of buyers over sellers, period τ of week 2 ($\tau = t = 6, 7, \ldots, 10$) or week 3 ($\tau = t' = 11, 12, \ldots, 15$), $B(\tau)$, buyer realized surplus in period τ, $S(\tau)$, seller realized surplus in period τ, $X_i^c = 1$, if ceiling price is imposed in week i; 0 otherwise, $X_i^f = 1$, if floor price is imposed in week i; 0 otherwise, $Y_i = 1$, if supply and demand shift down in week i; 0 otherwise.

We estimate the following OLS regression equations:

$$D(t) = 0.236D(t-5) + 0.464X_2^c - 2.02X_2^f + 1.09Y_2,$$
$$\qquad\quad (3.41) \qquad\quad (2.08) \quad (-6.03) \quad (4.81)$$
$$R^2 = 0.55, \; N = 70, \; t = 6, 7, \ldots, 10, \tag{1}$$

$$D(t') = 0.111D(t'-10) + 2.32X_3^c - 1.19X_3^f + 0.260Y_3,$$
$$\qquad\quad (1.94) \qquad\qquad (8.47) \quad (-6.54) \quad (1.38)$$
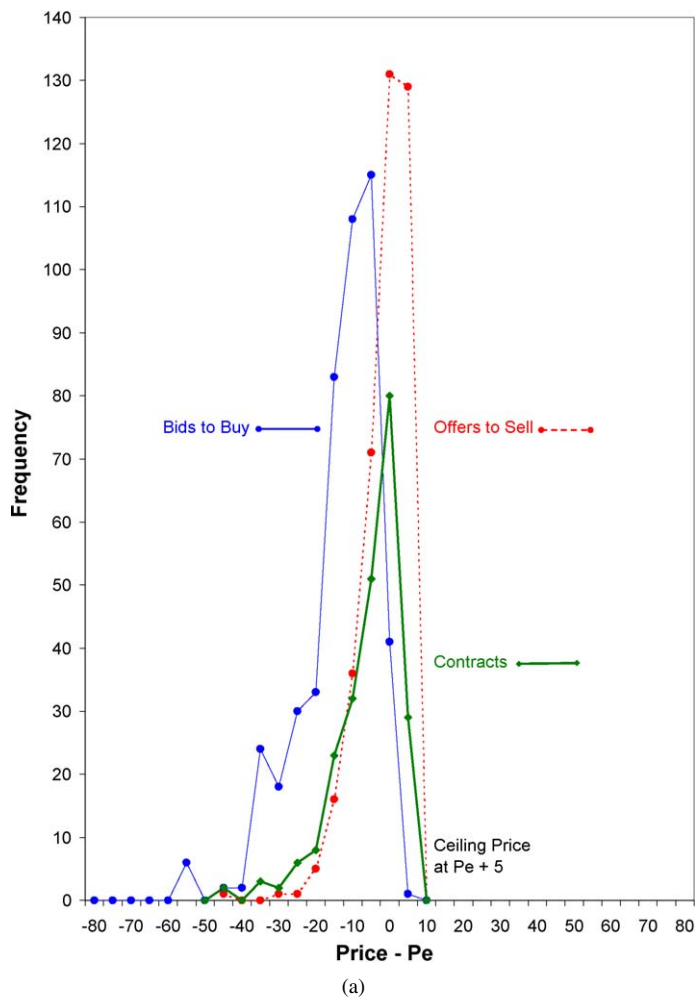$$R^2 = 0.74, \; N = 67, \; t' = 11, 12, \ldots, 15. \tag{2}$$

(a)

Figure 1. The pooled data from trading rounds 6 and 7 for all relevant experiments illustrate that a non-binding price ceiling (Pe) 5 cents above the competitive equilibrium truncates the distribution of buyer's bids (blue), seller's offers (red), and thus contract prices (green). The effect on the offer distribution is quite pronounced, since sellers are required to begin their bargaining with offers that are at or below the ceiling price, and much below the levels at which they would begin their contract negotiations in the absence of the ceiling. (This is seen by comparing with panel (b)). The effect on the bid distribution is less pronounced since a ceiling does not interfere with buyer inclinations to start their contract negotiations at low levels. Comparing the bid distribution in panel (a) with that in panel (b) it is seen, however, that the effect of the price ceiling is to shift the bid distribution somewhat lower than in an unconstrained market. This is because buyers, seeing lower offers from sellers (under the price ceiling), find it in their self interest to begin negotiations at a lower level when there is a ceiling. Hence, the main result is evident in panels (a) and (b): non-binding ceilings in DA trading distort prices, and retard convergence to the CE, because the ceiling truncates seller offers and lowers the distribution of both offers and bids, but most particularly the offers.
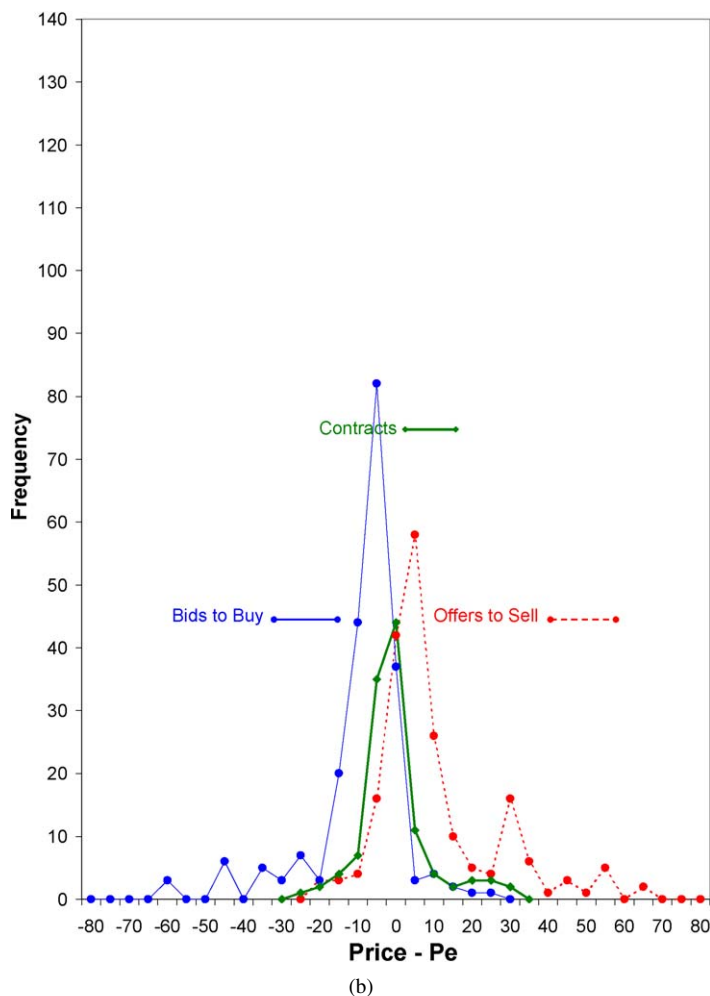
(b)

Figure 1. With no price ceiling, in trading rounds 6 and 7 the bid (blue), offer (red), and contract (green) distributions are not truncated by the non-binding ceiling price, as in panel (a). The chart illustrates an important property of unconstrained DA trading: the distribution of the contract prices is largely contained within the intersection of the distribution of bids and offers. This means that most of the bids accepted by sellers to form contracts are below the level at which 'sellers' make offers. That is, sellers can contract by accepting any bid entered by a buyer, but generally sellers wait to accept bids that are near or above their offers. The opposite is true for buyers. When there is a price ceiling (panel (a)) this property is somewhat compromised by the effect of the ceiling in truncating the bid and offer distributions.

Equations (1) and (2) support the following conclusions:

1. Price ceilings marginally transfer 46 cents per period in surplus from sellers to buyers in week 2 and $2.32 during week 3, while floors transfer $3.03 per period from
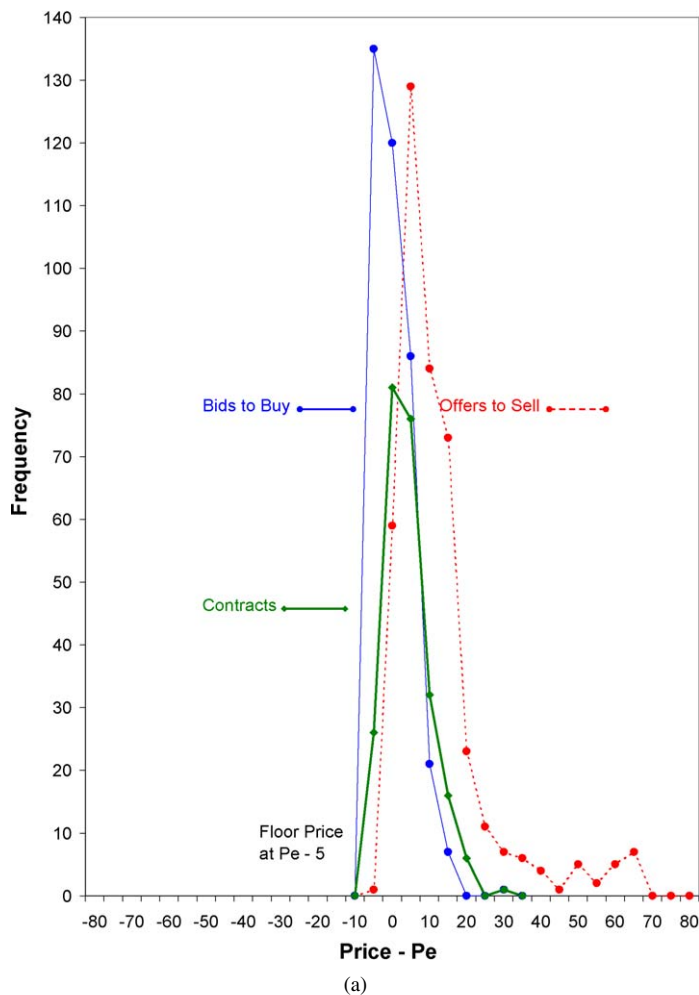
Figure 2. Data from trading rounds 11 and 12 illustrate that a price floor 5 cents below the competitive equilibrium truncates the distribution of buyer's bids (blue), seller's offers (red), and thus contract prices (green). Just as the ceiling in Figure 1a, truncates the distribution of bids, and especially the offers from above, here the effect of the floor is to truncate the offers, but especially the bids, from below. Thus, a floor interferes more with the bargaining strategies of buyers than those of sellers. But sellers definitely shift their offer price upward relative to the offers tendered when there is no floor, as in panel (b).

buyers to sellers in week 2 and \$1.19 during week 3. These results are significant ($P < 0.025$, one-tailed test).

2. The positive differential bargaining strength of buyers over sellers tends to persist in successive trading periods, and weeks, but with declining strength. The persistent ten-
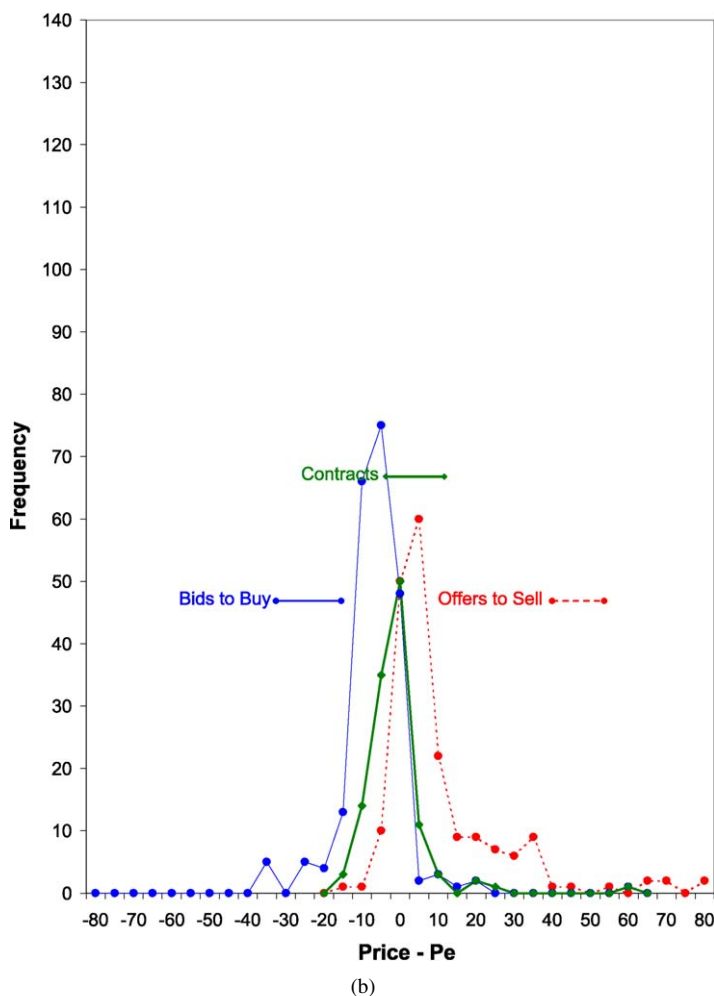
Figure 2. As in Figure 1b, when there is no constraint on free multilateral negotiation in DA markets – in this case no floor – the distributions are not truncated and are more symmetrical. The contract distribution tends to be contained within the intersection of the bid and offer distributions.

dency of buyers to be slightly stronger bargainers in DA trading has been documented in other independent experimental designs. (See Smith and Williams, 1982.)

3. A uniform shift, up or down, in demand and supply (and rerandomization among individuals) produces an overreaction (overshooting of the CE price), but with diminished effect in week 3 relative to week 2.

4. Why Do Non-binding Price Controls Interfere with the DA Market Process?

There is a simple reason why a non-binding price ceiling (floor) retards convergence to the static CE price, biasing prices below (above) the equilibrium.

A price ceiling strongly truncates the asking price distribution of sellers in the bid/ask negotiation process. Thus, in an unconstrained market, sellers start their negotiation at high prices, buyers start low. The ceiling limits seller initial asking prices much more than buyer bid prices. The bid distribution, however, is shifted down somewhat, as buyers bid lower in response to lower seller asking prices. A price floor has the opposite effect, limiting the buyer's negotiation stance more than that of the sellers. This is made plain by the pooled distribution of bids and offers in Figures 1a and 1b comparing all the price ceiling experiments, periods 6 and 7, with the experiments with no price ceilings. The same comparison for price floors is shown in Figures 2a and 2b.

5. Conclusions

Static price theory predicts that non-binding price ceilings and floors will have no effect on price determination in double auction markets. In fact they have substantial effects on price dynamics. Ceilings limit the negotiation strategies of sellers, while floors limit the strategies of buyers. The buyer side of the market responds with lower bids (in the ceiling case), and the sellers with higher offers (in the floor case) than would otherwise prevail, slowing convergence. Sellers have to learn to begin negotiation at the ceiling and concede only slightly, and similarly, buyers must learn to start at the floor and resist price concessions.

References

Isaac, Mark R., Plott, Charles (1981). "Price controls and the behavior of auction markets: An experimental examination". American Economic Review 71 (3), 448–459.

Labys, W.C. (1976). "Bidding and auctioning on international commodity markets". In: Amihud, Y. (Ed.), Bidding and Auctioning for Procurement and Allocation. New York University, New York, pp. 43–64.

McCabe, Kevin A., Rassenti, Stephen J., Smith, Vernon L. (1993). "Designing a uniform price double auction: An experimental evaluation". In: Friedman, D., Rust, J. (Eds.), The Double Auction Market: Institutions, Theories and Evidence. Addison–Wesley/SFI, Reading, pp. 307–332.

Smith, Vernon L. (1982). "Microeconomic systems as an experimental science". American Economic Review 72 (5), 923–955.

Smith, Vernon L., Williams, Arlington W. (1981). "On nonbinding price controls in a competitive market". American Economic Review 71 (3), 467–474.

Smith, Vernon L., Williams, Arlington W. (1982). "Effect of rent asymmetries in experimental auction markets". Journal of Economic Behavior and Organization 3 (1), 99–116.