Advance Production Duopolies and Posted Prices or Market-Clearing Prices

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Abstract

The paper reports the results of 39 laboratory duopoly markets for which pricing institution and participant experience are treatments. Duopolies in which producers with complete information about market demand make advance-production output decisions and sell their output at a clearing price (Cournot markets) are contrasted with comparable duopolies who post prices for sale through an efficient rationing mechanism (Kreps-Scheinkman or KS markets). Inexperienced participants in KS markets have much more difficulty selecting capacities consistent with the theoretical predictions than do those in Cournot markets. With experience, the differences disappear. If trading sessions last sufficiently long, it is likely that differences will disappear with inexperienced participants.

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1. Introduction

Within the discipline of industrial economics, there has been considerable literature published that analyzes model choice for oligopoly markets. The two models of most historical significance to this discipline were first described by Cournot (1838) and Bertrand (1883). In the Cournot model firms select a quantity of output they will produce, and price is set to clear the market.[1] In the Bertrand model firms offer a price to sell output, and the firm with the lowest price-offer sells all that is demanded at that price. A third model, described by Kreps and Scheinkman (1983, KS hereafter), incorporates the quantity setting of Cournot and the price setting of Bertrand in a two-stage advance-production environment. In the KS model 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. 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.

To many economists, the Cournot model is appealing because the equilibrium price depends inversely on the number of firms in the market. However, firms typically select prices at which to sell their output, thus it is criticized for not accurately picturing the real world. The Bertrand model is more realistic than the Cournot model, in that firms compete by setting the price of their output. However, the Bertrand model fails to accurately describe naturally occurring oligopoly markets with its equilibrium prediction of a competitive outcome. The KS

[1] This is consistent with producers bringing their output to a market in which units are sold through a competitive demand-revealing sealed-bid auction.

model reconciles the desirable features of both the Cournot and the Bertrand models, having the same equilibrium prediction as Cournot, but better depicting oligopoly markets with its two-stage, quantity-setting and price-setting environment.

This being the case, KS has been subject to scrutiny, evaluating its effectiveness as a model choice for oligopoly markets. In particular, Davidson and Deneckere (1986) criticize the efficient rationing rule assumed in the KS model. Using an alternative rationing rule, Davidson and Deneckere (p. 405) demonstrate that the equilibrium for KS producers is more competitive than the Cournot outcome, and hence that the Cournot outcome "underestimates the degree of competitiveness in markets that are characterized by technological commitment."[2] Yin and Ng (1996) criticize KS for its assumption of a homogeneous product, arguing that most products produced by firms in naturally occurring markets may be considered differentiated goods. Yin and Ng (p. 15) go on to argue that "with the assumption of product differentiation, artificial rationing rules are no longer necessary," and show that the KS (or Cournot) result still holds. Finally, Boccard and Wauthy (2000) argue that the KS model is deficient because it fails to consider the possibility that capacity constraints may be exceeded at a cost.

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

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[2] Davidson and Deneckere (1986) show that Kreps' and Scheinkman's Cournot prediction is contingent on the use of an efficient rationing mechanism. They agrue that under a proportional rationing mechanism there is no longer a pure-strategy equilibrium in prices, although there is in capacity, when producers face positive marginal costs. Furthermore, as costs rise, the equilibrium capacity under proportional rationing, which exceeds the capacity under efficient rationing, falls relative to the efficient rationing capacity. In an example provided by Davidson and Deneckere, when capacity cost is zero, their equilibrium quantity is 1.92 times the corresponding quantity under efficient rationing. When capacity cost rises to 10% of the market choke price, their proportional rationing quantity falls to 1.13 times the quantity under efficient rationing.

laboratory environments. Davis runs twelve triopoly posted-offer markets, six under standard rules, and six with binding production commitments prior to posting prices, effectively testing the KS model, using the Bertrand model as a baseline for comparison. Davis finds that advance-production capacity decisions raised prices and lowered output, but that the actual outcomes did not correspond to the theoretical prediction of the KS model. Muren also looks at capacity precommitment followed by price competition in experimental triopoly markets, using both inexperienced and experienced participants, to evaluate the equilibrium predictions of the KS model. Muren uses the experimental quantity-setting triopoly data of Fouraker and Siegel (1963) as a basis of comparison, and finds that inexperienced participants make capacity choices that are more competitive than theory predicts, and much higher than Fouraker's and Siegel's inexperienced Cournot triopoly results. When participating in a second session of the same experiment, Muren's participants set capacities that are closer to the prediction of the KS model. Anderhub *et al*. (2003) address the same problem as Davis and Muren with a number of extensions that allow them to focus their analysis on the pricing mechanism of the KS model. Namely, they address the concerns of Yin and Ng, Davidson and Deneckere, and Boccard and Wauthy by considering differentiated products, thereby modifying the rationing mechanism, and permitting output to be extended beyond initial capacity choices at a finite cost. This creates a unique pure-strategy equilibrium in prices and capacities which is comparable to the Cournot prediction.

This paper reports the results of eight laboratory controlled market sessions, in which the pricing institution (Cournot or KS) and the level of experience of participants are the treatment variables. These experiments were designed to build on the results of Davis and Muren. Muren

compares the results of inexperienced KS triopolists to Fouraker's and Siegel's inexperienced Cournot triopolists. The parameters of the Muren and the Fouraker and Siegel experiments are different, which brings into question the comparability of the results. Davis compares his KS triopolists with Bertrand triopolists facing the same cost and revenue parameters, rather than Cournot triopolists. Hence, the primary extension of this paper is the inclusion of Cournot sessions as a baseline for comparison to the KS sessions with inexperienced and experienced participants facing the same laboratory parameters. The results of these experiments show that inexperienced participants initially have difficulty with capacity choices in the KS environment and capacity tends to be much greater than in Cournot environments with inexperienced participants. Differences disappear with experience. Experienced participants in KS environments and Cournot environments behave similarly. Finally, there is a tendency for output to converge below the predicted Nash equilibrium. The experimental design and procedures are explained in Section 2. The benchmark outcomes are described in Section 3. Section 4 presents and discusses the results of the laboratory sessions, and Section 5 concludes the paper.

2. Laboratory Environment

Both Davis and Muren note that their KS triopolists tend to exhibit rivalistic behavior in setting capacities. Davis (p. 73) writes "...some players do appear to repeatedly make aggressive (large) output decisions in a strategic effort to increase relative earnings." Muren (p. 153) shows that over the last four decision periods 67.5% of triopoly markets with inexperienced participants and 37.5% of triopoly markets with experienced participants are closer to rivalistic (competitive) production than Cournot production, and in the last decision period these numbers are 70% and

50% respectively. The Cournot triopoly markets with inexperienced participants run by Fouraker and Siegel also show quantity choices which tend to exceed quantities predicted by the Cournot model.

In contrast to the triopoly results, data from Fouraker's and Siegel's duopoly experiments with inexperienced participants show quantity choices close to the Cournot predictions, as do those of Phillips and Mason (1992), while Mason *et al.* (1992) show quantities between the collusive and Cournot outcomes. Accordingly, to give the KS model its best chance to show results in a laboratory environment that are consistent with the theoretical predictions, duopolies, rather than triopolies, are used in this experiment.

Eight sessions, consisting of thirty-nine duopolies, were run during June 2002.[3] The inexperienced participants were recruited using posters and a message on the McMaster University website. After participating in their first session, the now experienced participants were asked if they wished to participate in another session.[4] The participants were primarily undergraduate students from various disciplines. Sessions were conducted with pen and paper, and each participant had a calculator.

Each of the sessions divided participants into pairs, with each pairing representing an

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[3] Seven sessions had five duopolies and one had four.

[4] Some self-selection bias could have been introduced by this recruitment process. A sufficient number of individuals volunteered for a second session to fill all of the slots for experienced participants. Some chose to return as alternates, who would only participant if someone else was unable to attend. The low earnings to many subjects in the KS markets with inexperienced participants did not affect volunteering. The average payoff to people who volunteered to return as experienced producers was slightly higher than, but not significantly different from, the average payoff to all participants in KS markets with inexperienced participants.

individual market with two firms. Participants knew they were paired with someone in the room, but did not know who this individual was. Communication was not allowed. During the two practice periods pairings remained the same, then were scrambled, and remained the same for the twelve paid periods.[5] Detailed instructions were read to the participants prior to beginning each session.[6] Participants were paid privately at the end of each session based on their earnings during the experiment. $5.00 was guaranteed as a "show-up fee" to everyone who participated.[7] Earnings ranged between $15 and $37, and sessions lasted between 1 and 2.5 hours, including the reading of instructions. Sessions with experienced participants were completed sooner than sessions with inexperienced participants, and KS sessions took longer than Cournot sessions.

Demand and cost information was also common knowledge, thus participants could compute the earnings of the other member of their duopoly. The demand side of the market was

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[5] Davis' and Mason's and Phillip's sessions ran for more than thirty periods. Fouraker's and Siegel's sessions ran for twenty-two periods. Generally, the results after the tenth period were relatively stable, although fluctuations are common.

[6] The instructions for the Cournot and KS environments are in Appendices A1 and A2, posted at <http://socserv2.socsci.mcmaster.ca/~econ/mceel/abstracts/gm2002abs.htm>. A series of examples were included in the instructions to help participants understand the environment. Participants had roughly two minutes to make each decision, which was written on their individual record sheet, when requested, and handed to the session monitor who recorded this information and returned the record sheets to the participants after providing information about other participants' capacities or clearing prices. The time limit was never a binding constraint. Participants calculated their own earnings after each period. The calculations were checked by the session monitors each time the participants submitted their record sheets. Correct calculations helped to ensure that the participants understood the results of their decisions.

[7] The two KS sessions with inexperienced participants lasted longer than two hours. The consent forms indicated that participants could leave the session after two hours if they wished, with no financial penalty. None of our participants chose to withdraw. We paid them an addition $10 on top of the show-up fee and their earnings from the session. Participants were not informed of this until after the session was over.

the same for each pairing in all sessions. The demand function used was Q = 92 – P, where P is the selling price of output in L$ and Q is the total market demand at the given price level. Each unit of output had a constant marginal cost of L$20. This market demand function was explained in the instructions, as well as presented to participants in the form of a price-quantity table, which they consulted when making quantity and price decisions.[8]

In pilot sessions reported in Bailey (2002) and Goodwin (2002), quantities in Cournot markets frequently were so large as to lead to a market clearing price well below the cost of production. One participant ended a session with negative earnings. This was also experienced by Muren (p. 150) in KS markets. Muren did not penalize participants with negative profits by reducing their show-up fee. Because sustained negative profits could affect participants' behaviors, a bankruptcy rule was introduced into the pilot sessions and the current experiment. Participants were given a schedule of accumulated losses, by period, which if exceeded would result in bankruptcy. The schedule was constructed in such a way as to assure positive profits if participants could stabilize the markets in which they participated at an output close to the output predicted by theory. The critical accumulated loss fell each period.[9]

In the Cournot sessions, participants made one decision each period, selecting a quantity to produce from the range of 0 to 92. The output of both participants in a pairing was then combined to determine the total market output and the associated market-clearing price. Participants then calculated their earnings, and moved on to the next decision period. In the KS

[8] The price-quantity table is in Appendix A3. This is posted at <http://socserv2.socsci.mcmaster.ca/~econ/mceel/abstracts/gm2002abs.htm>.

[9] This schedule is included in the Instructions in Appendices A1 and A2, posted at <http://socserv2.socsci.mcmaster.ca/~econ/mceel/abstracts/gm2002abs.htm>.

sessions, participants made two decisions each period. They first selected a capacity from the range 0 to 92. After being informed of their group member's capacity, they selected a selling price between 0 and 92 lab dollars. They were then informed of the price selected by their group member, as well as how much they were able to sell at their chosen price, and using this information calculated their earnings. The amount they were able to sell was based on the demand function, using the efficient rationing mechanism. The group member with the lower price sold output first, after which the other group member sold to any remaining demand at the higher price. When both participants selected the same price, each had the opportunity to sell to half of the market demand at that price.[10]

Participant experience and the pricing institution are the two treatment variables. An inexperienced person has never before participated in a duopoly session. An experienced person gained experience by participating as an inexperienced person in a Cournot or KS session. The pricing institution refers to the way prices are determined. In the Cournot market the price is the price which clears the market given the quantity supplied and the market demand schedule. In the KS market, prices are posted by sellers and the efficient rationing mechanism is implemented.

In KS markets, participants must decide on both capacity and price. In the Cournot markets, only capacity decisions are made. With inexperienced producers, convergence towards the predicted capacity occurs more rapidly in Cournot markets than in KS markets. A conjecture is that experience with Cournot markets leads to more rapid convergence to predicted capacity in

[10] This process is described in the Instructions in Appendix A2 posted at <http://socserv2.socsci.mcmaster.ca/~econ/mceel/abstracts/gm2002abs.htm>

KS markets than experience in KS markets. To evaluate this conjecture, five duopolies had participants experienced in Cournot markets and five had participants experienced in KS markets. Table 1 presents the experimental design and the treatment designations.

Insert Table 1 Here
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3. Benchmark Outcomes

Given the underlying demand and cost parameters and the pricing institutions characterizing the experimental duopoly markets, three benchmark outcomes can be identified. The first is a collusive outcome, the second is a rivalistic or competitive outcome, and the third is the Cournot (or KS) outcome.

The collusive outcome is consistent with joint profit maximization by quantity-setting duopolists. Given the demand and cost parameters introduced above, the collusive outcome requires an aggregate capacity of 36 units. A price of L$56 will maximize joint profit and result in no excess demand. Both duopolists have an incentive to increase their capacities, given what the other has set. This is not a Nash equilibrium.

The rivalistic outcome is consistent with capacity-setting producers who are trying to maximize the difference between their profit and their rival's profits. Rivalistic duopolists will each produce 36 units and the clearing price will be L$20, which is marginal cost. Because price equals marginal cost, this is also called a competitive outcome. This is a Nash equilibrium, if both duopolists are rivalistic.[11] Within the context of the laboratory environment, we are unable

[11] If one duopolist is rivalistic and the other is a quantity-setting profit maximizer, there is a Nash equilibrium with the rivalistic duopolist producing 36 units and the profit maximizing duopolist producing 18 units. The price will be L$38.

to determine what are the underlying motives of our participants. Our conjecture is typically that participants prefer more to less (monotonic preferences), and this rules out rivalistic behavior. Accordingly, this benchmark is not a Nash equilibrium for profit maximizing duopolists.

The final benchmark is the capacity and price associated with the Cournot duopoly model. If both duopolists facing the parameters described above are profit-maximizing quantity-setters, each will select a capacity of 24 units and the price which clears the market will be L$44. This is a Nash equilibrium. In the advance-production (KS) environment, Kreps and Scheinkman (1983) identify the same capacity and price as a Nash equilibrium.

4. Results

Data are collected for capacities, sales, contract prices, and market efficiencies by period, group, and treatment. Hypothesis tests described below are based on one observation for each duopoly. The observation is typically the mean of a per-period performance variable (capacity, sales, contract price, efficiency, or inventory) for a duopoly over a range of periods. Table 2 summarizes the data for experienced participants in KS markets by the market in which they gained their experience. The data are summarized for periods 1-8 and for periods 9-12 in an attempt to account for convergence patterns. The p-values for hypotheses that the source of experience is significant are also included in this table. Table 3 summarizes the mean data by experience and pricing institution for periods 1-8 and 9-12, and Table 4 contains p-values from the randomization tests of the hypotheses that experience and pricing institutions have no effect on the performance variables. Finally, the period-by-period mean data for each of the

performance variables are summarized by treatment in Figures 1-5.[12]

4.1 KS Markets with Experienced Participants

The set of tests presented in Table 2 evaluates the conjecture introduced at the end of Section 2, that the market in which participants gain experience prior to participating in a KS market is important. The p-values reported in Table 2 are the results of exact randomization tests of the hypotheses that there are no differences between means of the performance variables for KS duopolies by the source of the duopolists' experience. The p-values reported are for two-tailed tests. There are five observations for each treatment. None of the tests permit rejection of the null hypothesis of equality of means against the alternative hypothesis that the means differ (p-values exceed 0.238 in all cases). Accordingly, the data for experienced participants in KS markets are pooled. These data are reported in Table 3 and Figures 1-5.

Insert Table 2 Here

4.2 A Summary of Performance Variables

Figures 1-5 display mean per-period summaries of capacity, sales, excess capacity, mean contract prices and market efficiency for the two pricing environments and two levels of experience. Figure 1, with capacity data, shows clearly the effects of pricing institution and experience.

The solid symbols track the capacities set by first-time (inexperienced) participants in KS

[12] All of the data are included in a spread-sheet in Appendix 5 and posted at <http://socserv2.socsci.mcmaster.ca/~econ/mceel/abstracts/gm2002abs.htm>.

and Cournot duopolies. Capacities set by KS duopolists greatly exceed those set by Cournot duopolists early in the sessions. Cournot duopolists tend to select capacities very close to the Cournot baseline. Over time, capacities in KS duopolies fall and approach those in Cournot duopolies.[13] When participants are returned to these environments a second time (as experienced participants), the capacities set by both KS and Cournot duopolists are very similar (see the open symbols in Figure 1). Over time there appears to be a tendency for both Cournot and KS duopolists to reduce capacities below the Cournot benchmark.

Insert Figure 1 Here

Figure 2 displays actual sales by pricing institution and participant experience. These data do not display the striking difference between the KS and Cournot duopolies with inexperienced participants as do the capacity data. Still, the gap appears to be substantial. However, for experienced participants, the overlap in early trading rounds that was displayed by capacity choices appears to widen somewhat for sales, rather than narrowing. These differences, do not appear to be substantial. The importance of experience in the KS duopolies is clearly shown in Figure 3. The high capacities selected by inexperienced participants results in high excess capacity throughout most of the trading periods. The experienced KS duopolists generate very little excess capacity.

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[13] There were three KS duopolies with inexperienced participants out of the ten which were run which experienced a bankruptcy. Neither the time series of mean capacities and sales presented in Figures 1 and 2 nor the hypotheses tests reported later in the paper are significantly affected by the inclusion of data from markets which become monopolies due to a bankruptcy. These occur within the last three periods of their respective sessions. There are no bankruptcies in KS duopolies with experienced participants and none in Cournot duopolies.

Insert Figures 2 and 3 Here

The prices in Cournot duopolies are market clearing prices. Prices in KS duopolies are posted by the duopolists, after they are informed of their duopoly's total capacity to supply output. If market clearing prices were posted by the inexperienced duopolists, mean contract prices would average less than L$20 over the first eight periods. The excess capacity reported in Figure 3 suggests that market clearing prices were not posted. Figure 4 shows mean contract prices over the sessions.

The prices in Cournot duopolies are directly related to the capacities they selected. The narrowing of the gap between KS and Cournot duopoly prices reflects learning by the KS duopolists. With second-time participants, prices in KS and Cournot duopolies are much closer and tend to rise above the price consistent with the Cournot benchmark.

Insert Figure 4 Here

Figure 5 presents efficiency data for the four laboratory treatments. None yield average efficiencies substantially greater than the Cournot benchmark efficiency of 89%. The efficiency of the KS duopolies with inexperienced participants rose over time towards the efficiency in the experienced Cournot duopolies. With experience, however, the efficiency in the Cournot duopolies fell over time, as capacity fell. The experienced KS duopolies tended to be less efficient in early periods than the experienced Cournot duopolies, but these tended to converge over time.

Insert Figure 5 Here

4.3 Statistical Analysis of Data

The data presented in Figures 1-5 are summarized in Table 3. The following statements can be supported:

1. Inexperienced KS duopolists choose greater capacities over the first eight periods than do Cournot duopolists (exact randomization test, $p = 0.000$), but they choose the same capacities over the last four periods (exact randomization test, $p = 0.125$).

2 Similar patterns exist for Sales, Prices, and Efficiency (see Table 4).

3. With experience, KS duopolists and Cournot duopolists chose the same capacities over the first eight periods (exact randomization test, $p = 0.637$) and over the last four periods (exact randomization test, $p = 0.688$).

4. Similar patterns exist for Sales, Prices, and Efficiency (see Table 4).

Insert Tables 3 and 4 Here

Recent work by Mason *et al.* shows Cournot duopolists producing output between the Nash equilibrium and collusive benchmarks. If tacit collusion is going to emerge in a duopoly, it is more likely to emerge with experience. This conjecture is supported by the data summarized in Figures 1 and 2 and in Table 3. Capacity and sales are consistently about 48 units for inexperienced duopolists over the first eight and last four periods, as well as for experienced duopolists over the first six periods. Over the last six periods for experienced Cournot duopolists, capacity is consistently below 48 units. In addition, there is no significant difference between the capacity set by experienced KS and Cournot duopolists over the last four periods of

their sessions.

Given that we cannot reject the null hypothesis that the fifteen observations of capacity from experienced duopolies come from the same distribution, a crude test of convergence to the predicted Nash equilibrium based on the mean capacity data for the last four periods indicates that the experienced duopolies generate capacities different than that predicted by theory ($t = 2.880$ for a test that mean capacity of 42.93 units is not different from 48 units, where the critical value at a 0.05 significance level for a two-tailed test with fourteen degrees of freedom is 2.145). The null hypothesis that 42.93 units is different from 36 units (the collusive outcome) can be rejected in favour of the alternative hypothesis that the mean capacity exceeds 36 units ($t = 3.941$; the critical value is 1.761).[14]

5. Conclusions

This experiment is consistent with Muren's results with respect to the very high capacity choices made by inexperienced participants in KS markets. Muren's results are extended by demonstrating that with additional production periods, capacity and sales in KS markets may converge to the capacities set by inexperienced Cournot duopolists.

This experiment also is consistent with Muren's result that the capacities of KS oligopolies fall dramatically when sessions utilize experienced participants. In addition, by conducting sessions with duopolies, the experiment has demonstrated that there are no differences between the behavior of experienced participants in Cournot and KS duopolies. This

[14] This result can be supported with a non-parametric sign-test. The null hypothesis that 48 units is the median capacity for the distribution of mean capacities for the fifteen period 9-12 observations from experienced duopolies can be rejected ($p = 0.0593$). The median observation in this distribution is 43.5 units.

is consistent with the theory, but had not been demonstrated behaviorally.

Finally, there is evidence that experienced participants in both Cournot and KS duopolies may be able to exercise more market power than the theory predicts. This is consistent with slight downward trend in capacities reported by Mason *et al.* for their symmetric duopolies, and for the general conjecture that tacit collusion is more likely to evolve in duopoly markets than in triopoly markets such as Muren's and Davis'. This experiment is particularly interesting because while it confirms that the outcome of the KS and Cournot models yield comparable behavior, neither model, when implemented for duopolies, generate the result predicted by theory.

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Table 1. Experimental Design (Treatment Designations)

	Cournot Markets	KS Markets
Inexperienced	14 (Cinx)	10 (KSinx)
Experienced	5 (Cx)	10 (KSx)
in C	5	5 (KSxC)
in KS	0	5 (KSxKS)

Table 2. Means, Standard Deviations, and p-Values for Randomization Tests of Differences Between Experienced KS Treatments[a]

	Means (Standard Deviations)				p-Values	
	KSxC		KSxKS		KSxKS vs. KSxC	
Performance Variables	Periods		Periods		Periods	Periods
	1-8	9-12	1-8	9-12	1-8	9-12
Capacity	45.60 (8.67)	44.35 (8.44)	43.98 (9.15)	40.25 (6.22)	0.730	0.444
Sales	43.00 (6.89)	43.95 (7.93)	43.48 (9.50)	40.10 (6.07)	0.950	0.444
Prices	45.14 (7.99)	47.84 (8.12)	48.32 (9.35)	51.77 (6.19)	0.572	0.444
Efficiency	0.800 (0.059)	0.835 (0.081)	0.821 (0.095)	0.795 (0.067)	0.738	0.444
Inventory	2.60 (3.31)	0.40 (0.58)	0.50 (0.81)	0.15 (0.22)	0.238	0.564

[a] KS indicates markets with quantity-setting producers who post prices. x and inx indicate experienced and inexperienced producers respectively. xC indicates the producers are experienced in markets with quantity-setting producers selling in a competitive demand-revealing auction. xKS indicates the producers are experienced in KS markets. The C and KS benchmarks are 48 for capacity and sales, 44 for price, 0.89 for efficiency, and 0 for inventory.

Table 3. Mean and (Standard Deviation) by Period and Treatment[a]

Treatments	Obs.	Capacity		Sales		Prices		Efficiency		Inventory	
		Periods		Periods		Periods		Periods		Periods	
		1-8	9-12	1-8	9-12	1-8	9-12	1-8	9-12	1-8	9-12
Cinx	14	48.86	48.41	48.86	48.41	42.76	43.59	0.875	0.880	0.00	0.00
		(6.40)	(7.44)	(6.40)	(7.44)	(6.41)	(7.44)	(0.055)	(0.064)	(0.00)	(0.00)
Cx	5	47.03	43.85	47.03	43.85	44.98	48.15	0.865	0.840	0.00	0.00
		(8.53)	(6.07)	(8.53)	(6.07)	(8.53)	(6.07)	(0.083)	(0.067)	(0.00)	(0.00)
KSinx	10	74.75	51.10	55.86	47.68	30.37	40.62	0.777	0.828	18.89	3.43
		(13.15)	(7.27)	(6.84)	(7.96)	(6.84)	(7.96)	(0.094)	(0.119)	(9.97)	(3.29)
KSx	10	44.79	42.30	43.24	42.03	46.73	49.81	0.810	0.815	1.55	0.28
		(8.45)	(7.32)	(7.83)	(6.96)	(7.83)	(6.96)	(0.075)	(0.073)	(2.53)	(0.43)

[a] C indicates markets with quantity-setting producers selling in a competitive demand-revealing auction. KS indicates markets with quantity-setting producers who post prices. x and inx indicate experienced and inexperienced producers respectively. The C and KS benchmarks are 48 for capacity and sales, 44 for price, 0.89 for efficiency, and 0 for inventory.

Table 4. Randomization Test p-Values[a]

Treatments[b]	Capacity		Sales		Prices		Efficiency		Inventory	
	Periods		Periods		Periods		Periods		Periods	
	1-8	9-12	1-8	9-12	1-8	9-12	1-8	9-12	1-8	9-12
Cinx vs. Cx	0.307	0.110	0.307	0.110	0.270	0.111	0.772	0.238	N/A	N/A
Cinx vs. KSinx	0.000	0.125	0.012	0.410	0.099	0.154	0.003	0.188	N/A	N/A
KSinx vs. KSx	0.000	0.008	0.001	0.055	0.000	0.003	0.400	0.796	0.000	0.002
Cx vs. KSx	0.637	0.688	0.416	0.632	0.706	0.656	0.214	0.520	N/A	N/A

[a] For all tests, the null hypotheses are that the values from one treatment are equal to the values from the other treatment. The alternative hypotheses are one-sided for all tests except for efficiency and for tests comparing Cx and Ksx.

[b] C indicates markets with quantity-setting producers selling in a competitive demand-revealing auction. KS indicates markets with quantity-setting producers who post prices. x and inx indicate experienced and inexperienced producers respectively.

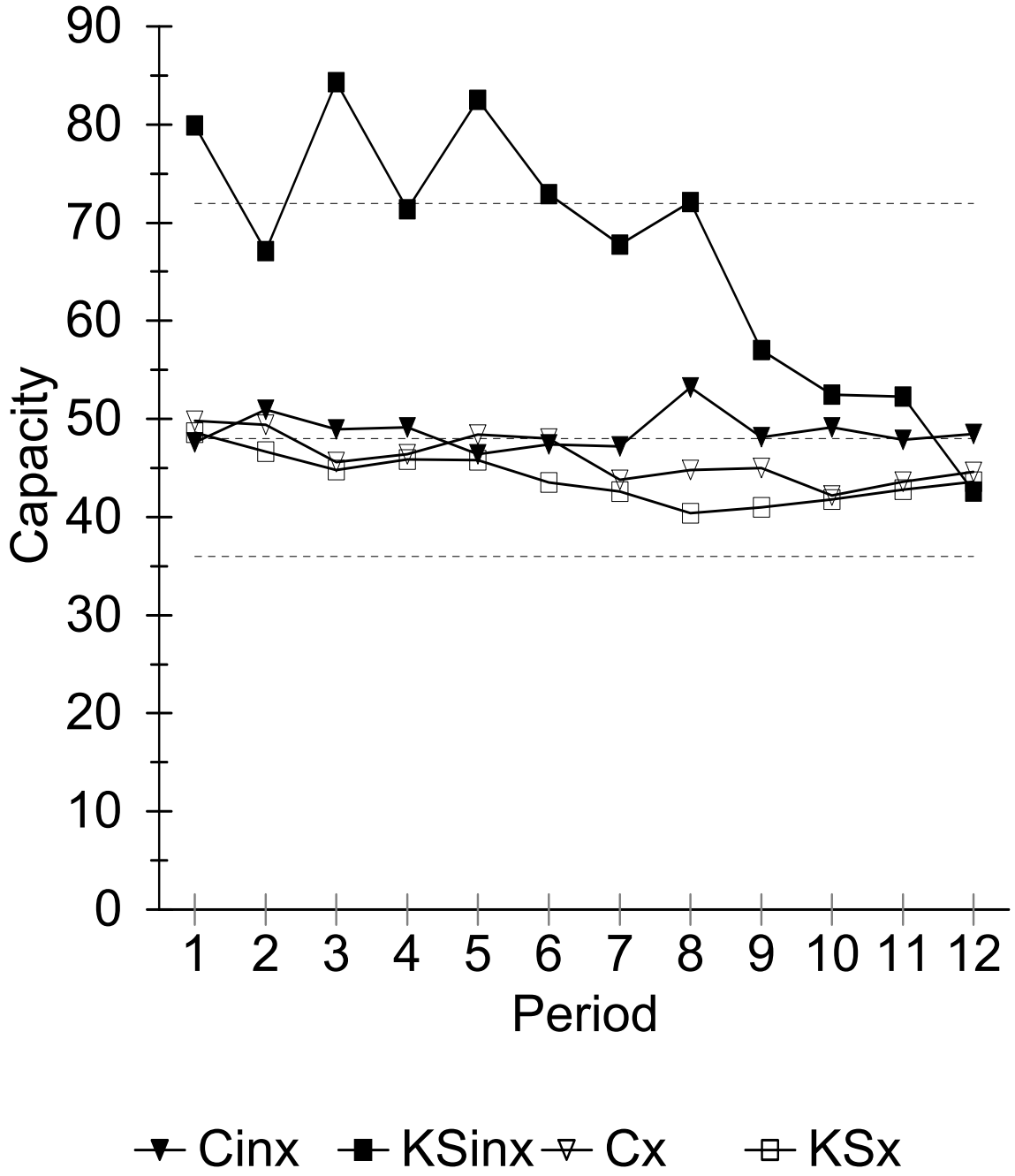

Figure 1. Capacity

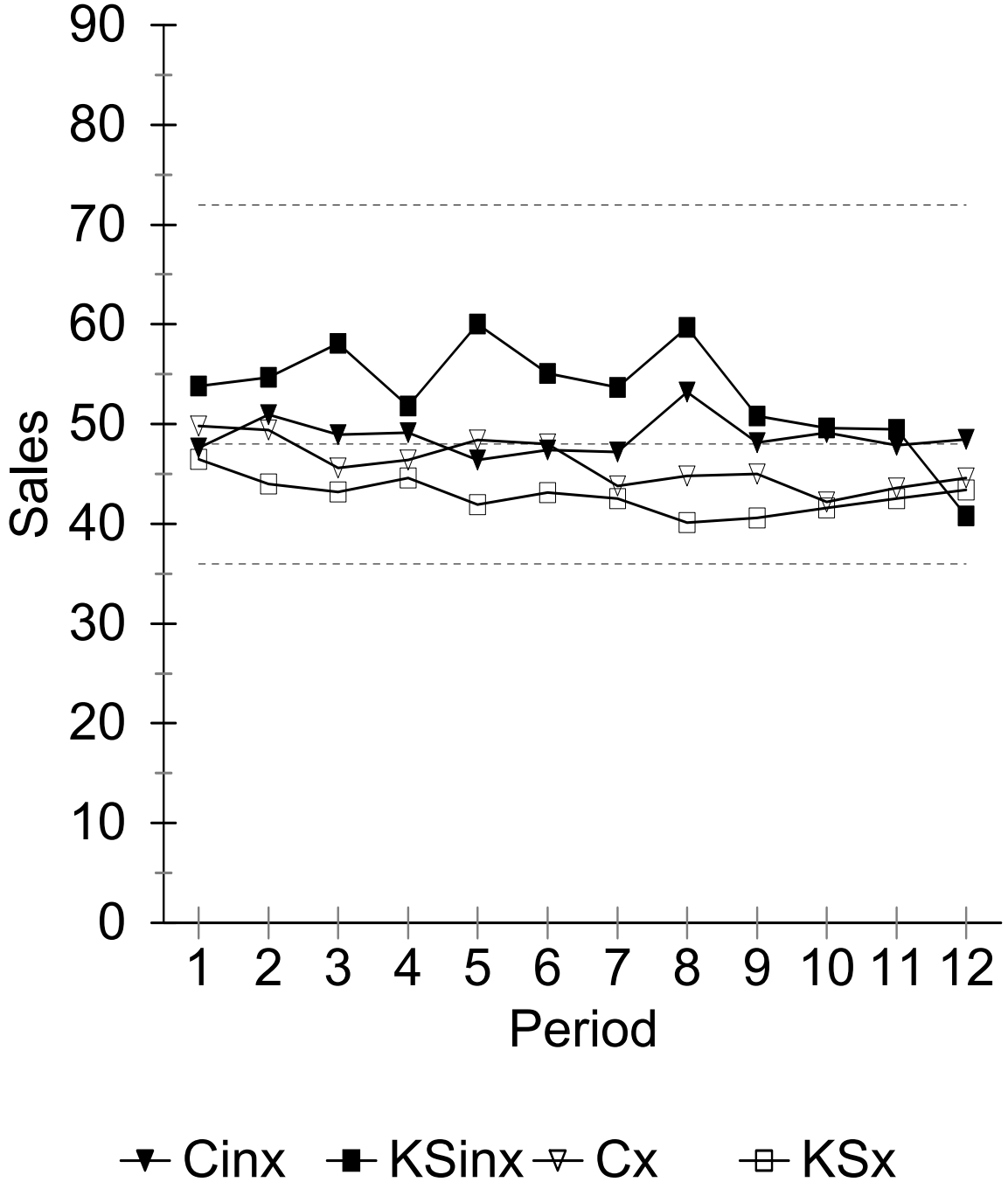

Figure 2. Sales

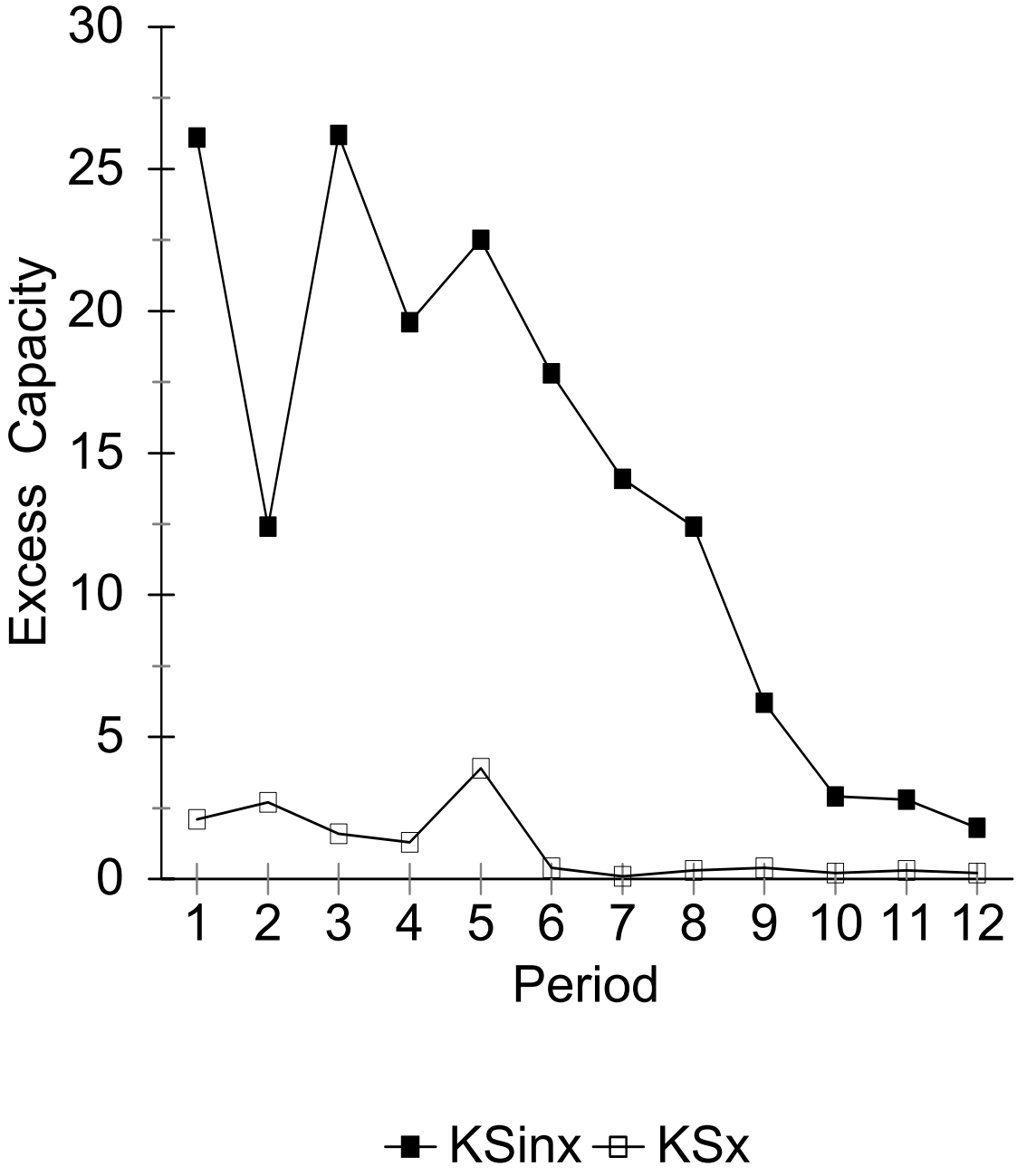

Figure 3. Excess Capacity

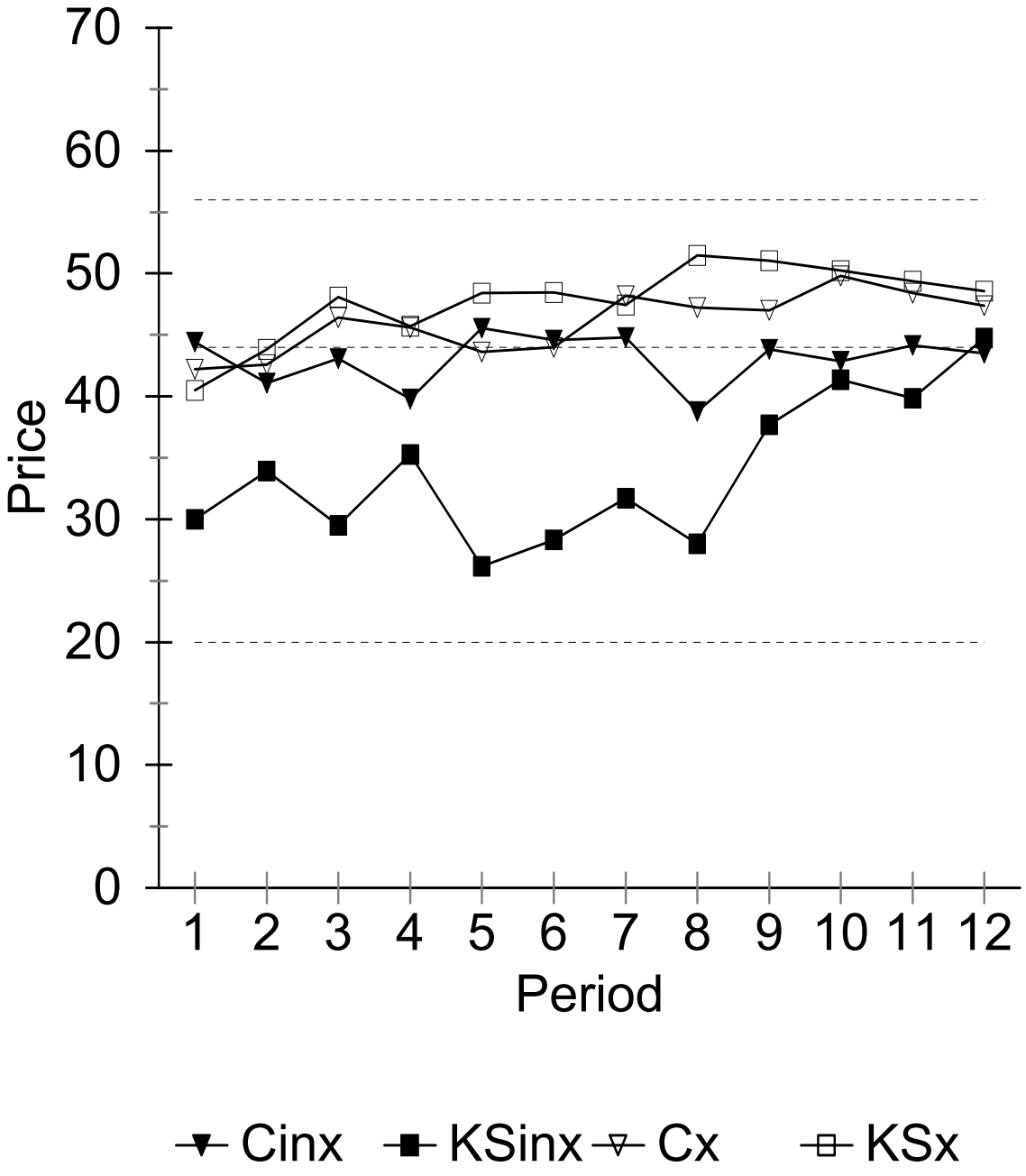

Figure 4. Mean Market Prices

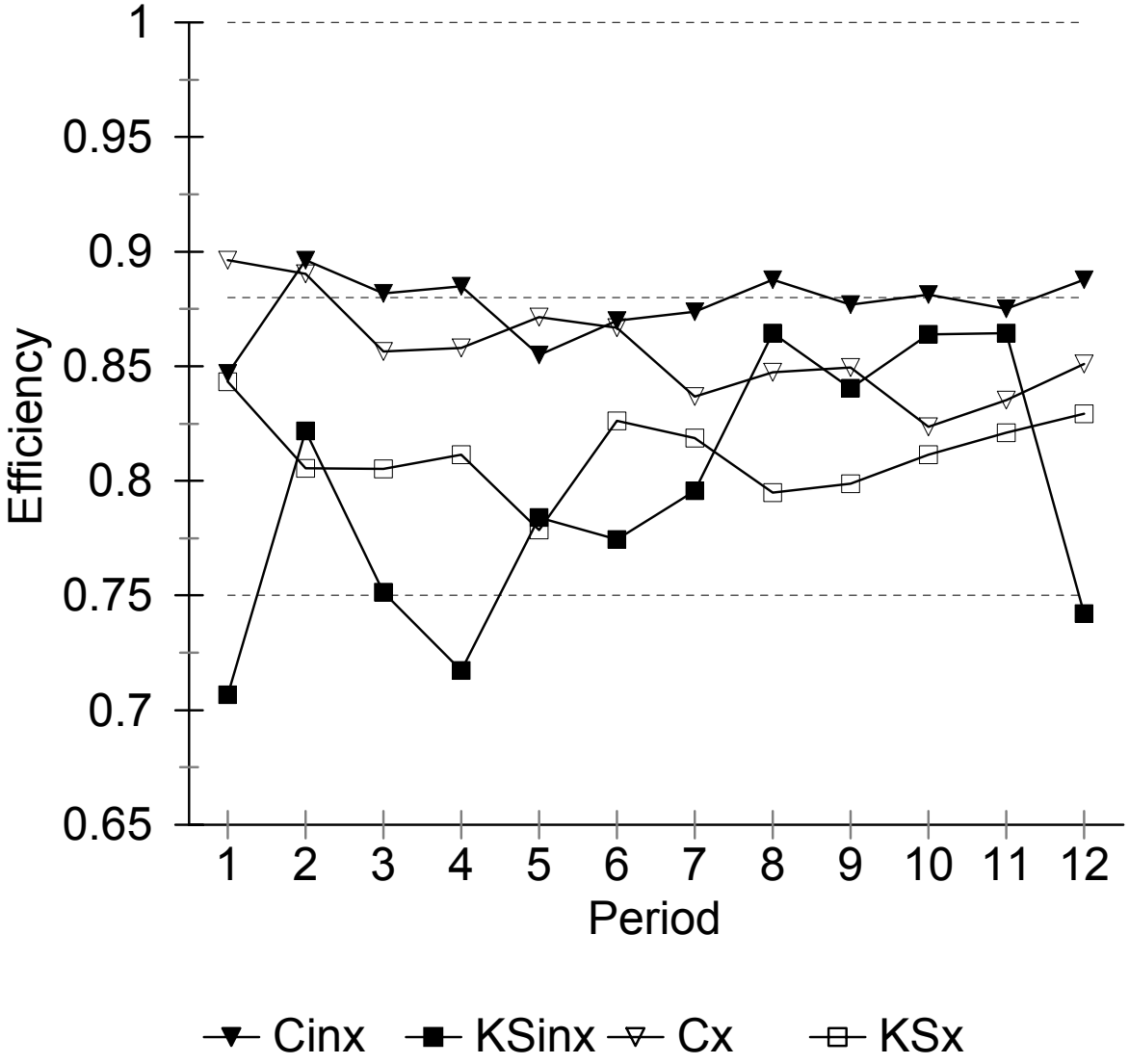

Figure 5. Market Efficiency