ALLOCATION OF GOODS BY LOTTERY

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Many authors have argued that lotteries are used to allocate resources because of the fairness of the mechanism. However, a number of historical examples suggest otherwise. Participation fees are almost always charged and they are often discriminatory. In addition, goods (or bads) allocated by lotteries are usually not transferable. Both lottery participation fees and restrictions on transferability reduce rent-seeking from speculators. Each feature increases the rents to the primary user groups relative to the rents attainable from alternative mechanisms such as auctions, queues, or merit allocations.

I. INTRODUCTION

Many goods such as hunting permits, oil drilling leases, cellular telephone licenses, and rights to fishing berths—as well as some "bads," such as the military draft, jury duty, and who is to be thrown overboard on a sinking life raft—are or have been allocated by lotteries. In neoclassical welfare economics, the random distribution of property rights does not affect allocative efficiency as long as transferability is allowed and the transactions costs are non-prohibitive. Lottery allocations, however, are generally not transferable. Thus lottery allocations are inefficient since the goods are not ultimately allocated to the users who value them the most.

A number of authors, such as Aubert [1959], Fienberg [1971], Eckhoff [1989], and Elster [1989, 36–122], have argued that lotteries are chosen as the allocative instrument because it represents a "fair" or "just" means of allocating the goods. Rawls [1971, 374] and Eckhoff [1989] have noted that where it is impractical to divide the goods equally among those who desire them, a lottery serves to satisfy both the requirement that the process be fair and that the allocation problem be resolved relatively costlessly. Elster [1989, 113], however, notes that lotteries are not the only fair allocation mechanism. For example, he points out that in Jewish ethics the problem of allocating an indivisible good such as life-saving resources is resolved by denying it to everyone. Even economists would probably prefer a lottery to this resolution.

The fairness hypothesis has a rich history. In the Old Testament, lotteries are deemed a fair way of allocating goods such as the inheritance of land [Numbers 33:54]. Lotteries are also used to allocate bads. In perhaps the most famous Biblical example of use of lots, Jonah was chosen by lot to be sacrificed to appease God who had brought a storm that threatened to wreck the ship. The story goes that the lot selected Jonah because he was shirking his duties elsewhere and should not have even been on the vessel [Jonah 1:6].[1] Notice that "fair" here is taken to mean

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1. See also Joshua 7:13. These and other examples can be found in Fienberg [1971], Eckhoff [1989] and Elster [1989].

Economic Inquiry
Vol. XXXII, July 1994, 457–476

"just." Given this theological foundation, it is not surprising that the lottery has seen frequent use in legal history as well. One of the most interesting cases occurred in Swedish and Finnish trials in the 17th and 18th centuries. In cases where a man was murdered by a mob, lotteries were used to allocate punishment. Since the law required an eye-for-an-eye, no more and no less, Eckhoff says that if "it was impossible to ascertain which of them had dealt the mortal blow," the courts determined that *one* of the responsible parties be sentenced to death and that the person be selected by lottery [1989, 19]. A similar use of lotteries occurs in military history to deal with cases of mass desertion: in Roman armies every tenth man was executed (decimated) and the remainder pardoned.

In more modern times, the lottery has been used in U. S. law.[2] First, of course, is the use of a lottery to decide who shall sit on a jury. A connection between fairness and lotteries, however, has also appeared in the common law. In an 1842 case, *U.S. v. Holmes*, which has been discussed by Fienberg [1971], Eckhoff [1989], and Elster [1989], a ship sank in a heavy storm and the lone surviving life raft was in grave danger of sinking. The crew threw overboard fourteen male passengers in an effort to save the rest. When back in port after being rescued, a crewman named Holmes (the only crew member who had not disappeared upon arrival to port) was brought to trial for the deaths of the passengers. The court ruled that the non-essential members of the crew should have been thrown overboard before any passengers, and if that was not sufficient, then passengers should have been selected by lot, which is "the fairest mode," (Elster [1989, 65]). The fact that a human life (presumably a large cost) was at stake ex post did not affect the decision.[3]

The environmental economics literature contains a number of references to the social preferences for and benefits of lottery allocations. Kahneman, Knetsch, and Thaler [1986] found that among mechanisms to allocate concert tickets, people preferred queues to lotteries to auctions.[4] In a similar study, Glass and More [1992] found that lotteries were preferred by hunters over market mechanisms and queuing systems. Each of these authors argue that the observed preferences are due to notions of fairness.

Economists studying lottery allocations are thus put into a quandary. Some, such as Oi [1967] and Hazlett and Michaels [1993], have explicitly recognized the economic costs due to allocative inefficiency. However, others, such as Loomis [1982], argue that "equity gains" must be compared with willingness-to-pay benefits in deciding between a lottery and a pricing mechanism for publicly provided recreation resources. Similarly, Sandrey, Buccola, and Brown, in a study of market allocations of antlerless elk hunting permits, argue that the primary losers from a market allocation would be the "hunters with relatively low willingness to pay who currently manage to be lottery winners but who would refuse to hunt under higher tag prices" [1983, 441].

The fairness hypothesis for the use of lotteries leaves unanswered several ques-

2. Elster [1989] argues that lotteries ought to be used more in legal decisions, for example in cases such as child care custody. However, he makes no mention of whether he believes the allocations should be transferable. Indeed, transferability and its political economy implications go unnoticed in his discussion.

3. Johnson [1991], for example, has argued that lotteries which seem fair ex ante may not at all be fair ex post. Suppose citizens are randomly selected by lottery to pay a million dollars each to alleviate the national debt. Ex ante, such a lottery would seem fair in the sense that the expected cost is identical to each person in society. However, ex post, the costs are not at all fairly distributed. This reasoning was clearly rejected in *U.S. v. Holmes*.

4. However, Elster [1989, 71] notes that queues which require an individual to physically stand in line are much different than queues where applications by mail are accepted first-come-first-served.

tions. First, if fairness is the objective, why is participation in lotteries typically restricted? Elster states that "I know of *no* instance of social lotteries without some sort of preselection or postselection scrutiny on the basis of need, merit and the like" [1989, 67, emphasis added]. Second, why is transferability not allowed for most goods allocated by lottery? Transferability would allow both a greater amount of wealth to be generated by the goods and allow that wealth to be spread over a larger number of people.

In this paper I show that preferences for lottery allocations may be consistent with purely self-interested behavior. Lotteries preserve more of the economic rents for the lottery participants than they would receive under alternative mechanisms such as allocation by auction, queues, or merit. A public choice explanation for lotteries also shows why participation in lotteries and transferability of the goods obtained in a lottery are generally restricted. A lottery without restrictions on the number of participants would dissipate the expected rents to those who participate. Similarly, while transferability creates the possibility of gains from trade, it also makes participation in the lottery more attractive to persons who otherwise place little value on the good. Thus "speculators" are drawn into the lottery if it is made transferable. Entry by speculators reduces the rents to the participants who value the good the most since it increases the chance that they will have to purchase it at the market price from a speculator.

II. LOTTERIES, AUCTIONS, QUEUES, AND MERIT ALLOCATIONS

Inefficiency of Non-Transferable Lotteries

The inefficiency of a non-transferable lottery lies in the fact that those who draw the goods in the lottery may not be the ones who value the goods the highest, or in the case of bads, may be the ones who have the highest cost of being drawn. For example, with respect to the military draft, Oi [1967] argues the draft is as likely to draw a person who places high value on not being drafted as it is to draw a person who places low value on not being drafted.

This argument can easily be formalized. Suppose there are k homogeneous goods, say hunting permits, which are to be allocated among N people, where $k < N$. Let the N people be ordered according to the value v_i they place on the good such that

$$(1) \qquad v_1 \geq v_2 \geq \ldots \geq v_N.$$

If a lottery were held to allocate the permits *and* the permits were not transferable, then the expected value of the k permits to society would be $k\mathrm{E}(v)$, where $\mathrm{E}(v)$ denotes the mean value placed on the good by members of society. As long as the population is heterogeneous in the value it places on the good, this value is less than the value that would be obtained if the goods had gone to the k people who valued the good the highest, i.e.,[5]

$$(2) \qquad k\mathrm{E}(v) < \sum_{i=0}^{k} v_i.$$

If $v_i = \mathrm{E}(v)$ for all i, then the lottery has no effect on allocative efficiency. However, the allocative inefficiency is due to the restriction on transferability, not to the lottery itself. As Coase [1960] argues, if transactions costs are high (e.g., if trans-

5. In the case of bads, such as being drafted, the argument runs as follows. Let c_i represent the costs of participating for the ith person, where

$$c_1 \leq c_2 \leq \ldots \leq c_N.$$

Then the cost of drafting k persons is $k\mathrm{E}(c)$, which is greater than

$$\sum_{i=1}^{k} c_i .$$

ferability is not allowed) then the initial allocation is very important. If transactions costs are low relative to the value of the resource, then the randomness of the lottery allocation has no effect on allocative efficiency.

Auctions, Merit, and Queuing Allocations

Non-lottery allocation mechanisms include auctions, allocations based on merit, and queues. In an auction, the goods are sold to the highest bidders. In a merit allocation, those who demonstrate that they are the "most qualified" get the goods. In a queue, those who arrive first get the allocation. Each of these methods of allocating goods forces the group that obtains the resource to pay for it, either directly or indirectly, as Barzel [1974] has argued. It is the lure of getting the good without having to pay for it that gives allocation by lottery its appeal.

Consider an auction allocation. Let the N possible users have values as in (1). Suppose that there is a fixed supply of k permits, and these are auctioned off to the highest bidders in a kth price auction. Then persons 1 through k each pay a market price, v_k, for the goods. These people, whom we shall call Group A, each value the good at least as much as the market price, i.e., $v_i \geq v_k$ for i=1,...k. Under an auction, the people in Group A each receive consumers' surplus equal to

$$(3) \qquad W_i^A = v_i - v_k \geq 0, \quad i=1,...,k,$$

where the price is set at the kth price instead of the k+1th price as would happen in a Vickrey auction. The remaining $N-k$ people in the population who value the permit less than v_k do not buy a permit. The only way these people obtain surplus value when an auction allocation mechanism is used is if the returns to the auction are dispersed back to the population. When there is no rebate of auction receipts only the persons in Group A benefit from the auction, and they receive only the surplus remaining above the market price v_k.[6] If there is a rebate, then the per capita rebate is kv_k/N.

Merit and queuing systems have an effect on the returns to Group A similar to that of an auction when there is no rebate from the revenues of the auction. In a merit system, each applicant must expend resources to demonstrate that he or she is more qualified than other competitors.[7] Barzel [1974], Johansen [1987], and Elster [1989, 70–72] all note that the same is true of a queuing system. In equilibrium, the amount of resources expended by members of Group A must approach the market price v_k. If they were to expend less than v_k, someone from the remaining population would be willing and able to expend more resources to obtain the good instead.[8] Thus to people in Group A, merit and queuing systems suffer from the same problem as an auction: part of the rents are lost in the process of competing for the goods. In the remainder of the paper, I explicitly use this stylized relationship by referring to the welfare under such allocations with the subscript "AQM,"

6. If the auction were set up as a descending Dutch auction, then the seller may extract even more of the consumer's surplus than occurs in the example. If this were the case, the lottery would be the preferred mechanism for Group A users as well as the remaining population.

7. This assumes that the merit system allows people to develop the necessary criteria to obtain a permit. An example of this is in mountaineering, where limited numbers of permits to climb prestigious peaks such as Mount Everest or K-2 are allocated to the most qualified applicants only. There are other instances where the merit system is based on criteria over which the person has no control, e.g., racial barriers. In this case, the inefficiency is similar to a non-transferable lottery, except that the sampling is non-random.

8. If there is some uncertainty over the signaling process in a merit or queuing allocation, then the problem may be worse since some people who are not in Group A will also expend resources to show that they are more qualified or have waited in the queue longer. The result is an even larger dissipation of rents than would occur under perfect information.

which refers to an auction-queuing-merit allocation.

Of course, auctions are not socially equivalent to either a queue or a merit allocation. In an auction, the revenues earned from the auction are not dissipated as they are in a queue or merit allocation. In an single-price auction the revenues equal kv_k. If the revenues are redistributed to the population, the per capita rebate would be kv_k/N. In the event where a proportion, q, $q \in (0,1)$, of the revenues are rebated, those persons in Group A would receive[9]

$$(3') \quad W_i^A = v_i - v_k + qkv_k/N \geq 0, \quad i = 1,...k,$$

and those not in Group A would receive qkv_k/N. For large N, this per capita rebate vanishes. It also vanishes as $q \to 0$, as in the case of an allocation by merit or by queue.

Non-Transferable Lotteries

Now, suppose that a non-transferable lottery is used to allocate the goods. Each participant in the lottery pays a non-refundable fee of F to participate in the lottery. The equilibrium condition for n risk-neutral persons to participate in the lottery is that for the nth participant the expected value of the return for winning a permit is equal to the fee for participating in the lottery. Let $p_n = k/n$ be the probability of being drawn to obtain a permit. The number of participants n will thus satisfy the condition[10]

$$(4) \qquad F = p_n v_n .$$

This condition is true only if each individual may be drawn just once. The condition may be derived as follows. Let $m_n = 1/n$. Then the expected gross return to the ith person of participating in a lottery in which n persons participate, k goods are drawn, and each person may be drawn at most once is

$$\mathrm{E}(v_i \mid n) = m_n v_i + (1-m_n)\{m_{n-1} v_i + (1-m_{n-1})$$
$$[m_{n-2} v_i + (1-m_{n-2})(m_{n-3} v_i + \ldots)]\} = p_n v_i,$$

which, when $i = n$, is the right-hand side of (4). Therefore, (4) implies the nth participant in the lottery earns zero net returns, ex ante. All other participants earn positive expected returns since $v_i \geq v_n$ for all $i < n$.

Define Group B to be the $n-k$ people who will participate in the non-transferable lottery, but who would not be willing to buy one of the permits at price v_k in an auction. That is, the ith person in Group B places value on the good that satisfies $v_k > v_i \geq v_n$. If no fee, either implicit or explicit, is charged, then either the entire population participates ($v_N > 0$), or the nth participant is indifferent between obtaining the good and doing without ($v_n = 0$). If the fee were equal to v_k, only those in Group A would participate in the lottery, and the result would be identical to an auction. Thus, the fee for participating in a lottery is bounded by $(0, v_k)$.

From (4), n and thus p_n each depend upon the fee, F, as well as the number of permits, k. Totally differentiating (4) yields

$$n dF - v_n dk = -(F - kv_n')dn.$$

9. The agent is assumed to consider the role of the rebate in the selection of allocation mechanism, but not in the decision to participate in the allocation mechanism once in place. This eliminates some strategic behavior of the agent in that his or her actions may affect the size of the rebate. However, this problem is secondary given that the rebate is assumed to be evenly distributed back to society.

10. This ignores the integer problem associated with participation.

Therefore, $\partial n/\partial F < 0$, and $\partial n/\partial k > 0$. Since p_n increases in k and decreases in n, we have that an increase in F causes p_n to decrease. However, an increase in the number of goods to be allocated has an ambiguous effect on p_n since an increase in k increases both the numerator and denominator of p_n.

Given that there are n people participating in the lottery, the expected return to a person in Group A or Group B is

$$(5) \qquad W_i^A \mid_{NTL} = W_i^B \mid_{NTL} = p_n v_i - F + qnF/N \geq 0, \quad i = 1,\ldots,n,$$

where the condition "NTL" refers to non-transferable lottery. The last term in (5) represents the per capita rebate given that a proportion q of the fee revenues are rebated. When the rebate is zero, the only person for whom the inequality is not slack is the nth person. That is, if the rebate is zero, all but the last person in Group B will prefer a non-transferable lottery to an auction, queue, or merit allocation. The remaining N–n people who do not participate in the lottery each receive a surplus return equal to the value of the rebate.

Transferable Lotteries

Now, consider a lottery in which the permits are transferable. Allowing transferability of the lottery good makes participation in the lottery more attractive to persons who place a low value on the permit. In fact, for persons *not* in Group A, the actual value that a person places on the permit is *irrelevant* to their decision to participate in a transferable lottery. What is relevant is what he or she expects the market price to be.

Define Group C to be the s–n persons who will participate in a transferable lottery, but who would not participate in a non-transferable lottery. Also, define Group D to be the remaining N–s people, those who do not participate even in a non-transferable lottery. Since the decision to participate depends upon v_k rather than v_i, one cannot identify which N–n people in Groups C and D will be in Group C and which will be in Group D. For convenience and without loss in generality the groups are ordered sequentially along the demand curve.

Since the people in Groups B and C value the permit less than the market price, they will sell their permit if drawn. Thus, the expected return to persons in Groups B and C participating in the lottery is

$$(6) \qquad W_i^B \mid_{TL} = W_i^C \mid_{TL} = p_s v_k - F + qsF/N, \quad i = k+1,\ldots,s$$

where the "TL" condition refers to a transferable lottery, $p_s = k/s$ is the probability of being drawn in the lottery given that s people participate, and qsF/N is the per capita rebate when q of the fee revenues are rebated to the population. The number of speculators is the value of s such that the value of speculating is driven to zero, which implies

$$(7) \qquad F = p_s v_k.$$

Note that (7) implies

$$(6') \qquad W_i^B \mid_{TL} = W_i^C \mid_{TL} = qsF/N, \quad i = k+1,\ldots,s.$$

The number of people who participate in a transferable lottery will be greater than the number in a non-transferable lottery ($s > n$) because the ex post value of being drawn is greater when the permits are transferable ($v_k \geq v_i$ for all $i > k$). Thus,

$p_s < p_n$.[11] Figure 1 shows the relationships between the different groups along the demand curve.

Several results regarding lotteries are now immediate:

PROPOSITION 1. *When agents are risk neutral, the revenues obtained from entry fees in a transferable lottery are identical to the revenues obtained from selling the goods in an auction.*

Proof: From (7), $sF = kv_i$. •

COROLLARY 1.1. *When agents are risk neutral, the revenues obtained from entry fees in a non-transferable lottery are less than the revenues obtained from selling the goods in an auction.*

Proof: This follows from Proposition 1 since $s > n$. •

Proposition 1 and its corollary show that an agency which chooses a non-transferable lottery to allocate resources under its control is not capturing the full social value of the resource (measured at its marginal value) for the government.

PROPOSITION 2. *All members of society are indifferent between a transferable lottery and an auction allocation.*

Proof: Under a transferable lottery, the net welfare to the ith member of Group A is

$$W_i^A \mid_{TL} = p_s v_i + (1 - p_s)(v_i - v_k) - F + qsF/N$$
$$= v_i - v_k + qsF/N,$$
$$= v_i - v_k + qkv_k/N,$$

where the second equality is due to (7) and the last equality is due to proposition 1. The proof for Groups B, C, and D makes use of proposition 1 in the same fashion. •

COROLLARY 2.1. *All members of society will strictly prefer allocation by an auction or transferable lottery to allocation by merit or a queue when $q > 0$, and will be indifferent when $q = 0$.*

Proof: A queue or merit allocation results in no rebate, which is equivalent to $q = 0$. •

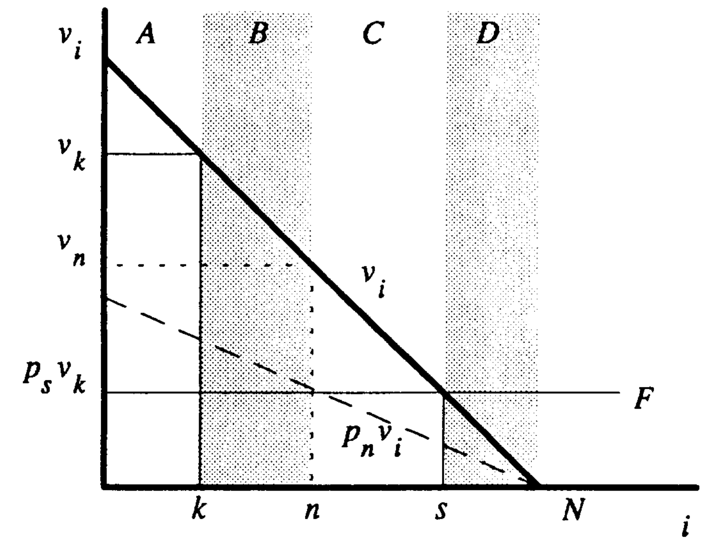
Lotteries with Heterogeneous Goods

In some lotteries the value of the good depends not so much on who receives the good, but on the good itself. An example of this is the cellular telephone licenses allocated by the Federal Communications Commission which has been analyzed by Hazlett and Michaels [1993]. Here, the value of the good being allocated depended far more upon the profitability of the monopoly right to the market than it depended upon who received the good. Consider now lottery allocations of such goods. Let there be k goods with rewards

(8) $$R_1 \geq R_2 \geq \ldots \geq R_k.$$

11. Note that there exists a serious coordination problem with the equilibrium number of participants in this market. In the non-transferable lottery, the number of participants was determined uniquely by solving (4) for n. The nth entrant earned an expected return just equal to the fee for participating. When the lottery is transferable, the *number* of participants is limited by (7), but the identity of *who* will and who will not participate is indeterminate. As long as only s people participate in the lottery, anyone who values the good less than v_k can participate in the lottery, regardless of the value that they themselves place on the good. Thus, among the $N - k$ people not in Group A, it will not be clear which $s - k$ people will participate in the lottery. It is even possible that more than s people will participate. If, by accident (or malice), one of the members of Group A were to wait until the last minute to sign up for the lottery, then more than s people in Groups B and C may have signed up under the assumption that everyone in Group A would have signed up at the beginning. In this case, all members of Groups B and C will earn negative expected earnings since entry by the remaining person from Group A will cause the probability of being drawn to decrease below p_s.

FIGURE 1
Equilibrium Number of Participants in an Auction, Non-Transferable Lottery, and a Transferable Lottery



Assume that a lottery is held to allocate the goods and that each person may be drawn at most once. With risk neutrality the equilibrium number of entrants will satisfy[12]

$$(9) \qquad F = (1/n) \sum_{i=1}^{K} R_i.$$

This condition will hold irrespective of whether the goods are transferable since there are no gains from trade if each person places equal value on the ith good. Also, it is easy to see from (9) that the sum of the fees equals the value of the goods being allocated. Thus:

PROPOSITION 3. *If people are homogeneous, a transferable lottery yields the same expected return to each individual as either a non-transferable lottery or an auction. However, as long as there exists a positive proportion of the scarcity rents that are rebated to society, each of these mechanisms will be preferred to a merit or queue allocation.*

Proposition 3 implies that society will be indifferent between lottery and market allocation mechanisms. Therefore, we cannot predict which mechanism will be chosen. However, if people place different values on the goods, the problem changes significantly. Suppose that R_i continues to denote the revenues obtainable from drawing the ith cellular telephone license, but that different individuals have different costs of operating the licenses (as is argued by Rudnitsky [1989]). Let individual i have the same costs of operating any license, but assume that i's costs differ from j's costs. Let the population be ordered according to

$$(10) \qquad c_1 \leq c_2 \leq \ldots \leq c_N.$$

Then the equilibrium condition when transferability is *not* allowed is

12. This result is simply an extension of the result obtained in (4).

$$(11) \qquad F = (1/n) \sum_{i=1}^{K} (R_i - c_n).$$

But when transferability *is* allowed, the condition becomes[13]

$$(12) \qquad F = (1/s) \sum_{i=1}^{k} (R_i - c_k).$$

Since $c_n > c_k$, we have that $s > n$, as before. Thus, it is only if the population is heterogeneous in the value people place on being drawn in the lottery that the non-transferable lottery is allocatively inefficient.

III. SELECTION OF AN ALLOCATION MECHANISM

Thomas Gataker [1619] in his *On the Nature and Use of Lots* observed that "lotteries are most frequent in democracies or popular estates" (quoted in Elster [1989, 104]). This section attempts to apply modern public choice theory to the selection of lottery allocations.

Let us return to the case where the value of the good depends only on who obtains the good. Table I summarizes the returns to the different groups under the various allocation mechanisms discussed in section II.

By proposition 2 we know that all groups are indifferent between an auction and transferable lottery allocation. By corollary 2.1 we know that an auction or transferable lottery is strictly preferred to an allocation by merit or by queue when there exists the possibility of rebate from the proceeds of the auction or lottery. The question that remains is how do different members of society feel about the use of a non-transferable lottery relative to an auction or transferable lottery?

13. This assumes that each person can only operate one license.

Preferences of persons in Groups C and D are easily derived. Since the only ex ante return these groups get is from the rebate, they prefer a system which produces a larger rebate. That system is the transferable lottery or its equivalent, the auction. However, in the limit as $q \to 0$, persons in Groups C and D are indifferent between the lottery allocation mechanisms since they obtain a rebate of zero under either. The members in Groups C and D also become less concerned about the outcome as $N \to \infty$. Thus, as the per capita rebate becomes smaller, the concern over the outcome, and hence the influence, of members of Groups C and D wanes.

In the event that the rebate is zero, all members of Group B (except the nth person, who is indifferent) prefer a non-transferable lottery to a transferable lottery or its equivalent, the auction. However, as the rebate proportion becomes positive, some members of Group B will prefer a transferable lottery or auction to the non-transferable lottery since the size of the rebate is larger than under the non-transferable lottery. In particular, members of Group B prefer the non-transferable lottery if and only if

$$(13) \quad W_i^B \mid_{NTL} - W_i^B \mid_{TL} = p_n v_i - F[N + q(s-n)]/N > 0.$$

This expression is increasing in v_i, indicating that all else equal a person in Group B with a higher willingness to pay for the good (higher v_i) will be more likely to prefer the non-transferable lottery. The expression in (13) is also decreasing in q, indicating that all else equal, a higher q means the ith person in Group B will be less likely to prefer the non-transferable lottery to the transferable lottery or auction. Thus as the proportion of the revenues that gets rebated rises, the proportion of Group B preferring the non-transferable lottery declines.

TABLE I
Net Welfare for Each Group by Allocation Mechanism

Allocation Mechanism	Group A	Group B	Groups C, D
Queue, Merit	$v_i - v_k$	0	0
Auction	$v_i - v_k + qkv_k/N$	qkv_k/N	qkv_k/N
Transferable Lottery	$v_i - v_k + qsF/N$	qsF/N	qsF/N
Non-Transferable Lottery	$p_n v_i - F + qnF/N$	$p_n v_i - F + qnF/N$	qnF/N

Members of Group A will prefer a non-transferable lottery over a transferable lottery if and only if

(14) $$W_i^A \mid_{NTL} - W_i^A \mid_{TL}$$

$$= (p_n v_i - F + qnF/N) - (v_i - v_k + qsF/N)$$

$$= v_k - (1 - p_n)v_i - F[N + q(s - n)]/N > 0.$$

An increase in v_i results in a decrease in the expression in (14). Thus persons with higher willingness to pay for the good are *less* likely to prefer the non-transferable lottery to the transferable lottery (or auction). As was the case with persons in Group B, an increase in q causes the expression in (14) to decrease, implying that members of Group A are less likely to prefer a non-transferable lottery when they perceive that a higher proportion of the revenues from the allocation will be rebated back to the population.

Let NTL denote the members of society who prefer a non-transferable lottery, and let TL denote those who prefer a transferable lottery (the compliment to NTL). Let $l_{(q)}$ and $u(q)$ denote the lower and upper bounds of the population favoring NTL for a given q, with $l(q) \in A$ and $u(q) \in B$. The transferable lottery is preferred for all $i < l(q)$ and for all $i > u(q)$. Thus, we have:

PROPOSITION 4. *The higher q, the proportion of revenues that are rebated, the lower the chance that an individual will prefer a non-transferable lottery to a transferable lottery or its equivalent, an auction.*

Proof: $l'(q) > 0$, and $u'(q) < 0$. Therefore, as q increases, the set of people in NTL decreases. •

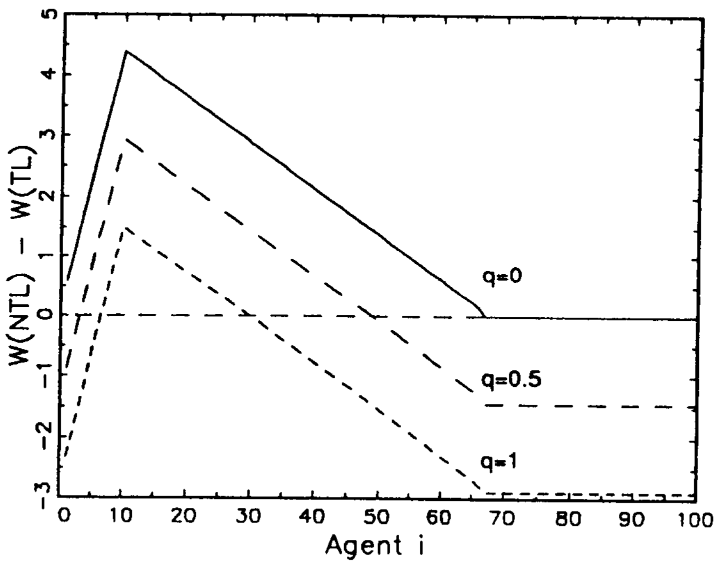
Figure 2 shows a parameterized depiction of the differences in welfare for members of the population between a non-transferable lottery and a transferable lottery. The figure is drawn for three values of q, 0, 0.5, and 1. Under the parameters selected for the figure, with a population of one hundred, Group A has ten members, Group B has fifty-six members, Group C has twenty-nine members, and Group D has five members.[14] Those who would belong to NTL are the persons for whom the net benefits lie above the zero line, and those who would belong to TL are those for whom the net benefits lie below the zero line. When $q = 0$, all mem-

14. Figure 2 assumes one hundred persons in society, with the willingness to pay function

$$v_i = 100 - 0.5i.$$

The lottery participation fee is 10.

FIGURE 2
Net Benefits of a Non-Transferable Lottery over a Transferable Lottery for Different Values of q



bers of Groups A and B prefer the non-transferable lottery to a transferable lottery, and all members of Groups C and D are indifferent. However, when q rises to 0.5, all members of Groups C and D and some members of Groups A and B prefer the transferable lottery to the non-transferable lottery. Under the parameters depicted, 66 percent of the people strictly prefer the non-transferable lottery when $q = 0$, but only 45 percent of the people will prefer the non-transferable lottery when $q = 0.5$. When the rebate is full ($q = 1$), only 23 percent of the people in the population prefer the non-transferable lottery over the transferable lottery for the parameters selected.

Figure 2 is drawn with specific assumptions regarding the demand curve, the number of goods to be allocated, and the participation fee in the lottery. The parameters affect the convexity of the net welfare functions for members of Groups A and B (though not for Groups C and D) and the location of the break points between the various groups. However, the shape of the net welfare function is in general as depicted in Figure 2: The difference between welfare from a non-transferable lottery and a transferable lottery is rising as v_i decreases in Group A, falling as v_i decreases in Group B, and is independent of v_i for Groups C and D. Furthermore, as q increases, each of the curves shifts downwards by the same vertical distance.

Now, suppose that a median voter-rule is used to select among the allocation mechanisms. A corollary to proposition 4 is the following:

COROLLARY 4.1. *All else equal, when a median-voter rule is used to select among alternatives, a non-transferable lottery is more likely to be selected over a transferable lottery for lower values of q.*

At the opposite extreme of the public choice models are models where one dollar equals one vote. Now, consider how aggregated benefits to the NTL and TL groups change as q increases. Aggregated net benefits to the NTL group are

$$(15)\ \Delta W^{NTL} = \sum_{l(q)}^{k} (W_i^A \mid_{NTL} - W_i^A \mid_{TL}) + \sum_{k+1}^{u(q)} (W_i^B \mid_{NTL} - W_i^B \mid_{TL})$$
$$= \sum_{l(q)}^{k} [v_k - (1 - p_n)v_i - Fw(q)] + \sum_{k+1}^{u(q)} [p_n v_i - Fw(q)]\,,$$

where $w(q) \equiv [N + q(s-n)]/N$, so $w'(q) > 0$. The benefits to the TL group are

$$(16)\ \Delta W^{TL} = -\sum_{l}^{l(q)-1} (W_i^A \mid_{NTL} - W_i^A \mid_{TL}) - \sum_{u(q)+1}^{n} (W_i^B \mid_{NTL} - W_i^B \mid_{TL})$$
$$= -\sum_{1}^{l(q)-1} [v_k - (1 - p_n)v_i - Fw(q)] - \sum_{u(q)+1}^{n} [p_n v_i - Fw(q)] + \sum_{n+1}^{N} qF(s-n)/N,$$

where the minus signs ensure that the elements in the summations are non-negative. From (13) and (14) the terms in square brackets are positive in (15) and negative in (16). In a one-dollar, one-vote model where group organization costs are ignored, the outcome will depend only upon the magnitudes of differences in net welfare to the two groups. Thus,

COROLLARY 4.2. *In a one-dollar, one-vote model, if all else is held constant, as q increases, the odds that a non-transferable lottery will be chosen over a transferable lottery or an auction decreases.*

Proof: The aggregate dollar benefits to the group favoring a non-transferable lottery decrease and the aggregate dollar benefits to the group favoring a transferable lottery increase as q increases. This can be seen by differentiating (15) and (16) with respect to q. Let the expression

$$\Delta W_i^A \equiv W_i^A \mid_{NTL} - W_i^A \mid_{TL}$$

(and similarly for B). From (15),

$$\partial \Delta W^{NTL} / \partial q = -l'(q)\Delta W_{l(q)}^A + u'(q)\Delta W_{u(q)}^B - \sum_{l(q)}^{u(q)} Fw'(q) < 0,$$

and from (16),

$$\partial \Delta W^{TL} / \partial q = -l'(q)\Delta W_{l(q)-1}^A + u'(q)\Delta W_{u(q)+1}^B + \sum_{1}^{l(q)-1} Fw'(q) + \sum_{u(q)+1}^{n} Fw'(q) + \sum_{n+1}^{N} F(s-n)/N < 0. \ \bullet$$

The median-voter rule used in corollary 4.1 and the one-dollar, one-vote rule used in corollary 4.2 are very simplistic public choice models. More sophisticated models, such as Stigler [1971], Peltzman [1976], and Becker [1983], make use of costs of organizing the different groups relative to the benefits to the group and the magnitude of the winnings and losses to both the winning and losing coalitions. One difficulty in applying these models to the selection of allocation mechanisms is the discreteness of the choice. Both in Peltzman's formulation of the Stigler model and in Becker's model, the amount of "regulation" is treated as continuous. However, the principle that groups with smaller per capita benefits have a more difficult time organizing still applies, as does the principle that groups facing large potential net benefits or costs are more capable of overcoming organizational costs.

Lotteries are more likely to be the preferred allocation mechanism for lower values of q. The question, then, is what does q measure? As defined, q is the proportion of proceeds from the allocation that are redistributed to the population. Thus $1-q$ measures the proportion of proceeds from the allocation that are *not* redistributed to the population. Becker's model of political redistribution assumes that the redistribution is a negative-sum game. Becker argues this is due in part to the dead-weight-loss triangles, but other factors include the "resources spent per member on maintaining a lobby, attracting favorable votes, issuing pamphlets, contributing to campaign expenditures, cultivating bureaucrats and politicians," as well as the resources to control free-riding problems within the group [1983, 377]. As the expenditures on producing political pressure rise, $1-q$ rises.[15] Hence, non-transferable lotteries are a more likely outcome when large proportions of the proceeds from the resource allocation are applied to create political pressure. In the sense that political allocation (or redistribution) is a negative sum game, we have that non-transferable lotteries are inefficient in a rent-dissipation sense as well as in the sense described by Oi [1967].

IV. SPECULATION IN TRANSFERABLE LOTTERIES

We have seen that allowing transferability invites speculation and that transferable lotteries are socially equivalent to auctions. There are several examples where transferability has been allowed in lottery allocations.

The Civil War Military Draft

An early example of a lottery with transferability occurred with the draft in the American Civil War. The Union army was made up of both volunteers and draftees. To be drawn in the lottery was certainly a "bad" since the draft only applied to those who had not already volunteered. Since it is a bad, the problem of speculation is reversed; instead of too many participants, there would not be enough willing participants in the lottery. However, the draft law of 1863 required *all* able bodied men to be eligible for the draft, thus eliminating a speculation effect. As in later drafts, exemptions were allowed for medical, religious, or hardship reasons such as being the sole male member of a family or being required to work the farm. What distinguished this draft from later drafts was there were two ways, aside from an exemption, a person drafted could avoid serving. One could hire a substitute at the market price or one could pay a flat commutation fee of $300. Alchain and Allen [1969, 525] argue that while the Civil War draft allocated the cost of the draft randomly, it did not require a payment in kind.

The Civil War draft was viewed as particularly pernicious in its effect on the lower classes. Useem [1973, 73] tells us that a popular saying of the day was that the war was fought with "the rich man's money and the poor man's blood." This perception was based on the transferability and commutation clauses in the 1863 law. Following the announcement of the draft in 1863 there were a number of riots in New York. However, Randall and Donald [1961, 317] argue that the number of free blacks hanged during the riots suggests that the lower classes were protest-

15. Note that q is the proportion of actual proceeds, which under a non-transferable lottery are less than the total economic rents from the resource. Thus q ignores the lost surplus due to the misallocation from the lottery.

ing having to fight in a war to free slaves who would compete with them for employment rather than the unfairness of the draft. The 1863 draft of 300,000 men seems to support the hypothesis that the draft had a disproportionate effect on the lower classes. According to Useem [1973, 73], fully 210,000 of the names drawn did not serve because of obtaining an exemption, 54,000 elected to pay the $300 commutation fee, 27,000 hired a substitute, and only 9,000 were actually inducted. During the entire war, slightly over two million men served in the Union army. Of this number, Randall and Donald [1961 311, n. 4] report that only 2.3 percent (50,000 men) were actually drafted, and less than 6 percent (120,000 men) were hired as substitutes. However, the "speculation" effect from the ability to hire substitutes likely reduced the number of volunteers prior to draft calls. A number of the draftees and persons hired as substitutes were probably men who would have volunteered, but were waiting for the increased compensation afforded by the transferability. At any rate, the next time the draft was used, transferability was not allowed. It has not been revived in this century.

Cellular Telephone Allocations

A second set of examples has to do with the Federal Communications Commission (FCC) and the allocation of licenses for radio and television spectrum airwaves. The evolution of the allocation of licenses to operate cellular telephones and interactive video data services comprise a case study in the differences between various allocation mechanisms.

The cellular telephone market allocations began in 1981 with the allocation of licenses for thirty major metropolitan areas. These allocations were made by a merit allocation. Applicants were required to demonstrate to the FCC that they were the most "qualified." Although, on average, less than four applicants applied in each area, Movshin [1989, 123] reports that the merit allocation resulted in numerous petitions to deny from opposing parties as well as amendments to correct the alleged deficiencies, causing costly legal battles.

For the allocation of the smaller markets, the FCC abandoned the merit allocation in favor of a series of lotteries to allocate the licenses for each market. According to Movshin [1989, 124], the FCC argued that a lottery would result in "substantial resource and cost savings to both the applicants and the commission." The first group of lotteries required a pre-lottery screening to assure that the applicant was qualified. However, the FCC set very loose guidelines for qualification. In addition, licenses were transferable. The result was that hundreds of applicants per license entered the lotteries. Anyone whose name was drawn in the lottery was bequeathed the market value of the license. Hazlett and Michaels [1993] argue that the technology was such that there were not large differences between operating costs of different firms, although Rudnitsky [1989] claims otherwise. Firms participating in the lotteries began to contract with one another to ensure a share of the market, and a new industry arose to meet the needs of satisfying the application procedures for interested clients. In the first lotteries the FCC drew not one winner, but an ordered list of ten applicants in case the first applicant(s) turned out to be ineligible. This resulted in legal petitions from each of the applicants next in line, as predicted by the rent-seeking model of merit allocations. The FCC reacted by raising the costs of speculators by requiring that financial commitments be demonstrated for each applicant. However, this was frustrated by the willingness of banks and vendors of cellular phone equipment to pre-approve financing to any applicant who won. Next, the FCC required a financial commitment, a restriction on transfers prior to final approval of the license, a limit on ownership shares in competing applications to less than 1 percent share; they also drew only one winner at a time. Movshin [1989, 128–9], Hazlett and Michaels [1993], and Hazlett [1993] argue that these rules reduced, but did not eliminate the rent-seeking behavior. Rudnitsky [1989] noted that one reason the lack of restrictions on speculators may have been allowed was that 80 percent of the smaller markets existed immediately adjacent to the larger metropolitan service areas which were already in place. Due to economies of scale, the firms already owning the metropolitan licenses stood the best chance of buying the adjacent area licenses. Thus, the Group *A* firms were insulated from other firms in each market by their competitive advantage.[16]

The FCC's most recent spectrum allocation is for two licenses each in 734 areas for interactive video data services. At present, the FCC plans to use a transferable lottery for these allocations also. According to Flint and Lambert [1992], applicants are restricted in the following ways: (1) an application fee of $1400 per area, (2) a restriction that within one year 10 percent of the operation must be built, within three years 30 percent must be built, and within five years 50 percent must be built, and (3) a restriction that the license cannot be transferred until 50 percent of the operation is in place. However, under the deficit reduction budget package being considered by the present Congress, the FCC would be allowed to use auctions to allocate the licenses rather than lotteries.[17] Given the theoretical equivalence between a transferable lottery and an auction (Proposition 2), the change in direction of policy (which has yet to pass Congress) appears to be an effort by the government to capture a larger share of the scarcity rents. Under the lottery allocations, much of the cost of participating in the lotteries was in the resources necessary for the application process.

BLM Oil Lease Lotteries

In contrast to the FCC, the Bureau of Land Management (BLM) historically has had no compunction with regards to allocating oil and gas leases on federal lands by auctioning. Lands with a "known geological structure" (kgs) have long been allocated by competitive bidding. Lesser quality lands (so called "non-kgs" lands) were allocated by queues from 1920 to 1959. According to Haspel [1985, 26], "would-be lessees engaged in furious battles with the government and with each other to be first to file claims" on lands believed by the industry to have promise. Corollary 2.1 suggests that some sort of a lottery or an auction method would be preferred to allocation by queues. After 1959 the queuing allocation was replaced by a lottery allocation in which the leases are transferable. Haspel offers two suggestions for the selection of lotteries. First, if

16. Hazlett and Michaels [1993] argue that the rent dissipation in the FCC case was much less than is suggested by the standard rent-seeking model. Their result could be due in part to risk-averse behavior, which neither they nor the present model considers. Their result could also be explained in part by Rudnitsky's claim that there existed a bilateral monopoly problem because of the advantage possessed by firms with existing contiguous operations.

17. Every administration since Carter has requested authority to allocate radio spectrum licenses by auction [Hazlett 1993, 2]. In a 1985 FCC Office of Plans and Policy working paper, Kwerel and Felker argued that "auctions are likely to impose lower costs on the Commission and society than other methods considered" [1985, 2]. President Clinton's 1994 budget estimates that $4.4 billion in revenues would be raised (over four years) if auctions are used to allocate FCC licenses. Presently, S335 (version as of June 16, 1993) and HR2264 (which passed the House on Thursday, May 27, 1993) each include sections that would allow the FCC to use auctions.

Hazlett [1993] argues that the use of lotteries was part of a long-time FCC policy to allocate licenses to many smaller businesses rather than to allow consolidation. He states "it is apparent to those who have studied the politics of radio and television licensing that the principal advantage of creating such a large number of television licensees...is that it offers advantages in the assignment process....[A]warding free licenses to three huge national firms would have failed to pass the political smell test" [1993, 21–22].

the leases had been sold by competitive bids the government would have to charge the "fair market price." The cost to the government per acre of leases sold by competitive bid was about \$3.50/acre (1983 dollars), compared to \$0.35/acre for leases allocated by lottery, the difference being the cost of appraisal. Haspel argues that if all the lands had been allocated by auction, more than 50 percent of the leases would attract a bid lower than the \$3.50/acre cost of administering the lease. Thus, the BLM is essentially passing on the costs of determining which tracts are profitable and which are not to the market by using a lottery. Second, and most importantly, the major source of revenues from the non-kgs leases has been from royalties paid once production starts (p. 30). Allowing transferability and charging low fees encourages speculation, which in turn encourages exploration and hence production.

Moose Hunting Permits in Maine

Maine law does not explicitly state that moose permits may be transferred. However, each year a few permits are sold through classified advertisements. It appears that the transferability is due more to an oversight in the enabling legislation for the hunts (they were revived in the early 1980s after a lengthy abeyance), rather than to a conscious political choice. This is supported by the fact that when contacted regarding this issue, the state agency responsible for management of moose permits denied that they are transferable.[18] If the state agency responsible for managing the moose hunts is beholden to Maine moose hunters for their budgetary support, then their denial that the permits are transferable suggests that they understand the costs of speculation on the local hunters. In fact, being quiet about the transferability is one way of imposing differential costs on the public. Those hunters who know of the program benefit by both the transferability and keeping the general public unaware of the speculation potential.

18. Personal communication with Kevin Boyle, University of Maine, Orono, and the Maine Department of Inland Fisheries and Wildlife, June 1992. Professor Boyle, who has been conducting contingent valuation studies on Maine moose hunters for a number of years, confirmed to me that transfers do occur.

V. DISCRIMINATORY PARTICIPATION FEES IN LOTTERIES

The fee for participating in the lottery has been treated as something which is exogenously determined. But the choice of the fee affects the number of participants, and is therefore to be expected to be a variable selected by the same process that selected the lottery. Raising the lottery fee reduces the number of participants. However, the net effect on a person who is willing to participate at the higher fee is ambiguous. While the higher fee increases the chance that the individual will be selected, it also decreases the expected net returns by the amount of the fee. A discriminatory fee does not have an ambiguous effect. From the point of view of a particular group, the best of all worlds would be a lottery allocation where the fee is low to the members of the group, but high to non-members. Such fees are observed in a number of instances.

Kodiak Brown Bear Hunting Permits

One illustrative case is the allocation of non-resident brown bear hunting permits on Kodiak Island, Alaska. Alaska state law requires that to hunt brown bear, a non-resident must hire a guide. Up until the early 1980s, this meant that guides placed their client's name in the lottery for permits and were notified by mail as to whether they received the permit. However, in the early 1980s animal-rights activists opposed to bear hunting became aware that any non-resident could put his or her name in the non-resident brown bear hunt permit lottery. (The restriction was that the hunter needed a guide to hunt, not to participate in the lottery.) Thus, for a few years, permits were being drawn by persons whose purpose was to prevent the hunting. The hunting guides, unhappy at the loss in clients, requested a change in the rules. Thereafter, the applicant or his appointed representative (e.g., the guide) had to be physically present at the drawing. While this imposed costs on the guides by forcing them to attend the drawing, it imposed even higher costs on the non-resident animal-rights activists because they had to travel much farther to participate. The restriction effectively stopped permits from going to people who did not intend to actually hunt.

Self-Managed Common Property Resources

Ostrom [1990] and Schlager and Ostrom [1992] cite several examples of lotteries being used to allocate common property rights to fishing berths, pastoral commons, and common timber resources within relatively closed communities. The fishing cases are described in the literature in the most detail, so they shall be used to illustrate the point. Fishing locations are known to vary in quality. Thus the goods being allocated are heterogeneous in value, but not because of differences in the value different people place on the goods.[19] The problem faced by a community is two-fold: they wish to devise a system whereby (1) rents are not dissipated in competing for the good locations (i.e., q is large), and (2) the rents are kept within the community (i.e., prevent speculation). The solution involves an interesting variant to proposition 3: a lottery is used to prevent the rent dissipation and a discriminatory fee is used to prevent speculation.

Berkes [1986] describes a system devised by fishermen in Alayna, Turkey whereby the right to a particular location is drawn by lot. The right is for different *starting* positions in a rotation (cf. Elster [1989, 72]). Persons not drawn for a particular fishing location must sit out, but only until their turn in the rotation occurs. Because enforcing property rights is costly, especially for the fisherman who has the best location, the lottery (and the rotation characteristic in particular) ensures that everyone has an incentive to recognize the property rights. To prevent speculation, a discriminatory fee is used. To participate in the lottery, a fishermen must submit a description of all the available locations. However, only fishermen who have participated in previous years are privy to this information, so newcomers are excluded.

Similar institutions exist for a number of common property allocations. In all examples who may participate in the lottery is restricted. Matthews and Phyne [1988, 167] quote a fisherman in Nova Scotia who describes the participation rules: "If a fella has a berth one year he can enter the draw the next." New fishermen are allowed in the draw only if one of the original participants drops out of the fishery. Martin [1973] observed that in the communities he studied, the federal government had *codified* their local rules into federal law for the area.[20] This occurred as early as 1919. Prior to then allocation of the fishing berths was by a queuing system. However, this system forced fishermen to set marking buoys several months before the season to ensure that they could use the location. The rules enacted in 1919 and continued thereafter in roughly the same form stated that "a

19. Note the similarity with the cellular telephone licenses.

20. Matthews and Phyne [1988] found that local rules were unenforceable since the federal government had not codified their rules. They argue that the local rules worked fine until the federal government extended its jurisdiction to 200 miles, at which time the local rules were invalidated.

committee of three trap-owners ... shall designate the trap-berths ... and decide as to the eligibility of all parties claiming the right to draw for a trap berth."[21] McC. Netting [1976] found that in lotteries used to allocate timber from common pastoral mountain lands in Switzerland participation is restricted to locals. McKean [1986, 539] found that in lottery allocation of common land in Japan not only are nonlocals restricted from being drawn in the lottery, but those who are drawn are restricted from selling their allotments. However, it is not clear why transferability is specifically restricted in this example since speculation has been prohibited by the local residency requirement.

Transferability is of small regard in many of these examples because with relatively homogeneous populations, the value of a good is similar to all. Since the value of the fishing locations depends upon the characteristics of the location itself rather than on who has the location, there is very little gain from trade except in those circumstances where someone has to leave the fishery because of an unanticipated event. Speculators are limited by discriminatory fees rather than restrictions on transferability. The cost of participating in each of these examples depends upon who the individual is. If the individual is already a member of the group using the resource, then the cost is low. If the individual is not a member of the group, the cost may be substantial. The fact that no trade occurs is a consequence of the homogeneity of the users of the resource and the heterogeneity of the resource being allocated. The lottery is fair, but only in a limited sense. It is fair to the members of the group, but not to potential members. Notice that in addition to the participation fee being discriminatory, the proportion of the economic rents returned to the participants, q, is also discriminatory. That is, to those in the community $q = 1$; to those outside the community $q = 0$. The discriminatory rebate and participation fees allow the community to overcome the problem of speculation from outside the community and rent-seeking within the community. Anderson and Hill [1983] have argued that when the rule-makers are also the residual claimants, the institution will be designed efficiently. This seems to be supported with the use of lotteries in self-managed common property resources.

Lotteries in Machiavelli's Florence

Lotteries were used in Venice, Florence and other Italian city-states in the Renaissance to appoint individuals to political offices for the same reason. Elster states "here political lotteries were used to prevent or dampen the murderous conflicts among factions of the oligopoly that would have arisen if instead the officials had been elected" [1989, 104].[22] He also notes that in Florence, even though a large number of people were allowed to be nominated to participate in the lottery, many failed to be *qualified* as determined by members of the *current government*. The identity of who was disqualified was not revealed publicly, thus ensuring a nonrandom sampling procedure [1989, 80–84]. Again, while reducing rent-seeking activities was one part of the idea, ensuring that the rents remained in the hands of a select group was another part.

VI. CONCLUSIONS

A number of authors have argued that lotteries are used to allocate resources because of the fairness of the mechanism. However, the observations that discriminatory fees are often charged and that

21. Quoted from the 1929 *Newfoundland Fisheries Regulations* by Martin [1973, 139].

22. See also Thaler [1980] on randomizing committee assignments in Congress.

some sort of a fee, explicit or otherwise, is charged in nearly every example suggests that the fairness argument is not capturing the real reason for selection of a lottery as an allocation mechanism. An alternative argument is that lotteries in self-managed resources are a mechanism to prevent rent-seeking behavior within the user group. Similarly, in government-allocated goods, lotteries are used because a lottery prevents rent-dissipation to members of the groups most likely to use the resource and that lottery fees and restrictions on transferability are used to prevent rent-seeking from speculators.

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