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ANALYSIS OF CALENDARING STRATEGIES FOR CRIMINAL JURY TRIALS IN COURT SYSTEMS

by

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Abstract

Criminal jury trials are characterized by considerable uncertainty as to whether they will proceed when scheduled. The problem of scheduling such matters to a calendar is considered in this paper. Several workload models are suggested which include this uncertainty; and two costs are suggested as relevant for any calendaring strategy, one for over-scheduling (i.e. cases must be forcibly continued) and one for under-scheduling (i.e. there are idle courtrooms). In several situations an optimal number of cases to assign to a courtroom under individual calendaring is found. Moreover, cost expressions are found for various master calendar strategies both when prosecutors individually prepare a case and must present it and when prosecutors are interchangeable in the courtroom. The best number of cases to assign to a master calendar is found in several examples. In these situations the per court cost of a master calendar is found and compared with that of an individual calendar. Dramatic savings are often possible. However, there are instances when an individual calendar is no more costly than a master calendar. The results are used to suggest a better calendaring strategy for the Berkeley/Albany (Ca.) Municipal Court.

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Introduction

One very costly activity in which a court system engages is the holding of criminal jury trials. In municipal courts in California, it is often the case that one-fifth of the available court time is so allocated. In the Berkeley/Albany Municipal Court (hereafter called the reference municipal court) the figure is one-fourth. In superior court systems, criminal jury trials normally utilize considerably more resources. In Alameda County Superior Court (hereafter called the reference superior court) the fraction is over one-third. A characteristic of municipal court criminal jury trials is that they frequently do not occur when scheduled. Among the reasons are: 1) the defendent decides to plead guilty, 2) witnesses fail to appear, 3) a last minute plea bargain is arranged, and 4) the defendent or his attorney cannot appear. Another characteristic of these cases is their lengthy processing requirements. Because jury selection is a time consuming process, it is very unusual for a trial to take less than half a day. Moreover, because misdemeanor cases are usually quite simple, trials can invariably be completed in a single day. This is especially true in the reference court because of court policy to stay in session beyond normal termination time to finish cases. As a result, jury cases require one court day to process.

In superior court, the same uncertainty about coming to trial exists. However, processing times are normally measured in terms of days. In the reference superior court it is very unusual to have a case which requires only a single day.

The obvious problem that arises, is how to schedule uncertain events to a calendar to achieve efficiency. There are several possible strategies:

1. Raise the probability of a trial occuring. Among the strategies to accomplish this are a policy of permitting no plea bargains after a trial date is set. Discussions with court officials in the San Francisco Bay Area indicate this policy is rarely successful for very long (at least in municipal court).
2. Schedule several cases to a single courtroom in the hope that one will proceed. In the reference municipal court, 4-6 cases are scheduled for each jury trial "slot".
3. Schedule several cases collectively to a group of courtrooms. This "master calendaring" depends on the averaging effect of a larger set of cases to achieve efficiency. The reference superior court master calendars its 7-9 criminal jury trial courtrooms.

It is our intention to investigate the best methods of practicing strategies 2 and 3.

The model of the workload which we shall adopt is indicated in the next section.

Workload Considerations

We shall assume that all cases have a probability p, $0 < p \leq 1$, coming to trial when scheduled. (In a subsequent section we shall generalize this assumption to cases having either of two probabilities of "going".) There are a maximum of L courtrooms (and judges) that can simultaneously be master calendared for jury trial cases. In municipal court it is reasonable to assume that a case requires one court day to process. Since the jury trial calendar is called in the morning, the number of courts available is known to be the number alloted to jury trials. In superior court cases may require several days. Hence, L may vary from day to day depending on trials conclusions. However, it is usually possible with complete accuracy to predict the number of courtrooms which will be available on the following morning for the jury trial calendar. This is done in the reference superior court and the calendar and jury calls are adjusted accordingly.

In either situation one must decide how many cases to call for the morning jury trial calendar. This is one issue considered here. Also, the relative efficiency of master calendaring versus individual calendaring will be investigated.

In both court systems it is possible for a court to conclude processing of a jury case during a day in time to commence another one the same day. The problem of whether or not to keep jurors and another case on "standby" in the courthouse or "on call" so that the remaining portion of the court's day can be utilized is a separate matter which is unrelated to the scheduling problems under consideration.

To this $L \geq 1$ pool of courtrooms are assigned $m \geq 1$ cases.[1] Moreover, there are a maximum of K District Attorneys (D.A's) who can be allocated to trying these jury cases. We shall make 2 alternate assumptions concerning allocation of these m cases to the K DA's.

1. Any DA can try any case. This "interchangeability" assumption suggests that K=L DA's are all that are needed, one to try each of the L cases which can conceivably "go".

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[1]This can be accomplished either by assigning cases to individual courtrooms and then switching them around if necessary or by scheduling them to a master calendar courtroom for subsequent assignment to a trial courtroom.

2. Each DA is assigned u cases and m = u*K. At most, one of these u cases can proceed since a DA cannot simultaneously try two cases.

The first assumption will yield greater master calendar efficiency than the second. Although assumption 1 is possible, its implementation would be opposed in the reference municipal court by both the DA's and Public Defender's (PD) offices. In the reference superior court more than one DA prepares each case and this assumption is more plausible.

Since the PD's office represents a considerable fraction of the defendants there can also be contention for these resources in a master calendar environment if PD's are not interchangeable. We ignore this effect in the sequel. This assumption is justified if each PD is paired with a DA so that the pair can be considered a resource for which there is contention. If PD's and DA's are not interchangeable and assigned to cases independently, the above assumption is invalid and the results to be presented will be too optimistic.

It is not our intent to include any administrative cost variations due to any calendar changes since they appear to be moderate. Also juror utilization will not be considered in the sequel as it depends sumarily on concurrency of operation and on whether jurors are keep in "standy" for portions of a day [1,2]. The calendaring strategy appears to have a lesser effect. Insofar as courts (including the reference municipal court) individually calendar courtrooms with no concurrency of jury trials, the potential benefits to be accrued through master calendaring will be understated by ignoring juror costs.[2] Any rule of thumb concerning juror costs as a function of the amount of concurrency could be added easily to the analysis which follows.

[2]This is true only if efforts aremade to stagger the commencement of jury trials so that potential jurors may be included in more than one panel.

There are two costs to any scheduling strategy.

1. A cost of x will be incurred whenever a courtroom sits idle because no case is available to be heard in it.
2. A cost of y will be incurred whenever a case is forcibly postponed because there is no available courtroom to hear it.

The first cost is due to lost processing resources; the second is due to the inconvenience caused to the participants in the postponed case. It shall not be our intent to predict value for x and y; our result will be entirely parametric in $y/x+y$. It is a judgement of court administrators as to what this ratio should be for a given court system and certainly it may vary with the existing backlog. However, it is the opinion of the author that no court system is so congested that $\frac{y}{x+y} = 0$.

Other analyses of calendaring known to the author are in [3,4]. In [3] the concern is with finding the best length of a court session and the best number of matters to allot to it under the assumption that all will be heard (p=1) and sequentially processed. This model might apply to scheduling pretrial motions or traffic court but not jury trials. A hypothetical analysis along the same general lines is presented in [4]. In [5] efforts at objectively predicting trial lengths are reported. This approach would allow greater lead time in predicting court availability. However, the subjective estimates by participants concerning trial length appear to have uncanny accuracy in the reference systems.

More general models of court systems dealing with resource allocation on a broader scale than day to day scheduling are reported in [5,6,7,8]. These "macro" models can be contrasted in scope and level of detail with our "micro" model. A survey of these and other models can be found in [9]. Descriptive studies concerning the operation of various court systems appear in [10,11].

Analysis of Individual Calendaring

Suppose m cases are scheduled for a single courtroom. We first derive the expected cost C(L,m,p), of this particular strategy where L = 1 and p is the probability of a case "going".

The expected number of cases ready to proceed is

$$E = mp$$

and the probability of no case being ready, $E^{\#}$, is

$$E^{\#} = (1-p)^m.$$

The expected number of cases forcibly postponed because the court is busy, E', is

$$E' = E - (1-E^{\#})$$

i.e., $$E' = mp - 1 + (1-p)^m$$

The cost of scheduling m cases is thereby

$$\begin{aligned} C(1,m,p) &= x*E^{\#} + y*E' \\ &= (x+y)(1-p)^m + y(mp-1) \end{aligned} \qquad (1)$$

The integer value of m which minimizes (1), $\hat{m}$, can be shown to be

$$\hat{m} = \left\langle \frac{\ell n(\frac{y}{x+y})}{\ell n(1-p)} \right\rangle + 1 \qquad (2)$$

where <b> denotes the greater integer less than b

Equation (2) can be illustrated as follows. If an empty courtroom and a forcibly postponed case are equally costly and $p = 1/4$, then $\hat{m}=3$. Since the reference court has a p in this range and schedules 3 - 5 cases/session, they must evaluate y/x+y approximately as assumed. We now turn to master calendaring under the interchangeable DA assumption.

Analysis of Interchangeable DA's

In this case, one need assign only L DA's, one to each courtroom. Here, C(L,m,p) can be found as follows.

The probability of i ready cases of m scheduled ones is:

$$B(m,i)p^{i}(1-p)^{m-i}$$

where B(m,i) denotes the binomial coefficient i.e. $B(m,i) = \frac{m!\ i!}{(m-i)!}$.
If $i \leq L$ then the number of idle courtrooms is L-i. If $i > L$, then i-L cases are forcibly postponed.

Denote by Q(L,m,p) the following expression

$$Q(L,m,p) = \sum_{i=0}^{L} (L-i)B(m,i)p^{i}(1-p)^{m-i}$$

It is clear that the expected cost of idle courtrooms is

$$x\ Q(L,m,p)$$

and the expected cost of postponed cases is

$$y(Q(L,m,p) + mp-L).$$

The latter follows because the expected number of postponed cases, E', is

$$E' = - \sum_{i=L+1}^{m} (1-i)B(m,i)p^{i}(1-p)^{m-i}$$

$$= \sum_{i=0}^{L} (L-i)\ B(m,i)p^{i}(1-p)^{m-i} - L + mp$$

Hence, the following generalization of (1) is readily found

$$C(L,m,p) = (x+y)\ Q(L,m,p) + y(mp-L) \tag{3}$$

The $\hat{m}$ that minimizes (3) is difficult to express analytically. However, it can be shown that $\frac{1}{L}\ C(L,L*m,p)$ is a monotonically decreasing function of L for any m and p. The author has proved this analytically for L=2 and by exhaustive computation for $L \leq 15$, $m \leq 10$. Hence the per court costs decrease with increasing degree of master calendaring. Thus L-1 sessions each of L courts are preferred to L sessions each of L-1 courts. This fact holds for any L if m cases per court are calendared.

In the sequel, we will compute the benefits to be derived from this scheme for a range of cases. First, however, we examine the situation of non-interchangeable DA's.

Analysis of Non-Interchangeable DA's

We wish to compute $\hat{C}(L,K*u,p)$, the cost of K*u cases scheduled to a master calendar of L courtrooms in the absence of interchangeable DA's.

Consider a given DA to whom is assigned u cases. There is a probability of $p* = 1 - (1-p)^{u}$ that he will have a ready case. Moreover, if he has more than one, the extras must be postponed. The expected extra ready cases for a given DA are:

$$N = \sum_{i=1}^{u} (i-1)B(u,i)p^{i}(1-p)^{u-i}$$

$$= pu - 1 + (1-p)^{u}$$

The K DA's each have a ready case with probability p* and the cost of this strategy is

$$\hat{C}(L,K{*}u,p) = C(L,K,p^*) + K{*}y{*}N$$

$$= (x+y)\ Q(L,K,p^*) + y(pKu - L) \qquad (4)$$

This can be seen to be identical to (3) except for the p* parameter in Q.

Again the u that minimizes (4) for a given K and L can only be found for particular examples. The best choice of K and L is likewise elusive. Before presenting examples, we present results for one workload generalization.

More General Workload Results

In particular, we turn to the situation where cases in the workload are characterized by either of two probabilities of being ready, p_1 or p_2, $p_1 > p_2$. Thus, there are some "likely" cases and some "unlikely" ones. Suppose F% of the workload is p_1-type cases. We discuss results concerning docketing these cases to an individual calendar.

If m_1 type p_1 and m_2 type-p_2 cases are docketed, the expected cost $C^*(1,m_1,m_2)$ can be shown to be the following generalization of (1).

$$C^*(1,m_1,m_2) = (x+y)[1-p_1]^{m_1}[1-p_2]^{m_2} + y[m_1p_1 + m_2p_2 -1] \quad (5)$$

The (m_1,m_2) which minimizes (5) can be easily shown to be $(\hat{m}_1,0)$ where

$\hat{m}_1$ satisfies (2). Thus, only type 1 cases should be calendared. However, in order to complete the workload one must schedule an appropriate number of sessions to which only type 2 cases are assigned. Thus there exist both $(\hat{m}_1,0)$ sessions and $(0,\hat{m}_2)$ sessions. This strategy, however, can be shown never to be optimal when the cost function is assumed to be the total cost of scheduling m type-p_2 cases and $(\frac{F}{1-F})$ m type-p_1 cases to a given number of sessions. Average cost/courtroom can always be decreased by a strategy which mixes case types to the sessions. Further results on this topic appear exceedingly difficult to obtain and depend on what scheduling indivisibilities and end conditions are assumed present.

Examples

We shall consider 8 cases which cover a spectrum of possible situations. We shall treat the cases where $z = y/x+y = 1/2$ and where $z = y/x+y = 1/6$. These are cases when an idle courtroom is as costly and 5 times as costly as a forced postponement, respectively. They are perhaps typical of a normal court system without a large backlog (such as the reference municipal court, and a heavily congested one (such as the reference superior court). Furthermore, we shall treat the cases where $p = 1/8$, $p = 1/4$, $p = 1/2$, and $p = 7/8$, respectively. This appears to cover the gamut of possibilities for p.

Figure 1 shows the situation where $p = 7/8$ and $z = 1/6$. Here, it is seen that individual calendaring as well as master calendaring with one non-interchangeable DA per judge results as expected in a constant cost per courtroom. However a master calendar with interchangeable DA's, assuming m is chosen to minimize (3), can result in a 100% decrease in the cost per courtroom. This is achieved in a 3 judge master calendar.

Larger degrees of master calendaring result in only marginal additional savings. When DA's are not interchangeable, note that the lower bound of cost can be achieved by the expenditure of only a single extra DA. This fact holds for $L \leq 6$.

On the other hand when $z = 1/2$, there is no savings whatever from any master calendar. One can do no better than assign one case per judge in an individual fashion. Thus, if p is large and z moderate one might as well calendar courtrooms individually.

Figures 2 and 3 indicate $z = 1/6$ and $z = 1/2$ for $p = .5$ respectively. In both cases a sizeable gain results from the master calendar strategy with one extra non-interchangeable DA. Lesser savings result from additional extra DA's and the lower bound (achieved with interchangeable DA's) is rapidly approached. In both cases benefits become exceedingly marginal (or negative) for $L > 3$. The comparable graphs for $p = .25$ are similar to Figures 2 and 3 and are not presented.

Lastly, note in Figures 4 and 5 the situation for $p = .125$. In Figure 4, note that the same results mentioned above are present. On the other hand, note in Figure 5 that master calendaring in any form results only in modest improvement.

Figure 6 indicates the best number of cases to schedule for various calendar strategies when $p = .50$ and $z = 1/6$. Note that large differences in cases to be scheduled are not observed between the various strategies. Also note that the situation of interchangeable DA's does not yield the smallest number of cases calendared. This result reflects the assumption that u cases must be assigned to each non-interchangeable DA. Hence, for $2L + 1$ DA's there must be $2L + 1$, $4L + 2$, $\cdots$ cases calendared. This restriction in scheduling, not present when DA's are interchangeable, causes the anamoly.

Figure 7 indicates courtroom utilization for various situations when $p = .50$. Note that initially the probability of an idle court decreases dramatically with degree of master calendaring. Gains are only marginal for $L \geq 3$. Note also that idle time decreases as z decreases. This result of course reflects the fact that utilization will rise as court resources become more valuable.

The following general conclusions can be reached.

1. Adding extra judges or extra non-interchangeable DA's to a master calendar becomes very marginal for $L > 3$ and for a number of DA's > L+1 or L+2.
2. With interchangeable DA's gains are very marginal for $L > 3$.
3. Gains are more pronounced the more valuable court time becomes as a resource (e.g. lower z).
4. Savings generally (but with exceptions) get larger as p increases.
5. The best number of cases to schedule does not vary drastically with calendaring assumptions.
6. Idle time decreases dramatically as L increases and as z decreases.

For the reference municipal court $p \approx 1/4$ and figures similar to 2 and 3 indicate that substantial savings (> 30%) can be obtained in a 2 judge - 3 DA master calendar for either value of z. This recommendation is feasible and is being studied by court administrators. Note, however, that if p should drop toward 1/8, Figure 5 indicates that gains from this master calendar would become quite small for $z = 1/2$. Therefore, should p drop the court might well consider readopting its current individual calendar.

Summary

The problem of calendaring jury trials in a court system has been considered in this paper. General conclusions have been drawn where appropriate and were discussed in the preceding section. We now discuss possible generalizations of this work.

In the reference municipal court, the workload appears to be divided into three groups.

1. Matters which take little time such as arraignment, sentencing, court trials for traffic matters, etc.
2. Matters which take 1 - 2 hours. These are primarily preliminary examination.
3. Matters which take several hours, i.e., jury trials.

The results discussed have applied to type 3 matters. It is clear that type 1 matters cannot be usefully expedited by a master calendar. The only scheduling issue in these instances concerns the number of cases to be docketed and how long sessions should be (as in [3,4]). In type 2 matters, it is possible that master calendaring is useful. In the reference court, several preliminary examinations are scheduled to sessions of one half day in length. It is very rare (although possible) that more than one examination can be held in a given session. Consequently, the scheduling of preliminary examinations falls approximately within the model developed herein; and hence, corresponding conclusions can be drawn. The generalization of the problem to include the scheduling of cases with various probabilities of being ready to proceed has been briefly investigated herein. This important aspect merits further study.

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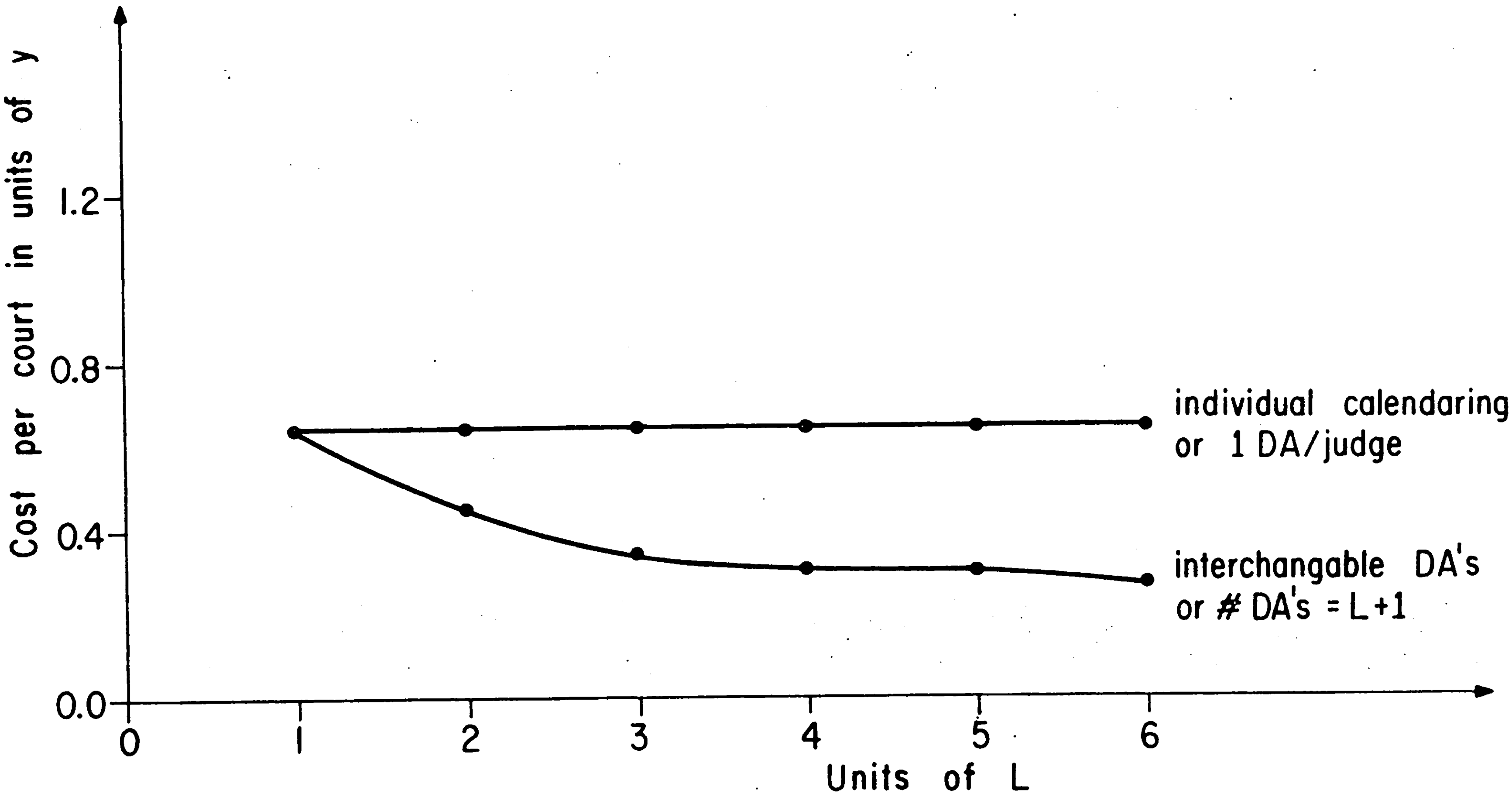

Fig. 1. Cost per court under various strategies for $p = .875$ and $z = 1/6$.

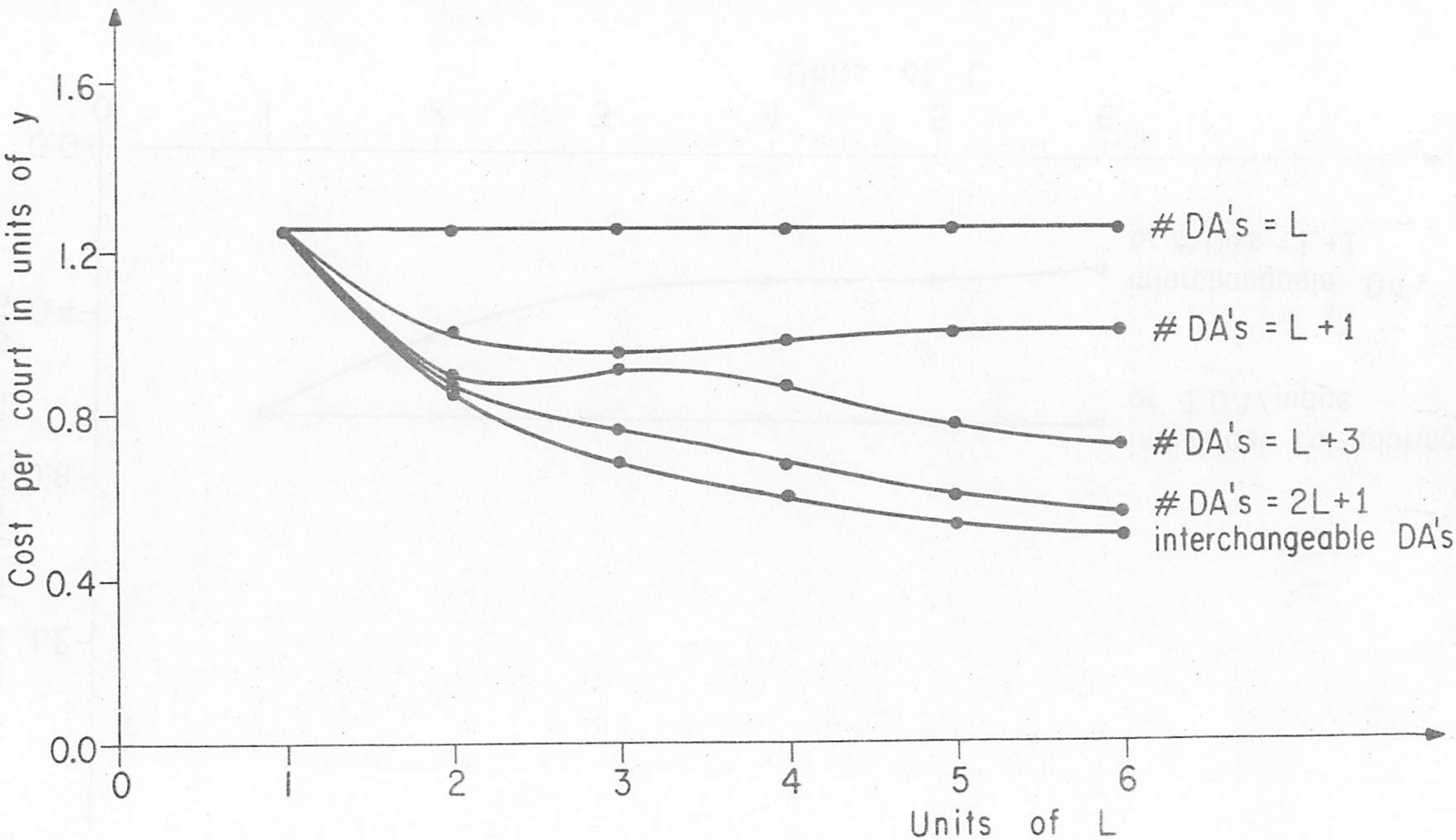

Fig. 2. Cost per court under various strategies for p = .50 and z = 1/6.

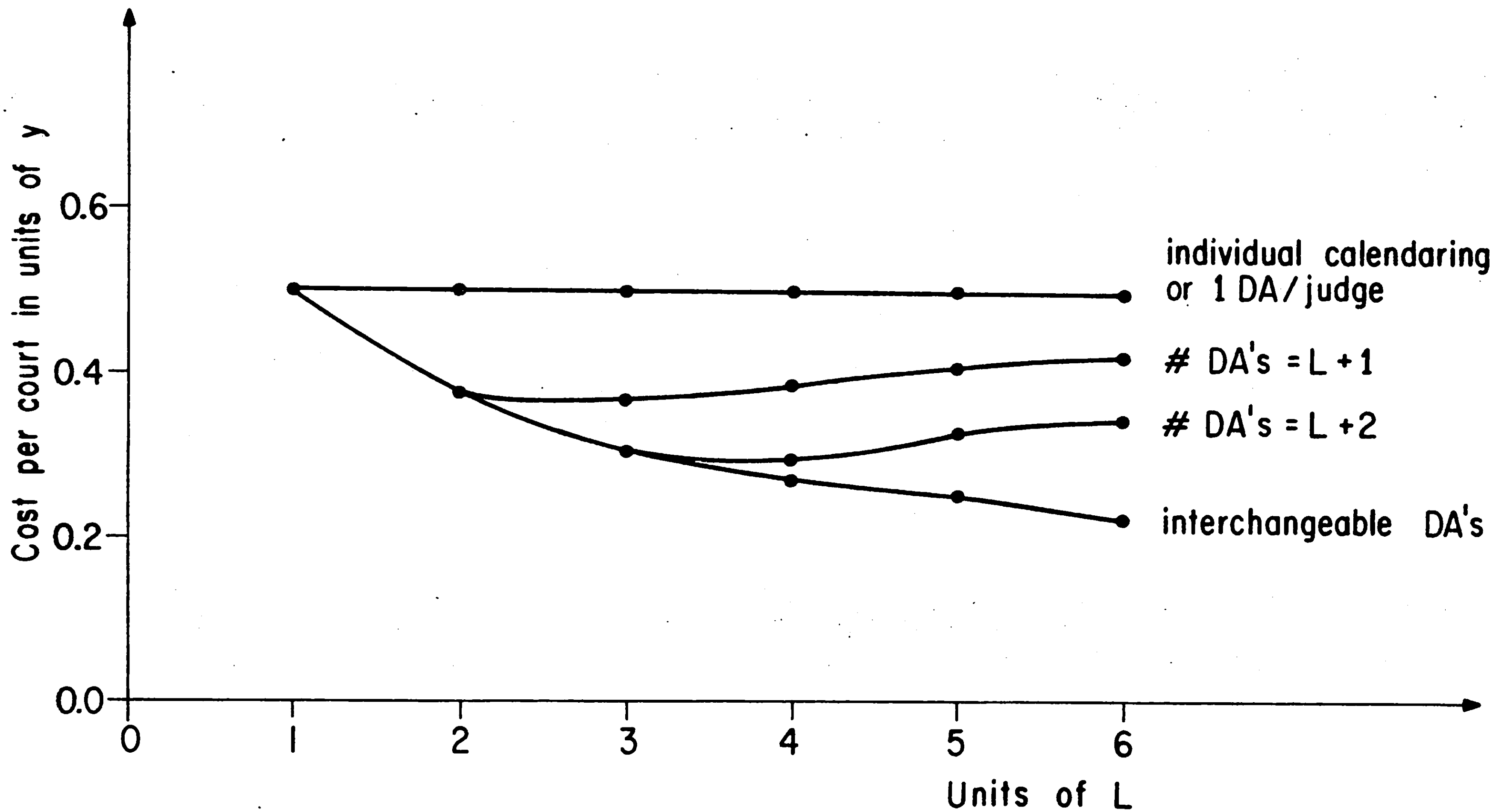

Fig. 3. Cost per court under various strategies for p = .50 and z = 1/2.

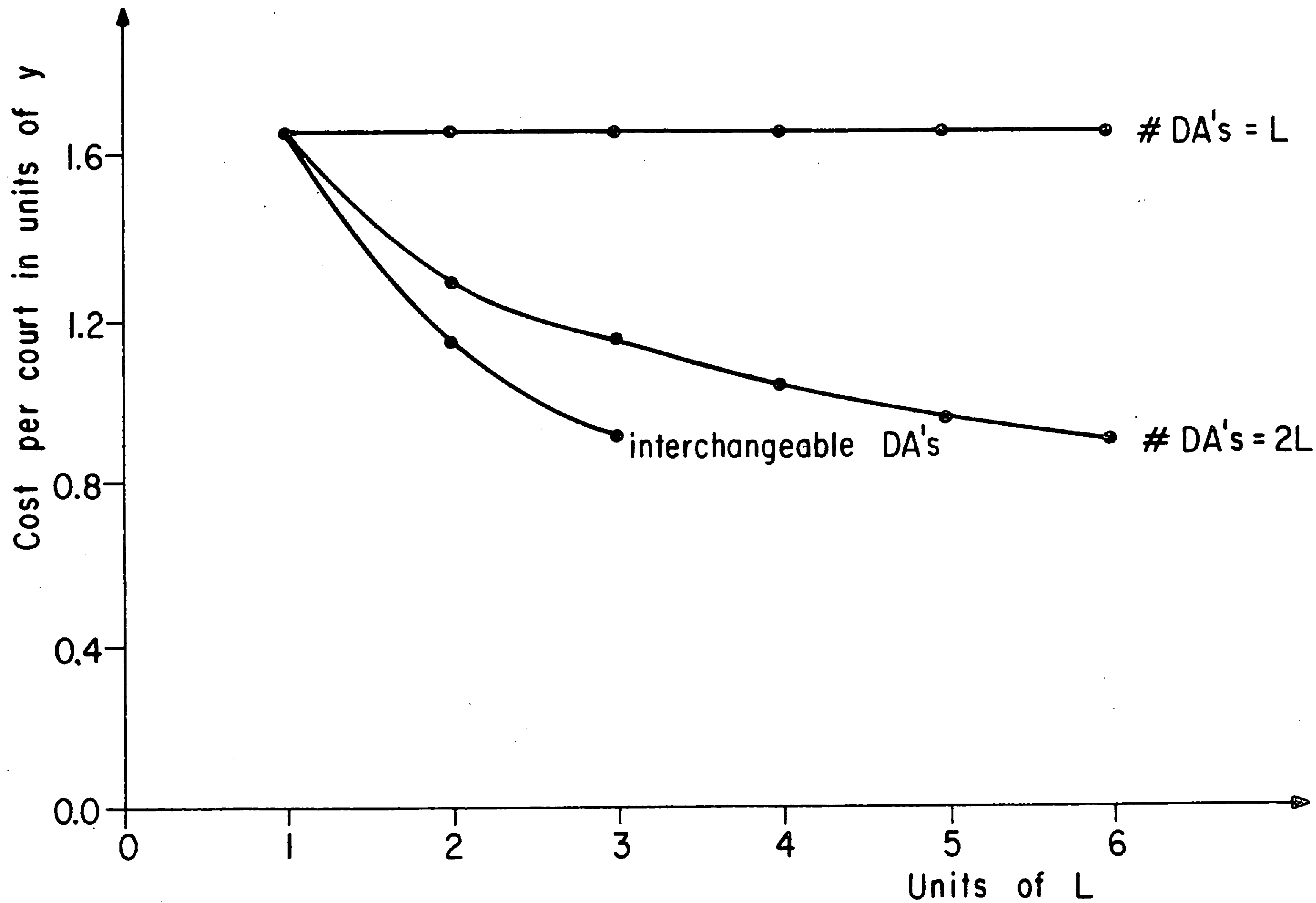

Fig. 4. Cost per court for various strategies for p = .125 and z = 1/6.

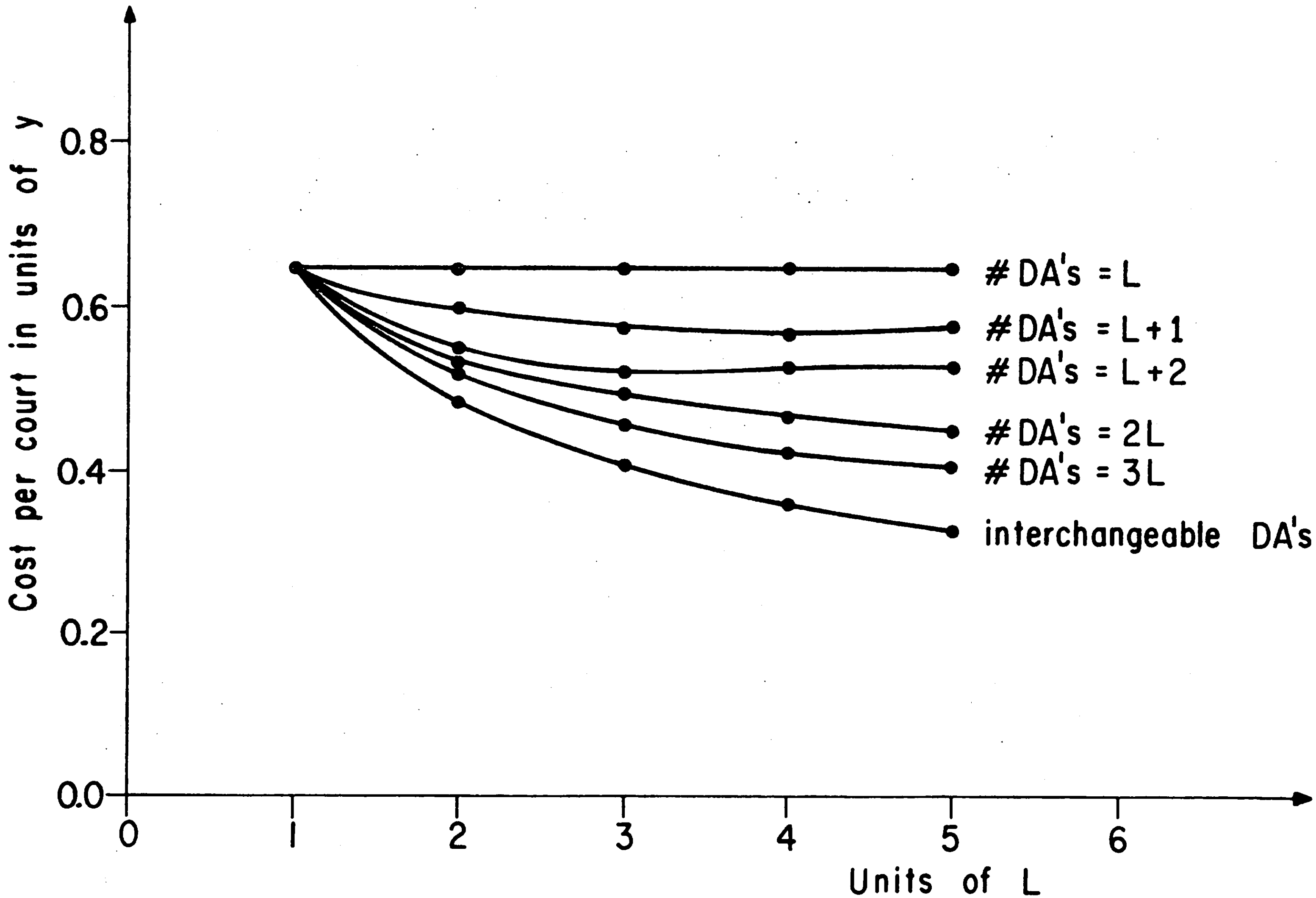

Fig. 5. Cost per court for various strategies for p = .125 and z = 1/2.

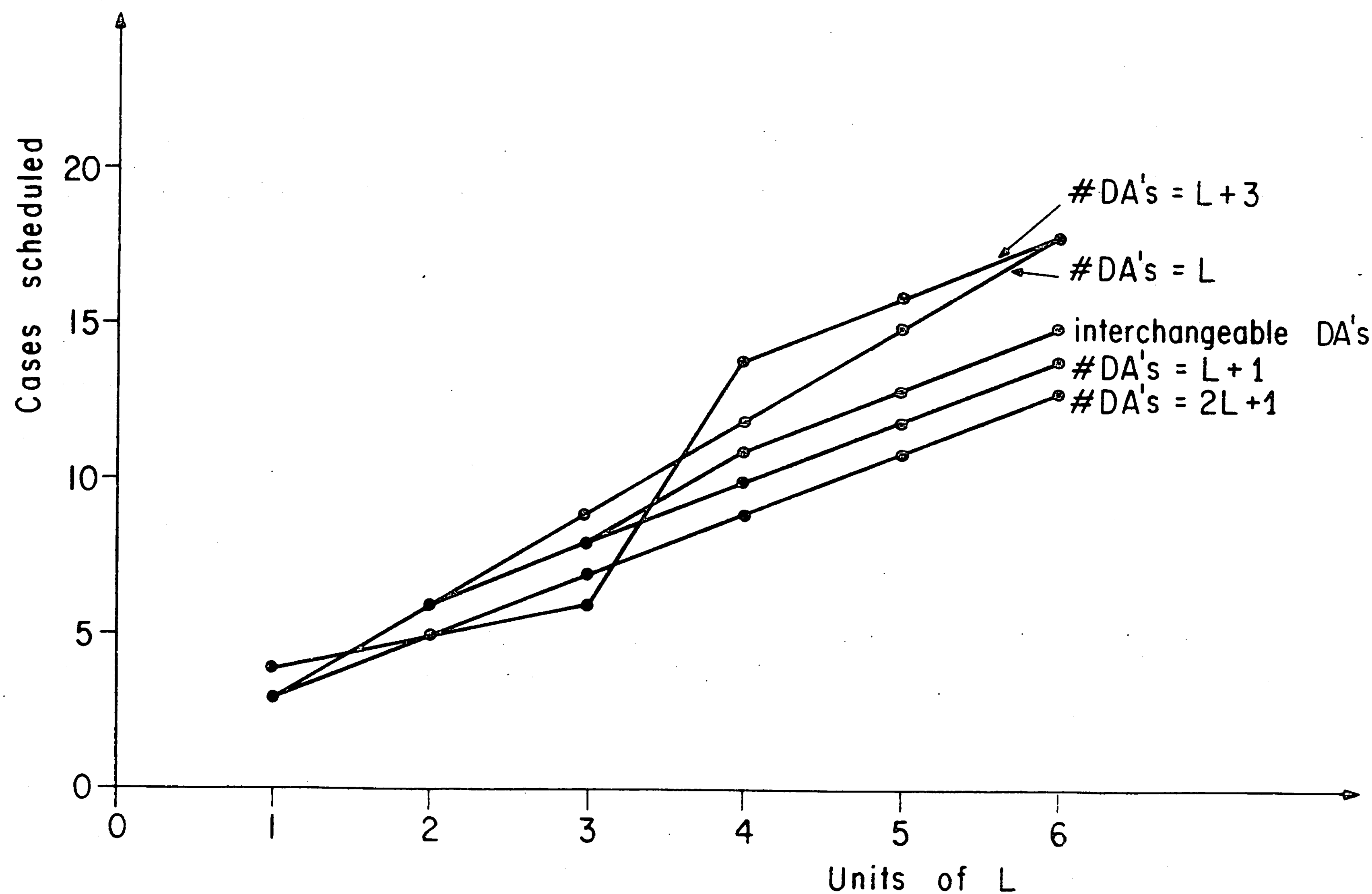

Fig. 6. Cases scheduled under various strategies for $p = .50$ and $z = 1/6$.

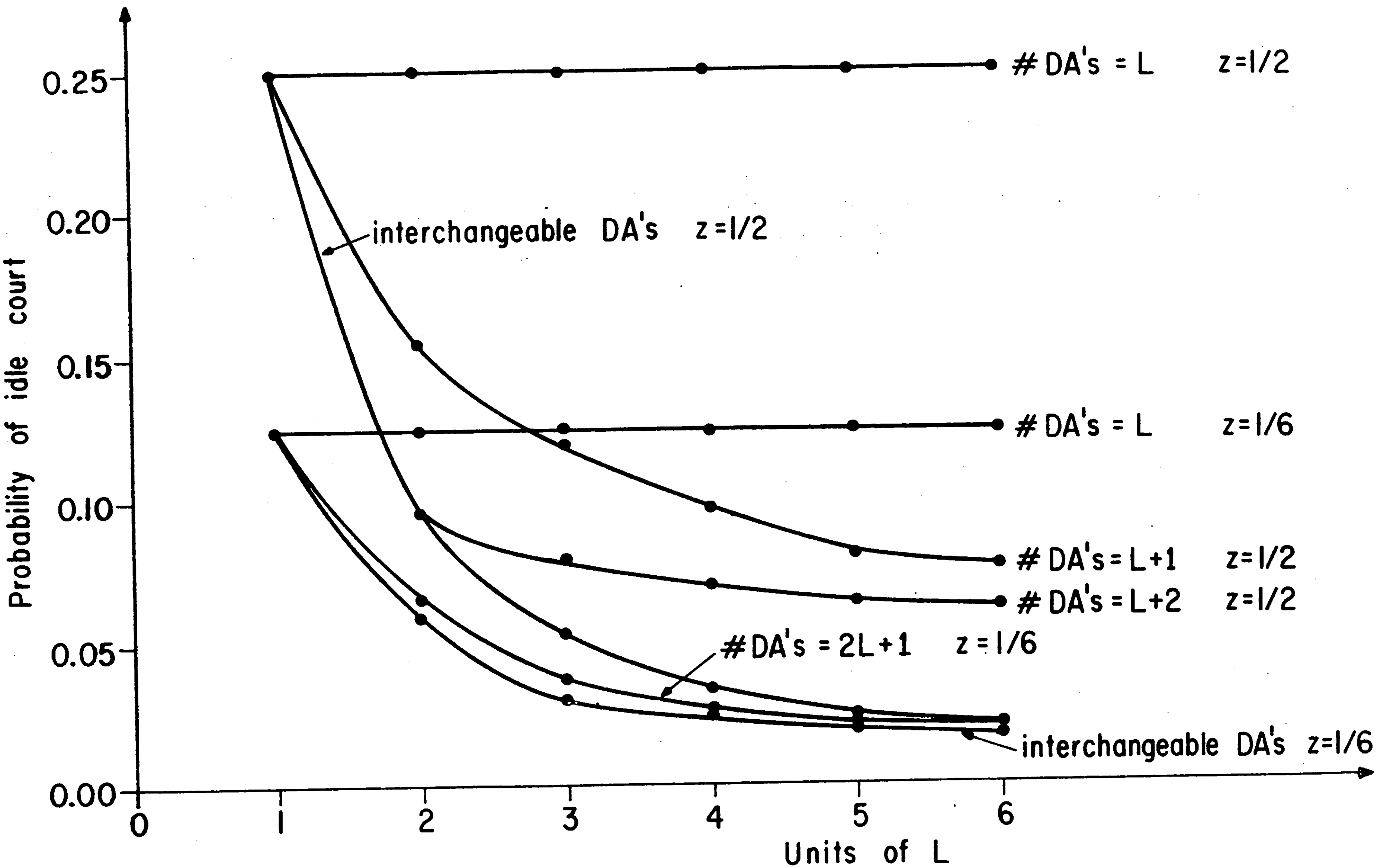

Fig. 7. Courtroom utilization for p = .50.