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1. INTRODUCTION

In metropolitan Adelaide, as in many other places, the number of taxi-cabs which can legally service the market is limited to those who hold government-issued licences, or 'plates'. These plates are resaleable, and given that entry to the industry is restricted, can become valuable, since they represent a right to earn a stream of rents into the future. With a growing demand for taxi-cabs and no expansion in the number of plates, the value of the rents which a plate holder can earn, and thus the value of the plate itself, can be expected to rise. This was the case in Adelaide between 1974 and 1989.

Although traditional economic efficiency arguments would indicate that the welfare of consumers would be enhanced by the issue of new plates, such an action, by increasing the number of cabs on the road and thus reducing the rents to be earned by driving a taxi-cab, is likely to cause a sharp fall in the value of existing plates, imposing a dramatic capital loss on holders of such plates. The political pressures which existing plate holders can exert are great, and governments are generally keen to avoid any actions which are likely to severely diminish the welfare of the incumbent plate holders.¹

This paper discusses two issues. First, does a small one-off increase in the number of plates cause the values of the existing plates to fall in a laboratory model of the market for tax-cab plates? Second, is the effect on experimentally determined plate values different for an issue of one-period non-resaleable leases, rather than the sale of an additional (resaleable) plate.

¹ It is an elementary observation of public choice theorists that democratic governments will rarely pursue policies which confer large benefits that are thinly spread over a large number of consumers, but impose smaller costs on an identifiable, highly concentrated group of voters.

2. MODELLING THE TAXI-CAB MARKET

When economic experiments are being designed for policy purposes, the aim is to capture in the design of the experiments the essential features of the market being analysed. The experiment should be a working model of the market, presenting a simplified representation of the policy issue under examination and allowing for a clear interpretation of the various outcomes which may result.

No attempt was made by the authors to model the processes involved in the day-to-day operations of the market for taxi-cab services. For example, the processes by which prospective customers decide between various alternative means of transport, by which the signal to use a cab is transmitted and received, and by which owners decide whether or not to drive their cab at any particular time, are not considered in the analysis below. The focus of our experiments was on the markets for taxi-cab licenses and leases, rather than on the market for taxi-cab services directly.

In particular, the central issues concerned the effects on the market prices of existing licences of issuing a small number of extra licences, or leases. In the experiments, a licence gave the owner the right to receive income in each period of the experiment, unless the licence was sold to another participant. Leases were not transferable and entitled the owner to income only in the period immediately following the purchase of the lease. The income which participants derived from the ownership of either a licence or a lease was equivalent.

In modelling the markets for taxi-cab leases and licences (that is, the market for the rights to drive a taxi-cab and collect the profits which derive therefrom), the following conditions were singled out as being crucial:

- 1) The experiment should be made up of a number of periods, where decisions made in one period affect the performance of the participant in later periods. This may seem a trivial observation, but the practice of allowing the conditions in any period of an experiment to be a result of the outcomes in previous periods is a relatively novel one in economic experimentation.²
- 2) The earnings from driving a taxi-cab should increase over the life of the experiment. Such earnings, even where price controls are in force, will depend upon the supply of and demand for taxi-cab services. Over time in the Adelaide market, the supply of services, as measured by the number of licences outstanding, has increased very little. The demand on the other hand is likely to have increased quite significantly due to increases in population and per capita incomes, increased tourism, and perhaps the general upswing in congestion of the city which results from the above factors.³
- 3) Incomes derived from the ownership of the right to drive a taxi-cab should exhibit some risk, that is, they should not be predictable with certainty in advance. This is clearly the case with any business venture, where conditions outside of the control of the operator, such as unpredictable fluctuations in demand, make a definite prediction of future earnings impossible. Yet it is possible to make some prediction about expected future earnings. The prediction which is made will not always equal the actual realized values of earnings, but under certain conditions, may be correct on average. In these experiments, risk was incorporated in a

² c.f. Smith, Suchanek and Williams, 1988.

³ A further point should be noted. Had the growth in earnings from ownership of licence or lease not increased over the course of the experiment, it would be likely that no upward trend would be observed in the market values of licences determined in the experiment. Since the upward trend in the real value of actual taxi-cab licences is one of the most striking features of the market, it constitutes a second reason for the incorporation of growth in earnings into the experimental design.

controlled way. Owners of leases or licences were told that the earnings which they derived from those assets would be, with equal probability, one of four pre-announced values.⁴

- 4) The increase in the number of licences or leases should be as proportionately small in the experimental market as is likely to be proposed for the Adelaide market. In most of the experiments, the issue of the extra licence or lease represented a five percent increase in the total number of licences.
- 5) The size distribution of taxi-cab ownership should, at least at the beginning of the experiments, be roughly the same as that of the Adelaide taxi-cab industry. In the experiments, most participants began owning only one licence, with a smaller proportion owning two, and with several rather larger holders.
- 6) Participants in the experiment should have an income producing alternative to owning a taxi licence or lease. Subjects in the experiments automatically earned interest of ten percent on any cash balances which they held over from one period to another. Apart from being realistic, the inclusion of an interest rate is theoretically necessary to define a non-infinite value for a licence.

Other features of the experiments which require explanation are:

- 1) There were a large number of licences in each experiment relative to the number of subjects. In each experiment there were twice as many licences available as there were subjects. It was found from pilot experiments that this design feature was necessary to ensure that sufficient trades would be made each period to record a market price, i.e. to ensure that the market for licences would be sufficiently "thick".

⁴ A further point in favour of this technique is that previous experiments have found that the existence of risk introduced in this way is sufficient to generate trade in the income earning assets (Smith, Suchanek and Williams, 1988)

- 2) Inflation was neither explicitly included in, nor excluded from, the experimental design. In fact, since subjects were paid entirely on the basis of the value of their assets in the final period of the experiment, relative to their initial endowments, the issue of inflation is not relevant for the experiments at hand. Furthermore, since there was no consumption in the model, there were no relevant prices of consumer goods. In that sense also, the question of inflation is not relevant. Nevertheless the growth in the incomes derived from the ownership of licences or leases, and the existence of a positive interest rate, make it likely that the institutional effects of increasing licence values have been included.

3. THEORETICAL RESULTS

Theoretically optimal licence prices can be derived from certain assumptions about behaviour. Assume initially that individuals within the market are risk neutral profit maximisers with an infinite time horizon, all with the same rate of time preference, r , equal to the interest rate on the alternative asset, money in the bank.

- 1) For a licence that pays a fixed dividend, X , in each period, the amount that a risk neutral individual would be prepared to pay for a licence, V , would be given by:

$$V = \sum_{t=1}^{\infty} X/(1+r)^t$$

$$= X/r \tag{1}$$

- 2) For a licence that pays a dividend X_0 at time $t=0$ which grows at rate g , $g < r$, dividends at time t will be given by $X_t = X_0(1+g)^t$, and the value of a licence at time t is:

$$\begin{aligned}
 V_0 &= \sum_{t=1}^{\infty} \frac{X_0(1-g)^t}{(1+r)^t} \\
 &= X_0 / (r - g)
 \end{aligned}
 \tag{2}$$

Hence more generally,

$$V_t = X_t / (r - g) \tag{3}$$

Application to the Experiments

(i) Expected Bounds for Licence Prices

In the experiments, the interest rate r was given as 10% and dividends were known to be increasing at 4%. Hence $V_t = 16.67X_t$. The range of initial dividends was 4, 5, 6 or 7 (average 5.5).

Most subjects would realise that earning 10% interest would give a return of 4, 5, 6 or 7 on 40, 50, 60 or 70 (dollars) so that on average they would make a profit in this period if they paid less than \$55 for a licence, completely ignoring capital gains. Even the most risk averse person, who noted that initial dividends from a licence can be no less than 4 would be prepared to pay \$40 for a licence. We therefore regard \$40 as the lower bound on the initial price of a licence.

A realistic upper bound on the initial prices can be found by considering a risk neutral profit maximiser with an infinite time horizon. Such an individual would be prepared to pay up to:

$$V_1 = \frac{X_1}{r - g} = 0.1 - \frac{5.5}{0.04} = 91.7$$

Both upper and lower bounds grow at 4% per period. Table 1 gives upper and lower bounds for each V_t up to V_{15} .

TABLE 1
Upper and Lower Bounds on V_t

t	Lower bound	Upper Bound
1	40.0	91.7
2	41.6	95.3
3	43.3	99.1
4	45.0	103.1
5	46.8	107.2
6	48.7	111.5
7	50.6	116.0
8	52.6	120.6
9	54.7	125.5
10	6.9	130.5
11	59.2	135.7
12	61.6	141.1
13	64.0	146.8
14	66.6	152.6
15	69.3	158.7

(ii) Lease Prices

A rational person's maximum valuation of a lease will be the expected value of the dividend for that period. Hence the risk-neutral valuation will be:

$$\frac{E(X_1)}{1 + r}$$

where $E(X_1)$ is the average of the four possible dividends announced at the beginning. Similarly the most risk averse valuation will be the present value of the lowest of the possible dividends and the most risk loving will be the present value of the highest possible dividend for that period.

Table 2 below shows the present values of the highest, lowest and average dividends for the relevant periods.

TABLE 2
Lease Valuations

Period	Risk Averse	Risk Neutral	Risk Loving
8	4.91	6.55	8.36
9	5.09	6.82	8.73
10	5.27	7.09	9.09
11	5.45	7.36	9.45
12	5.64	7.64	9.82
13	5.82	8.00	10.18
14	6.09	8.27	10.55

4. THE EXPERIMENTS

Six pairs of experiments were conducted between June and August 1989, making twelve experiments in total.⁵ The subject pool was varied from experiment to experiment in order to increase the robustness of the results to

⁵ A number of pilot experiments, which differed in a few significant details from the present set of experiments were conducted by the authors prior to finalization of the experimental design. Details of these pilot experiments are available from the authors on request.

variations in subject behaviour. The members of groups one and two were senior economics students from a private high school, group three consisted of public servants, groups four and five were university students and group six, taxi drivers. All subjects were volunteers and all were paid in proportion to the wealth which they accumulated during the experiment.⁶

Each group consisted of twenty subjects, with the exception of group six which had sixteen. After an initial instruction and practice session in which the entire group took part, half of the subjects in each group were allocated at random to one of the pairs of experiments. One of these experiment-pairs involved the introduction of a one-period lease at the end of period seven, whilst the other involved the introduction of another (perpetual) licence, again at the end of period seven.

In each of the ten-subject experiments (groups one to five) there were initially twenty licences, allocated such that two subjects held five licences each, two held two licences, and the remaining six held one licence each. In the eight subject experiments (group six), there were initially eighteen licences, distributed such that two subjects held five, two held two licences and the remaining four held one licence at the beginning of the experiment. In all experiments each subject also began with a stock of one hundred experimental "dollars". As is usual in such experiments, so as not to introduce unnecessary extraneous factors, no mention was made of taxi-cabs in the experiments, except in the case of group six, where such a reference was unavoidable.⁷ The licences were in general referred to simply as "assets".

⁶ Group six, consisting of taxi drivers, were paid more for their participation in the experiment, in order to compensate them for the lost time on the road which participation in the experiment involved.

⁷ The taxi-cab companies who provided the drivers did so because they were told that the authors were performing research into the taxi-cab market.

The experiments continued for up to fourteen periods, each period of three minutes, during which time the assets could be traded by means of an oral double auction. Subjects were informed that their aim was to maximise their total wealth at the end of the experiment. Total wealth was calculated as their cash holdings plus the market value of the assets they held. In order to reinforce this incentive, subjects were informed that their monetary rewards for participating in the experiment would be greater, the greater their total wealth at the end of the experiment.⁸ Subjects could increase their wealth during the experiment in three ways: by collecting the interest on their money holdings at the end of each period; by receiving the dividends on the assets (licences or leases) which they held; or by making trading gains (or losses) on licences. Subjects were alerted to all three avenues of gain, so as not to unduly bias their efforts toward the third of these possibilities.⁹

Each subject could buy or sell licences freely, with the one proviso that they could only buy if they had sufficient cash available, and sell only the assets they held at the time, i.e. no overdrafts or short selling.

Trading periods simulated one year for purposes of calculating interest on cash holdings and receiving dividends. In each period, trading was carried on for three minutes, unless no bidding took place for thirty seconds, indicating that all traders were satisfied with their holdings, in which case the market was considered closed. At the end of each period, interest of 10% was added to cash holdings, and the asset dividend was announced. The portfolio position (cash and assets) at the end of each period represented the starting cash and asset position at the beginning of the next period.

⁸ Since subjects began the experiment with different allocations of assets, adjustments were made in order to allow for this.

⁹ The authors felt that unless care was taken to ensure that subjects understood all of the opportunities to increase their wealth, they would feel bound to 'do something', that is, make gains through trading, rather than through the passive means of collecting interest or dividends.

Average dividend growth was constant at 4%. Subjects were advised at the beginning of the experiment of this rate of growth. There was no uncertainty, therefore, about the average growth rate of dividends and therefore of the average level of dividend incomes in any period.¹⁰

Appendix A includes copies of the instructions to participants, record sheets, and dividend schedules used in the experiments.

Each experiment was conducted by two experimenters. One of these was the auctioneer, recording all bids and offers on an overhead projector, indicating successful trades, and announcing the average market price at the end of each period. The other kept the time, wrote (on a blackboard) the possible dividends at the beginning of the period, announced the actual dividends at the end of each period, and attempted to ensure that the subjects' calculations on their record sheets were performed without error. A total of two hours was allowed for each experimental session, including about three-quarter of an hour for explaining the rules and practice.

Three practice periods were held at the beginning of each pair of experiments to ensure that players were familiar with procedures. All members of the group did the practice session together in one room and were then allotted to one of the two sets of experiments, which were conducted in separate rooms. Trading was then conducted for seven periods, after which a new asset was introduced into the market. In one of each pair of experiments, known as the "licence" experiments, an extra licence was auctioned in a single oral auction by

¹⁰ However, as stated earlier, to capture the risk which is inherent in the taxi business, and any other asset trading situation, a controlled form of risk was built into the experimental design. At the beginning of each period, subjects were presented with a set of four dividend values, and told that each of the four had an equal chance of being the actual dividend payout for that period. For their information, subjects were also told what the average of the four possible dividend payouts was for each period. It was this average that grew at four percent per period.

the experimenter and thereafter became part of the total stock of licences for the rest of the experiment. In the other experiments (the "lease" experiments) a lease was introduced in a single oral auction at the beginning of period eight, and at the beginning of every period thereafter. The lease entitled the holder to a dividend return for one period, but it reverted back to the experimenter at the end of the period with no resale rights. A new lease was then introduced by the experimenter again at the beginning of the next period.

To keep to the scale of increase in taxis proposed for the Adelaide taxi market, the increase in assets in the trading experiment was limited to one (5% of the experimental market). This meant that the number of assets was increased only once. The subjects were informed at the beginning of period eight when the new asset was introduced that there would be only one asset or new lease, and that no further change to market conditions would occur.

In one pair of experiments (group 5) an "income shock" was delivered at the time of introducing the new asset. This simulated the effect that an increase in taxi numbers might be expected to have on individual incomes. In this pair of experiments, the possible dividend payouts did not grow at 4% between periods seven and eight, but rather remained constant. To emphasise the uncertainty of the impact in these experiments, subjects were informed that there would be some sort of impact, but the dividends for period eight were not pre-announced as the preceding seven periods' dividends had been. (Statistical analysis, available from the authors on request, indicates that the results of the two group 5 experiments did not differ in a statistically significant fashion from those of the other groups).

5. RESULTS

(a) Licence Prices

Figures one to six show the average market prices of licences over the course of the experiments, together with the upper and lower bounds derived in Section 3, and the auction price of the new licence introduced in period eight. The price scales are logarithmic to give equal weight to equal percentage changes.

Because all markets were identical until a lease or licence was introduced in period eight, the data from periods one to seven were used to investigate differences in behaviour between the different groups of subjects. All analysis was performed on differenced log data, to remove the exponential trend which existed in data from all of the experiments, and which was inherent in the experimental design.

The analysis in Table 3 shows that differences between sets of subjects are significant. This can be identified as being due to the widely different behaviour of one of the second pair of experiments; i.e., the second group of secondary school students.

TABLE 3
Analysis of Variance

Source	Degrees of Freedom	ss	ms	F	5% Critical F
Subjects	11	0.0360	0.0033	2.44*	2.18
Periods	5	0.0091	0.0018	1.36 n.s.	2.45
Error	<u>55</u>	<u>0.0737</u>	0.0013		
Total	71	0.1188			

Standard error of difference between group means = 0.0211
Standard error of difference between periods = 0.0149.

An analysis of the differenced logged data, omitting group two, given in table four, indicates that the remaining sets of subjects were sufficiently similar to be treated as replicated. Removal of group two also reduced the error variance by a factor of about two.

TABLE 4
Analysis of Variance

Source	Degrees of Freedom	ss	ms	F
Subjects	9	0.0050	0.0006	0.91 n.s.
Periods	5	0.0123	0.0025	4.03***
Error	<u>45</u>	<u>0.0274</u>	0.0006	
Total	59	0.0446		

Standard error of differences between group means = 0.0142
Standard error of differences between periods = 0.0101.

Although the experiments were preceded by three practice periods, the first few periods in the actual experiments should perhaps be regarded as subject to learning effects, since the average price changes from periods one to two and from periods two to three are shown to be significantly different from those between the later periods in the analyses in Table 4 above and Table 5 below.

TABLE 5

Period	Period Totals
1 to 2	0.4865
2 to 3	0.1021
3 to 4	0.2885
4 to 5	0.3400
5 to 6	0.2353
<u>6 to 7</u>	<u>0.4794</u>
Grand Total	1.9319

It can be seen in figures one to six that, in most markets, from about period five to period ten, prices paid for licences changed in a way consistent with the theoretical predictions, on the assumption that the licences were valued purely for their stream of future earnings. This portion of the data was used in the analysis in Table 6.

However, in five of the twelve markets, prices rose above the theoretical upper bound in the later periods, suggesting perhaps that some speculation was taking place. This was not altogether unexpected. In the experimental markets investigated by Smith et al., (1988), it has been shown that speculative trading occurs in a proportion of their asset trading markets, and is unpredictable in its occurrence. Such speculation occurs even when the asset is known to have a fixed value at some future time. It is more likely to occur when subjects are inexperienced or when the initial market valuation of the asset is too low, so that in rising to their "correct" value, prices can overshoot. It was shown in Section 3 that even the most risk averse person should be prepared to pay 40 for a licence in period one. Thus at an initial price of 28, both markets in Group 2 started with

asset values that were too low. In one of these cases, "undue" speculation saw the price rise beyond theoretically predicted limits very early; in the other case, prices did not rise sharply until after period ten.

In the other cases, where starting prices were "reasonable", it is possible that end-of-experiment effects accounted for some of the late rises in prices. Subjects knew that the licences would be valued at their final market price, for purposes of subject payment. As the end of the experiment approached, therefore, subjects had an incentive to attempt to bid up these prices. For example, a subject holding five licences would have had an incentive to pay a large amount (in excess of the "rational" value) for a licence in what was thought would be the final period, since the high market price measured in the final period would have increased the valuation of all of the licences held. Interestingly, the two experiments which used actual taxi drivers did not exhibit speculative trading.

The statistical analysis of the data spanning periods four to ten is shown in Table 6. It shows no evidence that the introduction of a new asset in period eight had any effect in the relative change of licence prices. It therefore seems unlikely that the introduction of a new asset caused the speculative trading described above which appeared towards the end of some experiments.

TABLE 6
First Differences of Log Data Periods 5-10
Excluding Group Two

ANALYSIS OF VARIANCE				
Source	Degrees of Freedom	ss	ms	F
Licence vs Lease	1	0.0006	0.0006	1.21 n.s.
Before vs After	1	0.0002	0.0002	0.42 n.s.
Interaction	1	0.0001	0.0001	0.25 n.s.
Error	<u>56</u>	<u>0.0294</u>	0.0005	
Total	59	0.0304		

Thus we conclude that the introduction of a small number of leases or licences had no statistically significant effect on the future price of licences, and that the licence prices were not differently affected by the introduction of licences or leases. These results appear to be independent of the existence or otherwise of a possible speculative bubble in the market.

(b) Lease Prices

We now turn to an analysis of the lease prices in the markets, which are shown in Figure 7, along with the maximum and minimum prices which should be paid by risk-averse, risk neutral and risk loving individuals (as given in Section 3). Once again, the price scales are logarithmic so as to give equal weight to equal percentage changes.

Clearly, prices in all experiments were higher than one might expect on average, and the results from Group 3 reveal that at least two subjects did not comprehend the non-resaleable nature of a lease, for the duration of the experiment. In all other cases the auction prices, after learning periods of various lengths, began to track the "rational" values fairly well, even though they were on the whole higher than the "risk neutral" prices.

Two explanations suggest themselves. Subjects may not have grasped the notion that they should pay somewhat less than the expected dividend, to allow for interest foregone on the money used to buy the lease: that is, future dividends must be discounted by the ten percent interest rate to obtain their present value. The idea that subjects may not have understood this is supported somewhat by the fact that the undiscounted maximum and minimum values (shown in Figure 7 by dotted lines) sit more comfortably around the observed prices than do the discounted values.

Second, it is possible that the excitement of the single oral auction led to a tendency to overbid slightly. This view is lent weight by the observation that the single auction prices for the new licence was in several cases noticeably higher than the double-auction price for existing licences in the preceding or subsequent periods (see Figures 1-6).

A final interesting feature of the results is that the unstable licence prices observed in the Group 2 experiments does not appear to have carried over to lease prices.

6. CONCLUSIONS

The first set of conclusions relates to the experiments and their application to the market for taxi licences. The results of the above experimental model of the Adelaide market for taxi-cab licences indicated that an expansion of the number of assets in the market by 5% had no perceptible effect on licence prices. Neither was there any difference in effect on licence prices between the issue of an extra lease or licence. The relatively small impact of the new asset was either below the threshold of perception, or outweighed by other factors, such as some element of speculation on future resale price.

The development of speculation in some of the experimental markets suggests that it is possible that licence values in real world markets are subject to the same pressures. It is likely, however, that taxi licence markets in the real world are less subject to speculation than experimental markets for at least three reasons.

First, markets for taxi-cab licences have been well established for many years. If speculative bubbles are characterised by an initial undervaluation of the asset, followed by an excessive correction, this is more likely in the experimental markets, in which learning was still taking place, than in long-established real

world markets. Second, speculation in the real world has more appropriate outlets (stock market, real estate, futures, race courses, etc) than the taxi-cab licence plate market. Finally, there is evidence that people will be more risk averse with large amounts of real money than they are with the small amounts typically associated with economic experiments (Binswanger 1980).

In any set of experiments intended to model a real-world situation, doubts must naturally arise concerning the external validity of the results, that is, the extent to which they translate to the real-world situation being modelled.¹¹ Clearly, numerous institutional details of the Adelaide taxi-cab market were not incorporated into the experimental model described above. The central issue is whether any essential features have been left out. On the assumption that the experimental results extend to the Adelaide taxi-cab market, they would suggest that the market impact of issuing a small number of licences or leases would be negligible.

The second set of conclusions relates to the usefulness of experimental methods in transportation modelling in general. Experimental studies in this area are relatively thin on the ground, although some have been conducted. For example, Grether et al (1979, 1981) have conducted experiments to examine the effects of different policy proposals to overcome congestion at major U.S. airports, while Hong and Plott (1982) modelled the structure of barge traffic on the Mississippi River to examine the effects of legislation requiring all prices to be posted in advance. These models and the current one can indicate under tightly controlled conditions how human subjects are likely to interact in the marketplace, and can therefore throw light on possible policy initiatives, whose outcomes cannot otherwise be predicted with any certainty. While experimental

¹¹ In the terminology of experimental economics, the question is one of the degree of parallelism between the experimental markets and their real-life counterparts.

methods cannot settle real-world questions with absolute certainty either, they can at least give policy makers a much more likely indicator of outcomes at relatively low cost.

This analysis has had fairly limited objectives. While the results are not unexpected, given these limited objectives, we regard the method by which these results were obtained as important. The framework of Smith et al (1988), which allows decisions at one point in time to impact upon later periods, has been successfully applied to a transport market. This framework could act as a base from which, for example, greater shocks, or shocks which persist over longer periods could be administered, variations could be made in the signalling of future shocks to the market, or those conditions conducive to the formation of price bubbles could be explored.

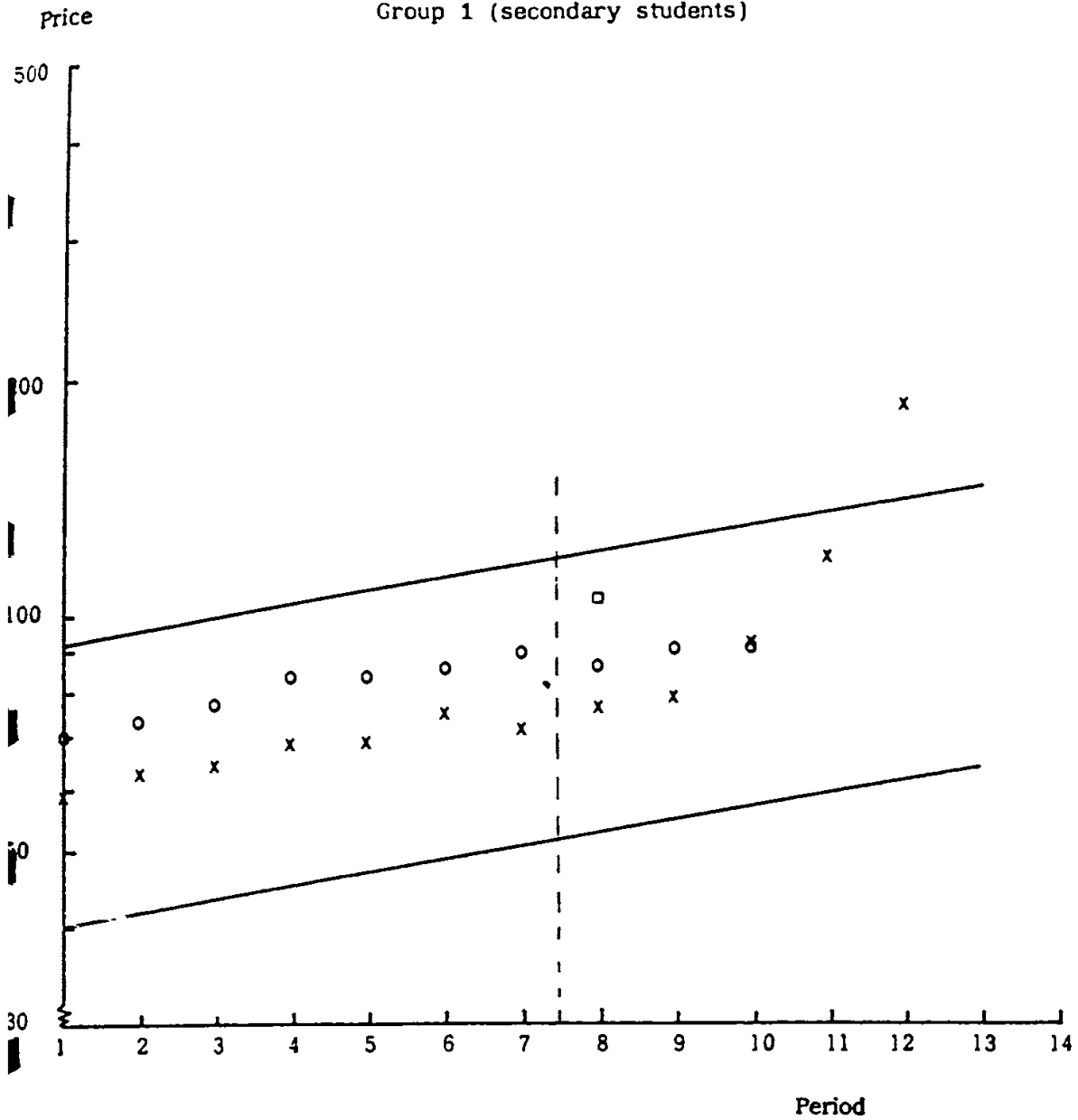
REFERENCES

- Binswanger, H.P. (1980), "Attitudes towards risk: experimental measurement in rural India", American Journal of Agricultural Economics, August, pp. 395-407.
- Coffman, R.B. (1977), "The economic reasons for price and entry regulations for taxicabs: a comment", Journal of Transport Economics and Policy, 11(3), September.
- Grether, D.M., Isaac, R.M., and Plott, C.R. (1979), "Alternative Methods of Allocating Airport Slots: Performance and Evaluation", paper prepared for the Civil Aeronautics Board and Federal Aviation Administration, Pasadena Ca, Polinomics Research Laboratories Inc.
- Grether, D.M., Isaac, R.M., and Plott, C.R. (1981), "The Allocation of Landing Rights by Unanimity among Competitors", American Economic Review, 71(2), May, pp. 166-71.
- Hong, J.T., and Plott, C.R. (1982), "Rate Filing Policies for Inland Water Transportation: An Experimental Approach", Bell Journal of Economics, 13(1), Spring, pp. 7-14.
- Smith, V.L., Suchanek, G.L., and Williams, A.W. (1988), "Bubbles, Crashes and Endogenous Expectations in Experimental Spot Asset Markets", Econometrica, 56(5), September, pp. 1119-51.
- Williams, D.J. (1979), "Is the Regulation of Price and Entry in the Taxicab Industry still acceptable?", paper delivered at the 49th ANZAAS congress, Auckland N.Z., 22-26 January.

FIGURE 1

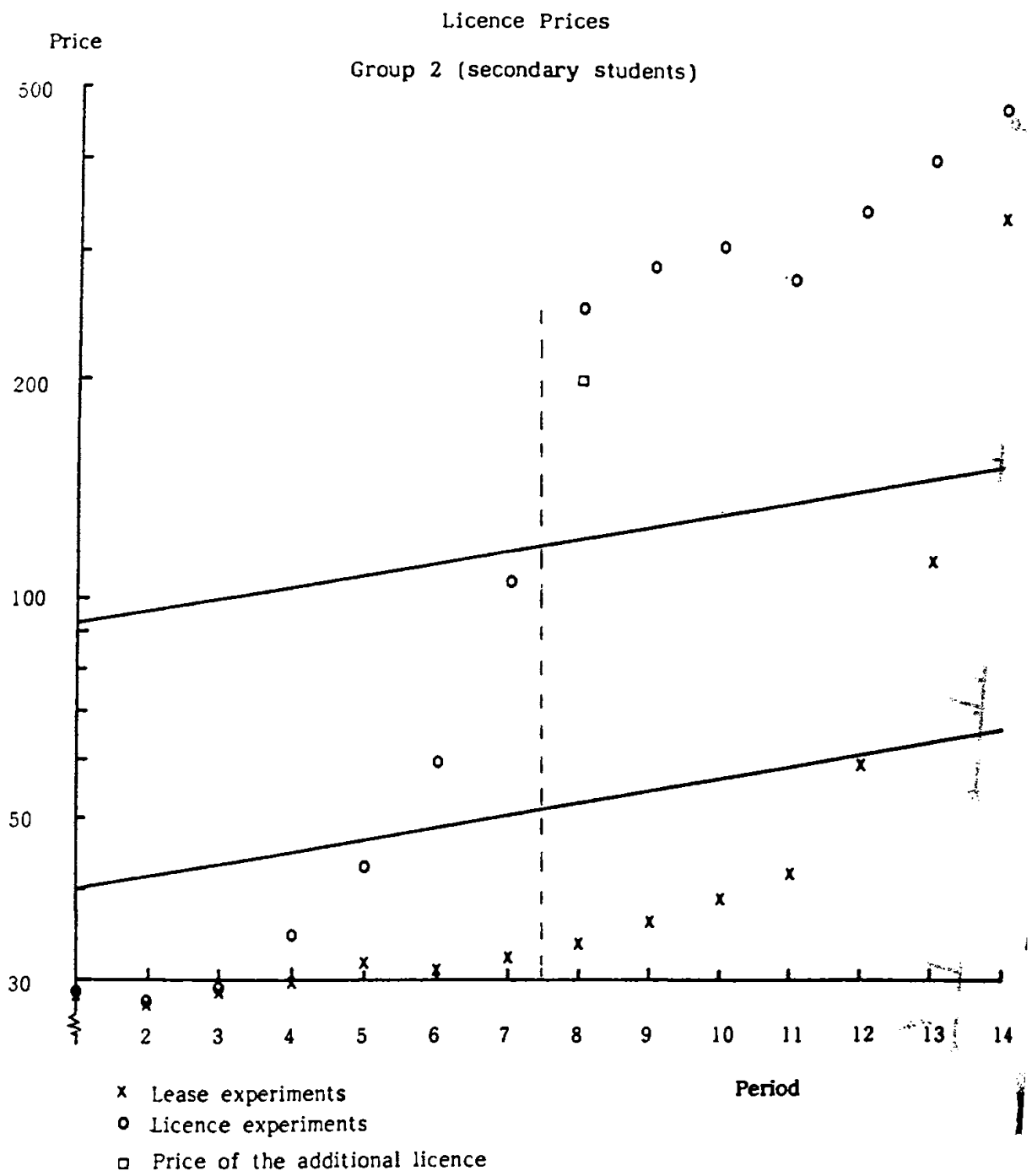
Licence Prices

Group 1 (secondary students)



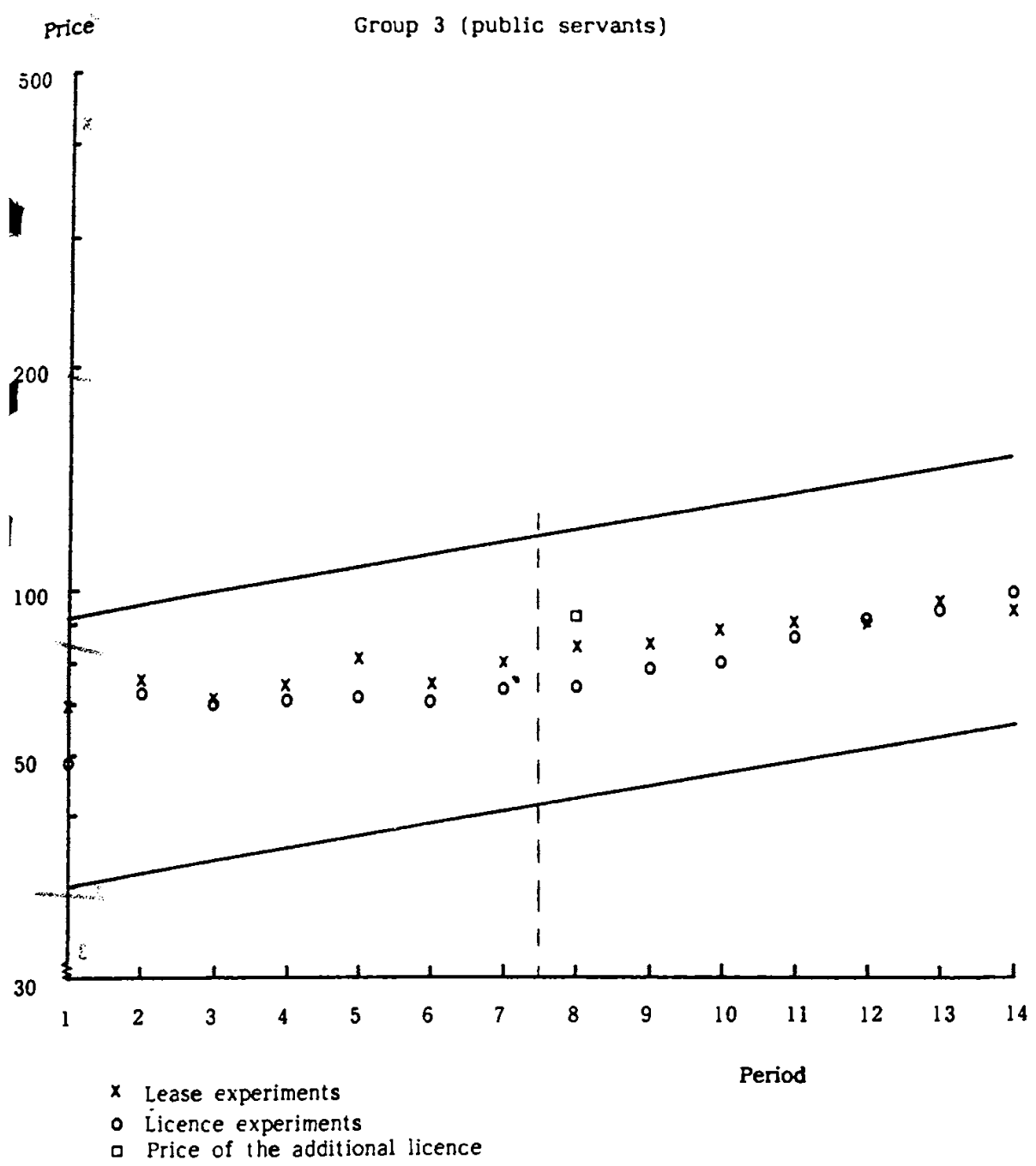
- x Lease experiments
- o Licence experiments
- Price of the additional licence

- Notes:
1. The vertical axis (price) is expressed logarithmically.
 2. The upper line on the graphs represents the risk-neutral valuation (the Upper Bound of page 12) and the lower line the risk averse valuation with no growth allowed for (the Lower Bound of page 12).



- Notes:
1. The vertical axis (price) is expressed logarithmically.
 2. The upper line on the graphs represents the risk-neutral valuation (the Upper Bound of page 12) and the lower line the risk averse valuation with no growth allowed for (the Lower Bound of page 12).

FIGURE 3
Licence Prices

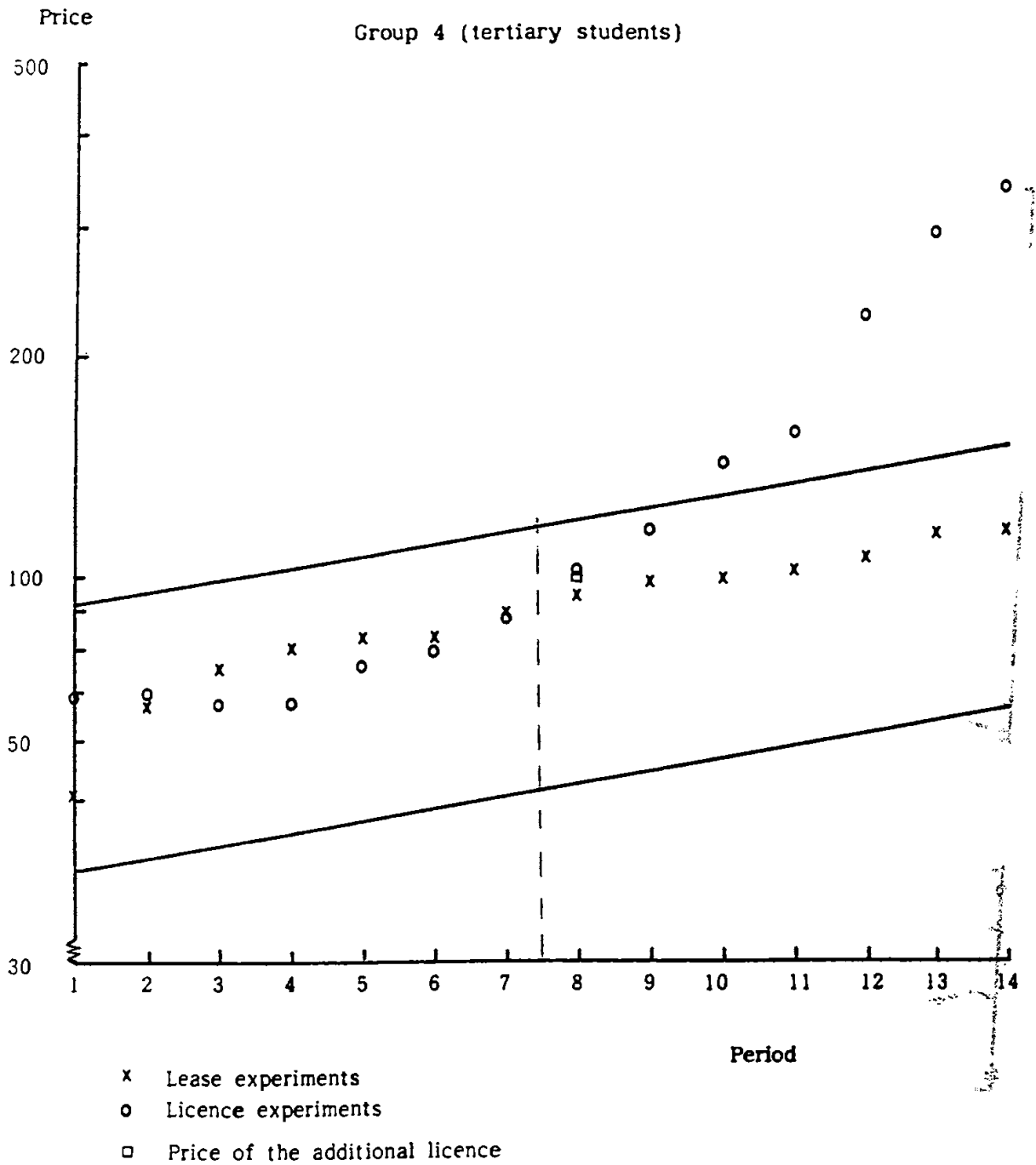


Notes:

1. The vertical axis (price) is expressed logarithmically.
2. The upper line on the graphs represents the risk-neutral valuation (the Upper Bound of page 12) and the lower line the risk averse valuation with no growth allowed for (the Lower Bound of page 12).

Licence Prices

Group 4 (tertiary students)

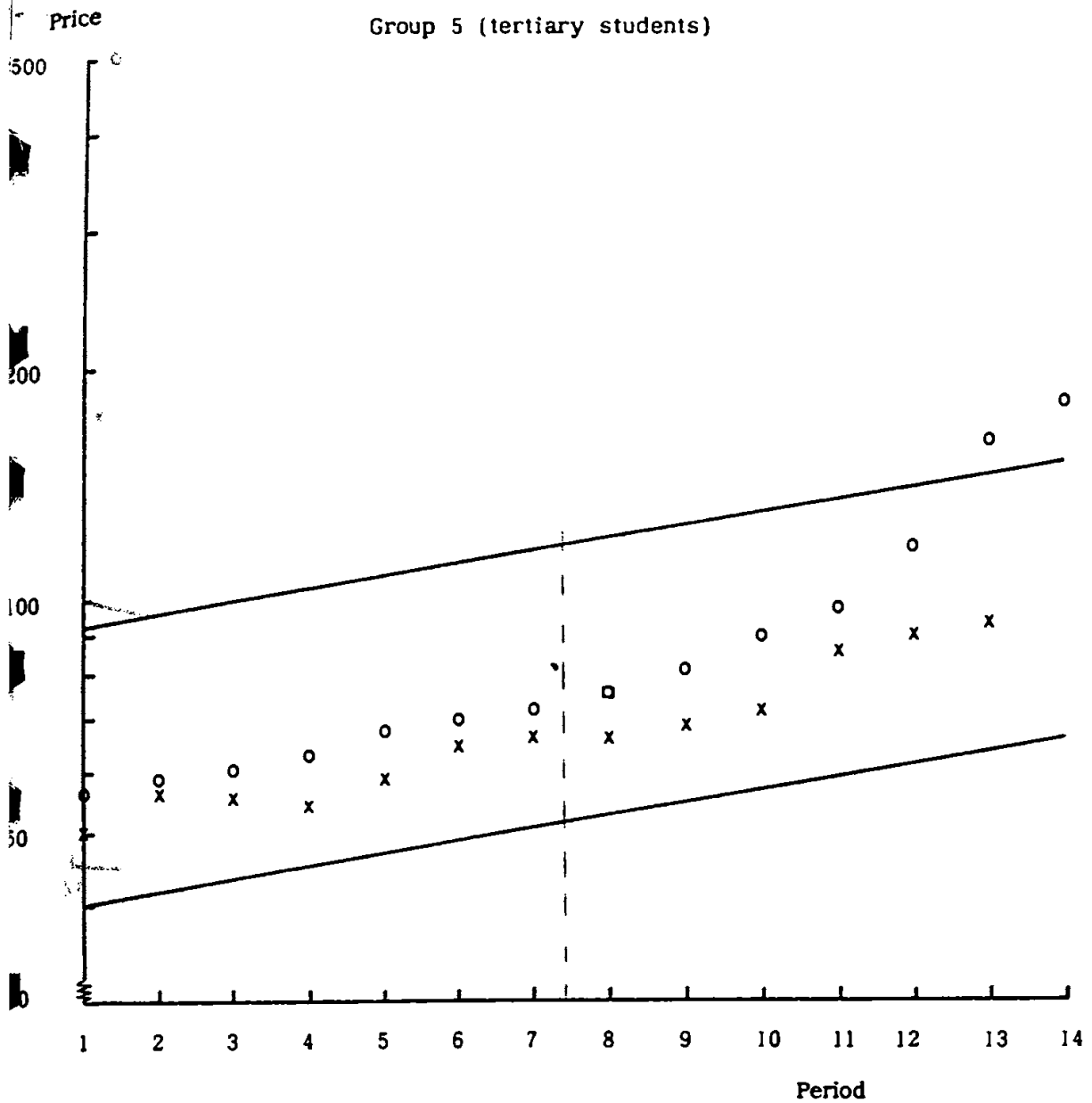


- Notes:
1. The vertical axis (price) is expressed logarithmically.
 2. The upper line on the graphs represents the risk-neutral valuation (the Upper Bound of page 12) and the lower line the risk averse valuation with no growth allowed for (the Lower Bound of page 12).

FIGURE 5

Licence Prices

Group 5 (tertiary students)



- x Lease experiments
- o Licence experiments
- Price of the additional licence

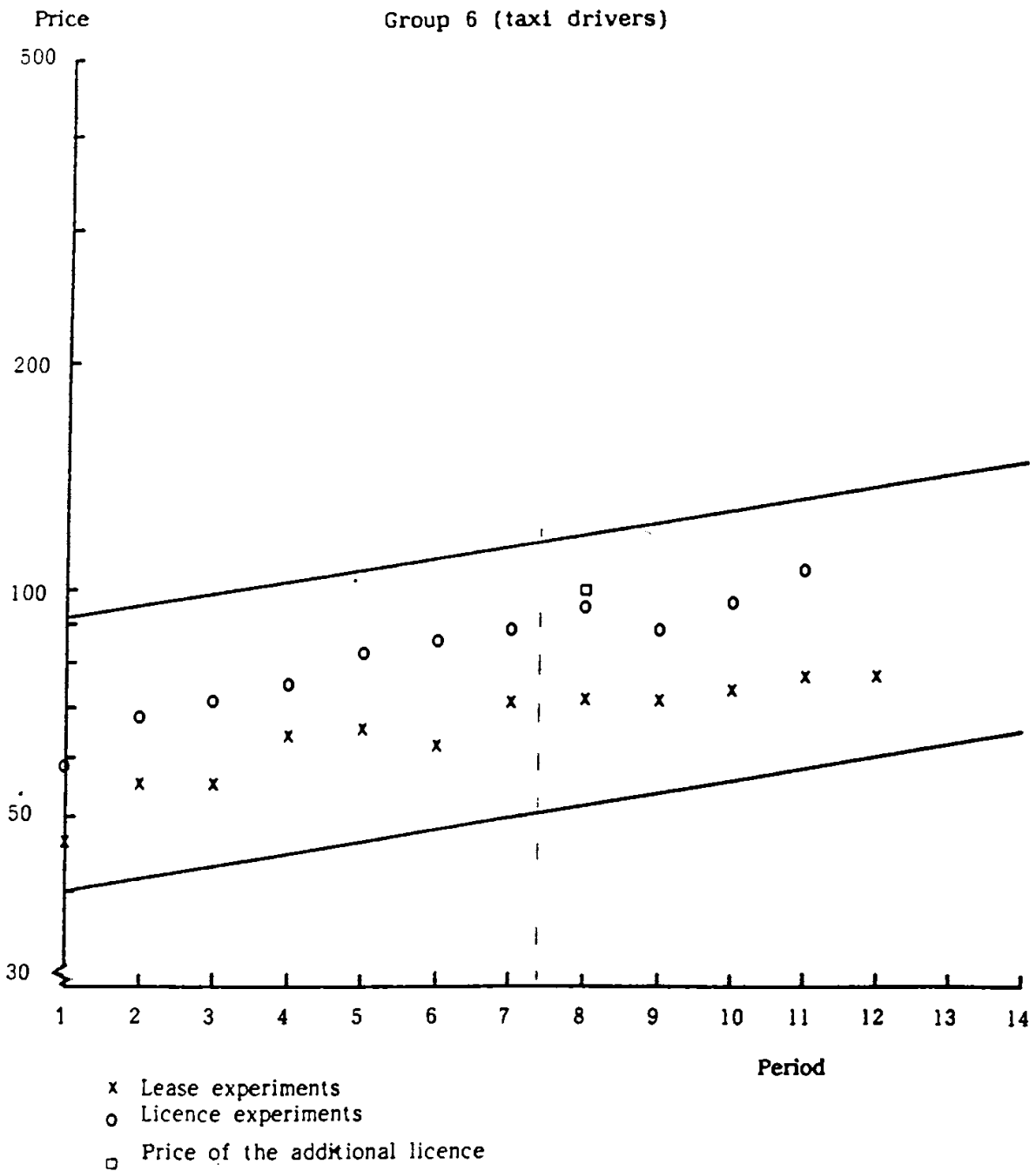
(13)
(11) 11.

- Notes:
1. The vertical axis (price) is expressed logarithmically.
 2. The upper line on the graphs represents the risk-neutral valuation (the Upper Bound of page 12) and the lower line the risk averse valuation with no growth allowed for (the Lower Bound of page 12).

FIGURE 6

Licence Prices

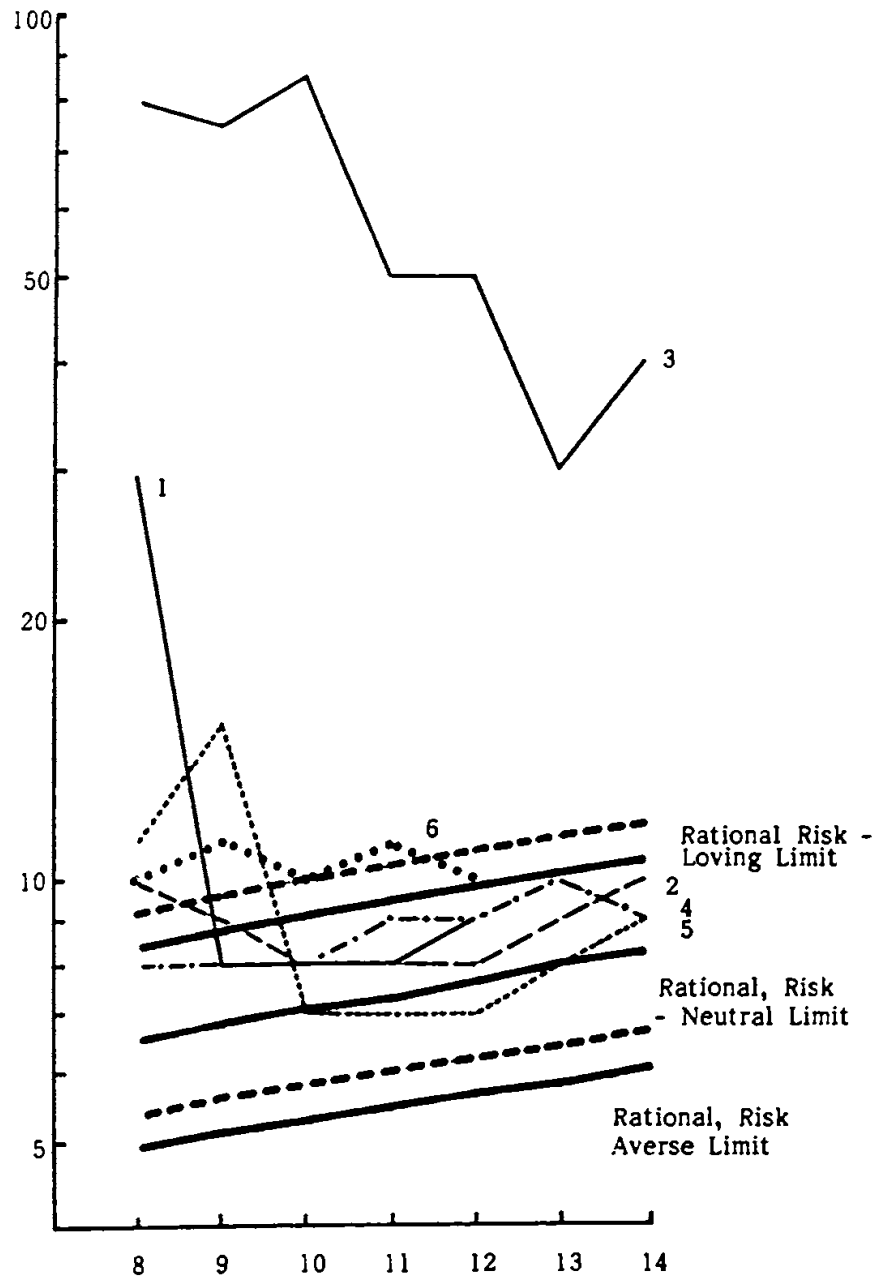
Group 6 (taxi drivers)



- Notes:
1. The vertical axis (price) is expressed logarithmically.
 2. The upper line on the graphs represents the risk-neutral valuation (the Upper Bound of page 12) and the lower line the risk averse valuation with no growth allowed for (the Lower Bound of page 12).

FIGURE 7

Lease Prices



1. The vertical axis (price) is expressed logarithmically.
The solid black lines on the graph represent the rational limits of bidding outlined in the table on page 13.

APPENDIX B

Copies of experimental materials

B-2 Instruction sheet handed to subject

B-3 Subject's record sheet

B-4 Auctioneer's record sheet

B-5 Table of dividends

B-6 Copy of instructions read by the auctioneer to the subjects at the
time of introducing the lease or the new licence.

ASSET TRADING EXPERIMENT

You are about to take part in an asset trading experiment. Think carefully about your decisions as the greater your total wealth at the end of the experiment the greater your cash payout.

You start with a sum of money and a number of assets. Money earns 10% interest. Each asset is in the form of a licence to produce the same fixed amount of a product. The profits from holding a licence in any period is uncertain but will be one of four values each with an equal chance of occurring. These values increase at 4% per period.

Your wealth is increased by

- (a) earning interest
- (b) making profits
- (c) making trading gains on licences (if your sale price exceeds your purchase price).

Wealth increasing opportunities may conflict. Spending money to acquire licences means forgoing interest otherwise earned. Sometimes it may pay to take a trading loss to improve your money asset position.

TRADING RULES

You cannot SELL more licences than you hold (represented by white tokens), nor BUY more than you can pay for. You can both buy and sell in the one session. To trade call out the trader number on your lapel badge and the words "to buy at (price)" or "to sell at (price)". For example "9 to buy at 43" or "5 to sell at 69".

The auctioneer writes all buying bids and selling offers on the board. Buying bids must go up and selling offers go down during the course of trading in one session. To accept a buying bid or a selling offer, call out your trader number and say "accepts (price)".

When a trade takes place, the seller passes a token to the buyer. Buyer and seller immediately record the change in cash holdings on their record sheet, after which they may resume trading.

The possible profit values and their average will be announced before each trading session. The session lasts 3 minutes (or less if there are no bids or offers for 30 seconds). The final session will not be pre announced.

After each trading session there will be one minute to fill in the record sheet (see overpage). Your new money holdings should be transferred to the top of next period's column. You will be told the actual profits and the market value of the licence. This licence value is the average of the prices for which licences were traded during the period. The combination of money holdings and licence value gives your TOTAL WEALTH. This is what you should aim to maximise by the end of the experiment.

The record sheets will be demonstrated and your questions answered.

PLAYER NUMBER: 10 NAME:

DATE:

RECORD SHEET

START THE EXPERIMENT YOU HAVE / LICENCES AND \$100 CASH (YOU THEREFORE HAVE / LICENCE TOBACCO AND \$100 IS RECORDED AS YOUR STARTING CASH HOLDINGS)

READING OPERATIONS	PERIOD 1	PERIOD 2	PERIOD 3	PERIOD 4	PERIOD 5	PERIOD 6	PERIOD 7
BY AT START	100						
BY AT END							
+ INTEREST (00%)							
+ DIVIDENDS							
TOTAL TO C/P							
KEEP VALUE OF LICENCES							
TOTAL WEALTH							

USE ONLY INTEGERS. ROUND .5 AND ABOVE UP, ROUND .4 AND BELOW DOWN.

Table of dividends

<u>Period</u>	<u>Distribution of net earnings of taxi</u>				<u>Average earnings</u>
1	4.0	5.0*	6.0	7.0	5.5
2	4.2*	5.2	6.2	7.3	5.7
3	4.4	5.4	6.4*	7.6	5.9
4	4.6*	5.6	6.7	7.9	6.1
5	4.8	5.8	7.0*	8.2	6.4
6	5.0*	6.0	7.3	8.5	6.7
7	5.2*	6.2	7.6	8.8	6.9
8	5.4	6.4*	7.9	9.2	7.2
9	5.6*	6.7	8.2	9.6	7.5
10	5.8	7.0	8.5*	10.0	7.8
11	6.0	7.3	8.8	10.4*	8.1
12	6.2	7.6	9.2*	10.8	8.4
13	6.4	7.9*	9.6	11.2	8.8
14	6.7	8.2	10.0	11.6*	9.1
15	7.0	8.5	10.4	12.1	9.5
16	7.3	8.8*	10.8	12.6	9.9

Practice sessions

<u>Period</u>	<u>Distribution of net earnings of taxi</u>				<u>Average earnings</u>
1	8.0	9.0	10.0	11.0*	9.5
2	8.3	9.4	10.4*	11.4	9.9
3	8.6	9.8	10.8*	11.9	10.3

Notes:

- (1) The first row shows that in period 1, the earnings per licence held were, with equal probability, either 4,5,6 or 7 units. Subjects were given these figures and their average (5.5) at the beginning of period 1.
- (2) At the end of period 1, subjects were told which of the four alternatives had been chosen by random number. An asterisk was placed on this chosen figure, which was "5" in period 1. The asterisks were placed on the same numbers as given above in each of the experiments.
- (3) In the two experiments in which there was an income shock, no earnings figures were posted for period 8 until the end of the period, at which time the same figures for period 7 were posted, but with the asterisk on 7.6 (the third figure). After that, in each period, the earnings distribution was again posted at the beginning of the period. However, what is called period 8 in the above table was period 9 for these two experiments, and the time displacement of one period continued for the remaining periods.
- (4) The three practice periods preceded the main experiment .

REDUCTION A NEW

new asset will be introduced into the system in this period and licence for this asset will be sold to the highest bidder at beginning of the auction process. Thereafter it will be part the trading stock of the purchaser and can be resold in the any other licence

Any question

INTRODUCTION OF A LEASE

A new asset will be introduced into the system in this period. However it will not be the subject of a licence in the way of existing assets.

The rights to the dividends from this asset will be sold on the basis of an annual lease.

That is, for your lease payment you get the dividends of the asset for the current year only. You do not get a licence to resell

Since you only get the dividends from the asset for one year, the value of the lease will be less than the value of a licence. You have to decide how much you wish to pay for the chance to earn this years dividends

From now therefore, you will have two ways of earning dividends

buy a licence or
get a lease

will only be lease available each year. At the end of or the current lease holder, relinquishes the asset which to the controller, to be leased out again.

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d