DEPARTMENT OF ECONOMICS

WORKING PAPER SERIES

2009-04

McMASTER UNIVERSITY

Department of Economics
Kenneth Taylor Hall 426
1280 Main Street West
Hamilton, Ontario, Canada
L8S 4M4

http://www.mcmaster.ca/economics/

Quantity Precommitment with Price Competition versus Quantity Precommitment with Market Clearing Prices in the Laboratory

David Goodwin [a]
Stuart Mestelman [a]

[a] Department of Economics
McMaster University
Hamilton, Ontario L8S 4M4
Canada

Abstract

The paper reports the results of 39 laboratory duopoly markets for which pricing institution and participant experience are treatments. Cournot (C) duopolies (quantity precommitment and a price determined to clear the market) are contrasted with Kreps-Scheinkman (KS) duopolies (quantity precommitment and posted prices). Inexperienced participants in KS markets have much more difficulty selecting capacities consistent with the theoretical predictions than do those in C markets. With experience, the differences disappear.

Corresponding author:

Stuart Mestelman
Department of Economics
McMaster University
Hamilton, Ontario L8S 4M4
Canada
Phone: 905-525-9140 x23113
FAX: 905-521-8232
e-mail: mestelma@mcmaster.ca

JEL Codes: C92, D43, L13

Key Words: Duopoly; Laboratory experiment; Quantity precommitment; Posted prices; Price competition; Market-clearing prices; Experience

19 January 2009

Acknowledgements

Goodwin thanks McMaster University's Vice-President Research, the Faculty of Social Sciences, and its Experiential Education Initiative for supporting his work on this project with an Undergraduate Student Research Award. Goodwin and Mestelman acknowledge financial support from the Social Sciences and Humanities Research Council of Canada and comments from Marc Duhamel and John Spraggon.

Quantity Precommitment with Price Competition versus Quantity Precommitment with Market Clearing Prices in the Laboratory

1. Introduction

Holt (1995, 377) states that "despite its prominence in the theoretical literature, the Cournot model is deficient for the experimental study of many IO issues because the essential mechanics of price determination are simulated. One open question, taken from Kreps and Scheinkman (1983), is whether quantity precommitment and Bertrand competition yield Cournot outcomes (in the laboratory)." The objective of this letter is compare the capacity setting performance of the Kreps-Scheinkman (KS) model with the Cournot (C) model in a laboratory setting.

C firms select a quantity of output they will produce, and price is set to clear the market based on the quantity produced. In the Bertrand (B) model firms offer a price to sell output, and the firm with the lowest price-offer sells all that is demanded at that price. The KS model incorporates the quantity setting of C and the price setting of B in a two-stage advance-production environment. KS firms first make a binding capacity decision, are informed of the capacity of the entire market, then decide at what price they wish to sell their output.[1] Prices are posted and demand is allocated using an efficient rationing mechanism, matching the low-price sellers with the high-valuation buyers until no further units are demanded or no supply remains.

Davis (1999) and Muren (2000) have evaluated the performance of the KS model in

[1] The KS model reconciles the desirable features of the C and B models, having the same equilibrium prediction as C, but better depicting oligopoly markets with its two-stage, capacity-setting and price-setting environment. In turn, the KS model has been criticized because of the lack of realism in the efficient pricing rule (Davidson and Deneckere, 1986), because of the assumption that products are homogeneous (Yin and Ng, 1996) and because they do not permit short-run capacity expansion (Boccard and Wauthy, 2000).

laboratory environments with homogeneous goods. Davis runs 12 posted-offer triopoly markets, 6 without binding production commitments, and 6 with binding production commitments prior to posting prices, effectively testing the KS model using the B model as a benchmark for comparison. Davis finds that quantity precommitment raises prices and lowers output from the competitive B benchmark, but that the actual outcomes did not correspond to the theoretical prediction of the KS model. Muren runs 16 posted-offer triopoly markets with binding production precommitment, 10 with inexperienced traders and 6 with experienced traders. The results show that inexperienced participants make capacity choices that are much higher than the choices of inexperienced triopolists in Fouraker and Siegel (1963). When participating in a second session with the same parameters as the first, Muren's participants set capacities that are closer to the prediction of the KS and C models, but on average are still above it. Muren does not run sessions using C triopolies.

An experiment has not been reported that compares the capacities set by C and KS oligopolists with identical underlying parameters. This paper reports the results of 39 duopoly markets. The treatment variables are the pricing institution and trader experience. The results show that inexperienced participants initially choose excessively large capacities in the KS environment relative to outputs chosen in the C environment. Differences tend to disappear over time. There are no differences between experienced participants in comparable KS and C environments.

2. Laboratory Environment

Forty-eight inexperienced participants were recruited using notices posted on bulletin boards on a university campus and messages posted on the university website. Participants were primarily undergraduate students from various disciplines. Sessions were conducted with pencil and paper; each participant had a calculator.

Participants were anonymously paired with others in their session; each pair formed a duopoly. Communication was not allowed. Detailed instructions were read to the participants prior to beginning each session.[2] Sessions began with two practice periods during which the pairings remained the same. Pairs were then reassigned, and new pairs remained together for 12 paid periods.

Demand and cost information was common knowledge. The demand function was Q = 92 – P; P was the price of output in lab dollars (L$) and Q was the total market demand at the given price. The market demand function was explained in the instructions, and presented to participants in a price-quantity table.[3]

In C sessions, participants made one decision each period, selecting a quantity to produce from the range 0 to 92. The cost of each unit was L$20. The output of both duopolists was combined to determine the market output and the associated market-clearing price. Participants calculated their earnings, and moved to the next decision period.

In KS sessions, participants made two decisions each period, selecting units of capacity from the range 0 to 92. The cost of each unit was L$20. After being informed of their group's capacity, participants selected a price between L$0 and L$92. They were then informed of the price selected by their group member, as well as the quantities they each were able to sell. These

---

[2] Go to http://socserv2.socsci.mcmaster.ca/~econ/mceel/papers/gma1.pdf and http://socserv2.socsci.mcmaster.ca/~econ/mceel/papers/gma2.pdf for C and KS instructions.

[3] Available at http://socserv2.socsci.mcmaster.ca/~econ/mceel/papers/gma3.pdf .

amounts were based on the demand function, using the efficient rationing mechanism. Participants then calculated their earnings. The specific mechanism was described in detail to the participants in the instructions using several different examples (including equal posted prices) to illustrate how the units sold were related to the demand schedule and the prices posted by the duopolists.

For both C and KS environments, participants had two minutes to make each decision, enter it on their individual record sheets, and return the sheets to the session monitor. The monitor recorded this information and returned the record sheets to the participants after disseminating the relevant information to all participants. The time limit was never a binding constraint. Calculations were checked by the session monitors each time the participants submitted their record sheets. After participating in their first session, the now experienced participants were asked if they wished to participate in another session.

14 C markets and 10 KS markets with inexperienced participants were run. 5 C markets and 10 KS markets were run with experienced participants.

Participants were paid privately at the end of each session. $5.00 was guaranteed as a show-up fee. Earnings ranged between $15 and $37 with a mean of $23.15. Sessions lasted between 1 and 2.5 hours, including the reading of instructions.

3. Benchmark Outcomes

Given the underlying demand and cost parameters and the pricing institutions characterizing the duopoly markets, three benchmark capacities or outputs are identified. The first benchmark is the joint profit maximizing output or capacity of 36 units. The second benchmark is the competitive, zero profit, outcome of 72 units. The third benchmark is the duopoly Nash equilibrium outcome of 48 units. This third outcome is the theoretical prediction for both the C and KS environments.[4]

4. Results

Figure 1 displays mean per-period capacity or output for the two pricing institutions and two levels of experience. The data for inexperienced participants are in the leftmost 12 periods; the data for experienced participants are in the rightmost 12 periods. Circles represent KS duopolies and triangles represent C duopolies. Table 1 reports the means and standard deviations of the mean capacity or output of the duopolies across periods 1-8 and 9-12 by institution and experience. The data reflect the excess capacity decisions of inexperienced KS duopolists as well as their convergence towards the Nash equilibrium benchmark reported by Muren (2000).

[Insert Figure 1 and Table 1 Here]

Capacities set by inexperienced KS duopolists greatly exceed those set by inexperienced C duopolists across the first 8 periods of their sessions. The difference is significant (exact randomization test, $n_C = 14$, $n_{KS} = 10$, one-sided, $p = 0.000$). C duopolists tend to select capacities very close to the Nash equilibrium benchmark. Over time, capacities in KS duopolies fall and approach output in C duopolies. The average capacities selected by inexperienced KS duopolists across periods 9-12 are not significantly different from mean output set by inexperienced C duopolists (exact randomization test, $n_C = 14$, $n_{KS} = 10$, one-sided, $p = 0.125$). When duopolists are experienced in these environments, the differences between KS capacities and C output across periods 1-8 and 9-12 are not significantly different (exact randomization

[4] In the discrete implementation of this environment in the laboratory, participants must select integer output values. There are three Nash equilibria. One is a symmetric equilibrium when each player selects an output of 24. The other two result if one selects 23 and the other selects 25. This can happen two ways. The equilibrium price remains 44.

tests, $n_C = 5$, $n_{KS} = 10$, one-sided, $p = 0.637$ and $p = 0.688$).

Over time there appears to be a tendency for both C and KS duopolists to reduce outputs and capacities below the Cournot benchmark. The evidence for this result from C duopoly markets in the literature is mixed.[5] We noted there were no significant differences between the mean capacities and outputs of the experienced KS and C duopolists; their aggregate mean over periods 9-12 is 42.82 units. Simple tests of the hypotheses that mean capacity and output selected by experienced KS and C duopolists does not differ from the benchmark of 48 units and from the benchmark of 36 units can be rejected in favor of the alternatives that it is less than 48 and more than 36 ($t = 2.974$ for the former and $t = 3.912$ for the latter, the critical value at one percent for a one-tailed test with 14 degrees of freedom is 2.624).

Suetens and Potters (2007, 71) "argue that there is often signficantly more tacit collusion in Bertrand price-choice than in Cournot quantity-choice markets." This suggests that KS duopolists may display more tacit collusion than C duopolists. This is visually supported by the C duopoly capacities generally exceeding that for KS duopolies for experienced duopolists. However, as noted above, these differences are not significant.

5. Conclusions

Holt (1995, 377) notes that "an open question ... is whether quantity precommitment and Bertrand competition yield Cournot outcomes (in the laboratory)." Although laboratory experiments which evaluate the performance of markets with quantity precommitment and price

---

[5] Holt (1995) notes that "in multiperiod Cournot duopolies, the outcomes fall on both sides of the Cournot prediction..."

posting have been conducted, none have directly addressed Holt's question by contrasting the KS and C environments with the same cost and demand parameters.

The results of this experiment show that with experience, traders in laboratory duopoly markets who have to make quantity commitments will make comparable commitments regardless of whether they also post prices at which to sell their output or they defer the pricing decision to an exogenous clearing mechanism. While the behavior is comparable across pricing institutions, it does not necessarily conform to the theory when the market structure is duopoly.

References

Boccard, N. and X. Wauthy, 2000, Bertrand competition and Cournot outcomes: further results, Economics Letters 68, 279-285.

Davidson, C. and R. Deneckere, 1986, Long-run competition in capacity, short-run competition in price, and the Cournot model, Rand Journal of Economics 17, 404-415.

Davis, D., 1999, Advance production and Cournot outcomes: an experimental investigation, Journal of Economic Behavior and Organization 40, 59-79.

Fouraker, L. and S. Siegel, 1963, Bargaining Behavior. (McGraw-Hill, New York).

Holt, C. A., 1995, "Industrial organization: a survey of laboratory research, In: J. H. Kagel and A. E. Roth, eds., Handbook of Experimental Economics (Princeton University Press, Princeton, NJ) 349-443.

Kreps, D. and J. Scheinkman, 1983, Quantity precommitment and Bertrand competition yield Cournot outcomes, Bell Journal of Economics 14, 326-337.

Muren, A., 2000, Quantity precommitment in an experimental oligopoly market, Journal of Economic Behavior and Organization 41, 147-157.

Suetens, S. and J. Potters, 2007, Bertrand colludes more than Cournot, Experimental Economics 10, 71-78.

Yin, X. and Y.-K. Ng, 1996, Quantity precommitment and Bertrand competition yield Cournot outcomes: a case with product differentiation, Australian Economic Papers 36, 14-22.

Table 1. Means and Standard Deviations of Output and Capacity Decisions by Period Range and Treatment[a]

		Inexperienced Duopolists				Experienced Duopolists	
		Periods				Periods	
Institution	Obs.	1-8	9-12	Institution	Obs.	1-8	9-12
C	14	48.86	48.41	C	5	47.03	43.85
		(6.40)	(7.44)			(8.53)	(6.07)
KS	10	74.75	51.10	KS	10	44.79	42.30
		(13.15)	(7.27)			(8.45)	(7.32)

[a] C indicates markets with quantity-setting producers who do not post prices. KS indicates markets with quantity-setting producers who post prices.

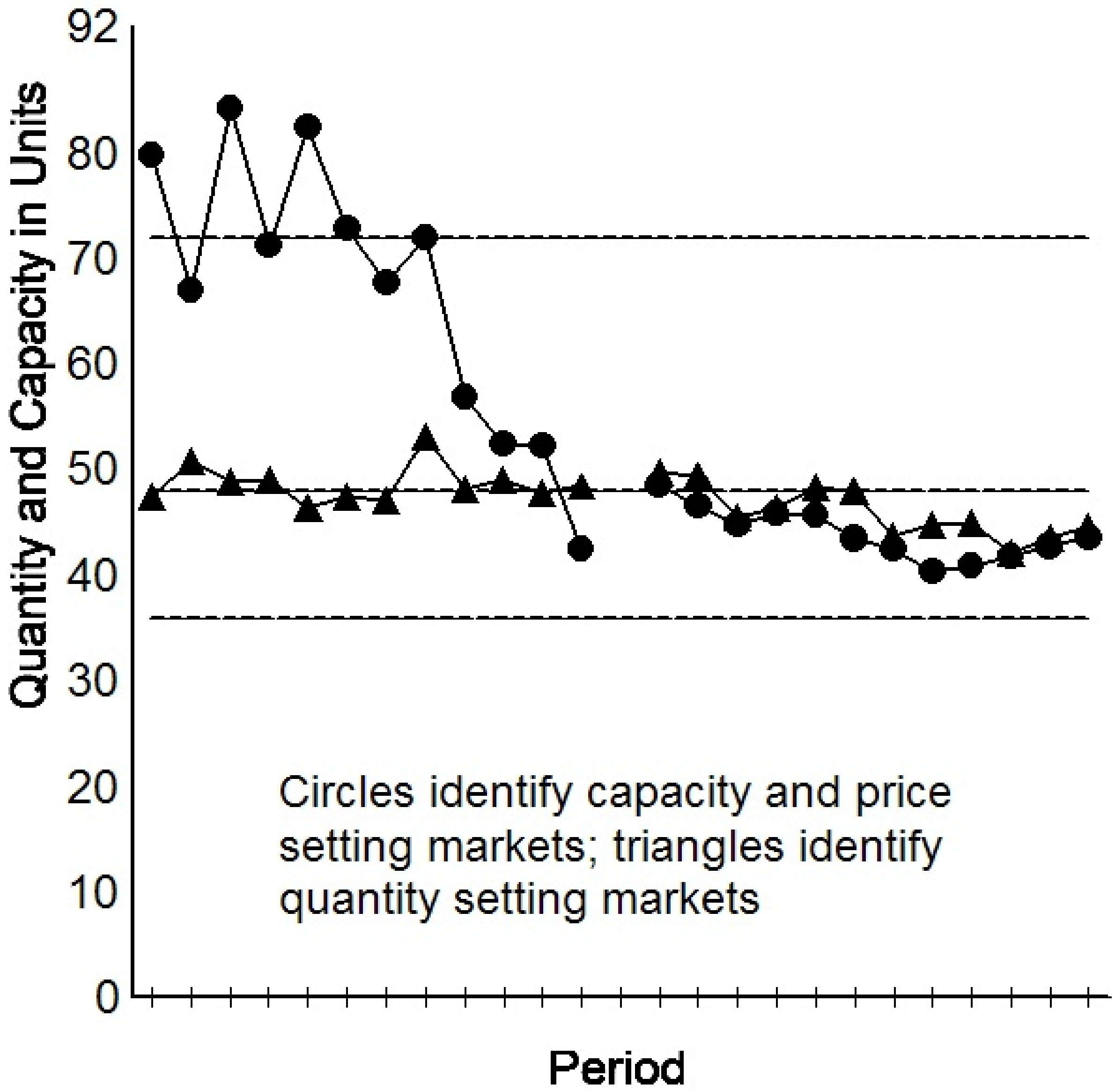

Figure 1 Capacity