AN EXAMINATION OF THE DIAMOND PARADOX: INITIAL LABORATORY RESULTS*

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1. Introduction

The "information economics revolution" of the 1970s had a major impact because of proofs that the presence of even a small amount of uncertainty could have a dramatic effect on equilibrium behavior. Perhaps the most dramatic result of this nature was the "Diamond paradox": that the introduction of small search costs will raise equilibrium prices from competitive to monopoly levels (Diamond, 1971). This paradoxical discontinuity (of the effect of search costs on prices) is an ideal topic for experimentation, since information can be controlled in a precise manner in a laboratory environment. This paper reports initial results from an experimental examination of the Diamond paradox.

The intuition behind the Diamond paradox is quite simple. Consider a Bertrand model with price-setting firms that produce a homogeneous product. In the absence of capacity constraints, a small price cut will capture all sales if that cut is freely observed by buyers. Thus price is driven down to marginal cost in the Bertrand equilibrium. Now suppose that prices are not observed, but rather, that buyers must pay a search cost, c, in order to observe a seller's price. Thus a unilateral price increase made by one seller will not alter the probability that a buyer will pay to see the seller's price. A sufficiently small price increase will not cause the buyer to pay another search cost to get an alternative price quote, so sellers have unilateral incentives to raise price. This incentive remains as long as price is below monopoly levels. The paradox is that this argument does not depend on the magnitude of the search cost, as long as it is positive.

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There are at least two reasons to question the empirical validity of the theoretical argument given above. First, any variability in prices may make it difficult for a seller to determine what is a safe unilateral price increase, i.e. an increase that is so small that it will not divert buyers. Second, the argument pertains to a single period, but a buyer who does not switch away in response to a price increase may not come back in the next period. Both of these objections can be answered by making sufficiently strong theoretical assumptions about the absence of decision errors and repeated interactions. This raises the question of whether the Diamond paradox is relevant to any markets of interest to economists, i.e. markets populated by real people who interact in a series of time periods.

2. Experimental Design

The experiment design consists of two treatments: 1) a "Posted Price" treatment in which sellers choose prices independently, and these prices are observed by all buyers prior to incurring a travel cost, c, in order to purchase from a specific seller, and 2) a "Search" treatment in which the buyer must incur the cost, c, prior to seeing a seller's price. Thus the difference between the two treatments is in terms of whether or not sellers' prices are publicly posted.

Six sessions were conducted at the University of Virginia, with undergraduates who volunteered to participate in order to earn money. Each session, which lasted about two hours, involved three sellers and three buyers. Sellers could earn money by selling "units" of a commodity for prices above their assigned costs, and buyers could earn money by purchasing units for prices below their assigned reservation values. In addition, buyers paid a cost was 15 cents to approach each seller, regardless of how many units were purchased from that seller.

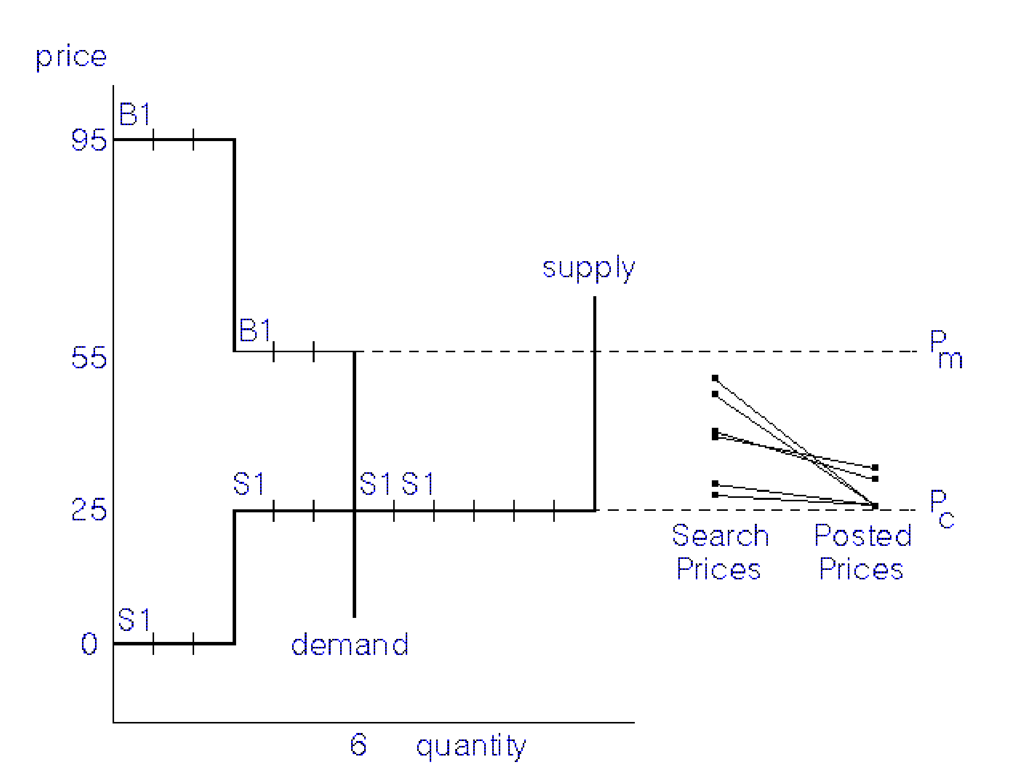

Figure 1. Experiment Design and Transactions Prices for Six Sessions
(prices averaged over the final 5 periods of each treatment)

The financial incentives given to buyers and sellers determined the supply and demand arrays shown on the left side of figure 1. For example, the subject assigned to be buyer B1 was given the option to purchase up to two units of the commodity during a trading period; the first unit with a reservation value of 95 cents and the second with a reservation value of 55 cents, as indicated by the "B1" labels.. If the buyer purchased both units from the same seller for a price 30 cents, the buyer would earn 95 - 30 + 55 - 30 - 15 = 75 cents. Buyers B2 and B3 also had the same profiles of reservation values, so the demand is 6 units for prices below 55 and 3 units for prices between 55 and 80. (A fully anticipated price above 80 does not allow the first-unit reservation value of 95 to cover the 15 cent search cost.) Similarly, the three sellers were given identical cost profiles. For example, the seller assigned to be S1 had a unit with a zero cost and two more units with costs of 25, as shown by the "S1" labels on the supply function in figure 1. With three identical sellers, the market supply is 3 units below 25 cents and 12 units above. Thus the competitive equilibrium price is 25. It is straightforward to show that the joint-profit-maximizing sellers' price is 55, since prices above 80 will result in no sales. Davis and Holt (1994) show that 55 is the Nash equilibrium price for this design under the search treatment.

Buyers and sellers received their own (but not others') value or cost information via networked personal computers. After instructions were read, subjects entered price and purchase decisions on their own computers. The posted price treatment was conducted as a standard "posted-offer auction," with sellers making independent price choices and buyers shopping in a random sequence in each period (see Davis and Holt, 1993, chapter 4). Buyers had to pay a shopping cost of 15 cents before approaching a seller or switching to another seller. The search treatment was different in that sellers' prices were not posted on buyers' screens. In this treatment, the buyer only learned a seller's price after paying the 15 cent shopping cost and designating that seller. Each cohort of subjects traded for 20 periods under one of the treatments and then for 20 additional periods under the other treatment. The search treatment came first in 3 of the 6 sessions. The number of periods was not announced in advance. Sessions lasted for about two hours, after which subjects were paid their earnings in cash. Earnings ranged from $12.50 to $35.25.

3. Results

There was considerable price variability in the early periods of each session. In addition, there was considerable price variability across sessions, especially in the search treatment. The main focus here, however is in the extent to which the Diamond paradox shows up in the data after the initial adjustment phase. The average transactions prices for the final five periods of each treatment are shown on the right side of figure 1. Each session is summarized as a pair of dots, connected by a line. The six dots over the "Posted Prices" label show that prices in this treatment fell to near-competitive levels, as would be expected in a Bertrand market with a homogenous product and large excess capacity. In contrast, the six dots over the "Search Prices" label are more or less uniformly distributed in the range between the two dashed lines that show the competitive and monopoly prices.

The costly nature of price information in this treatment has a clear effect on price levels.[1] But the predicted monopoly price outcome is not observed in this treatment, despite the fact that the shopping cost is relatively large (half of the 30 cent difference between the competitive and monopoly prices).

4. Future Work

This experiment shows that imperfect price information can raise prices significantly above the levels that would prevail with freely observable prices. However, there is no strong support for the Diamond paradox prediction of a monopoly price outcome. One possible explanation is that unilateral price increases are "punished" by buyers who fail to return in the next period. In at least one session, a seller seemed to earn a high-price reputation that deterred some buyers from paying to find out that seller's price in later periods. Another explanation is that there was considerable price variability during the early adjustment periods, so that buyers were observing different price quotes and were forming different expectations. This heterogeneity in buyer beliefs would make it difficult for sellers to determine a price increase that will not scare buyers away. In a stochastic environment of this nature, it is no longer clear that sellers have unilateral incentives to raise prices. Our subsequent work will attempt to evaluate these alternative explanations.

References

Davis, D. and Holt, C. (1994) "An Experimental Examination of the Diamond Paradox," working paper, University of Virginia.

Davis, D. and Holt, C. (1993) *Experimental Economics*, Princeton University Press.

Diamond, P. A. (1971) "A Model of Price Adjustment," *Journal of Economic Theory*, pp. 158-68.

Grether, D. M., Schwartz, A., and Wilde, L. L. (1988) "Uncertainty and Shopping Behavior: An Experimental Analysis," *Review of Economic Studies*, pp.323-42.

[1] This effect is significant in the sense that the search treatment raised prices in all six sessions, as indicated by the negative slopes of all six lines on the right side of figure 1. The chance of this happening under a null hypothesis of no effect is the same as the chance of flipping a fair coin and getting six heads in a row: $(1/2)^6 = 1/64 = .015$.