Managing competition:

A survey of methods for allocating scarce resources

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1 Introduction

The essence of resource management is determining the optimal rates of use and allocation of scarce resources. However, a problem arises in determining what optimality means. Often the resource management agency uses different criteria than other parties to define desirable outcomes. This paper concentrates on the problem of allocating resources in isolation from the problem of determining the rate of their use, to understand better the implications of choosing alternative resource allocation methods.

The optimal methods for allocating scarce resources amongst potential users differ depending upon the objectives of the resource administering agency and the number and characteristics of those wishing to obtain rights over scarce resources. When resource control is held by commercial organisations it is typical to observe distribution of resources by any of a number of pricing tools, including fixed prices, discriminatory prices, and auctions. However, many resources administered by public agencies are distributed by mechanisms other than pricing. Social welfare and health services are often distributed on merit, and there is usually a well defined order for meeting demands; severe head injuries, for example, are likely to be treated before ingrown toenails. Other services are provided free of charge and without any other form of restriction (e.g. street lighting, access to national parks), while others are distributed by queuing (state housing), or lottery (hunting permits). Many resources previously allocated by public agencies using non-price methods have recently been, or may soon be, transferred to price allocation, either directly (e.g. the implementation of backcountry hut fees) or indirectly by entrusting distribution to commercial organisations or state-owned corporations (e.g. electricity supply to remote regions).

The optimal allocation method is clearly dependent upon the objectives underlying supply of the service. For example, most people would consider it ludicrous to expect the poor to pay for social welfare services that they require only because of their poverty. While price allocation mechanisms can often be shown to meet efficiency goals, the reasons underlying provision of many of the goods and services administered by public agencies are not efficiency based. They are directed at distributional matters, often to meet some minimum standard, or to supply those services to which society considers individuals have a right. Hence, while it may in some narrow sense be efficient to allow the poor to starve, society does not condone this and actions are taken by public agencies to ensure that starvation does not occur.
The place of distributional matters in the ways society chooses to allocate resources is emphasised by Zajac (1978):

"Governmental intrusion in the market place in the name of equity or social justice is widespread. Minimum wage and child labour laws, occupational and safety standards, environmental protection regulations, ceilings on interest rates for home mortgages are but a few examples. There are also obvious forces at work to make the phenomenon more widespread. The natural desire to right apparent wrongs creates pressures to pass laws and regulations to ensure justice is done. But the creation of a law or regulation in turn usually both interferes with the efficient operation of markets and creates a class of persons who gain. The gainers then of course fight any attempts to repeal the law or regulation" (p.1).

Zajac's comments are directed at government regulation. They indicate that society is concerned about distributional matters and will go to great lengths to address perceived injustices. Regulations are not the only things to influence the actual distribution of resources and their benefits. Resource allocation tools cause dramatic variations in the allocation of goods and benefits. A lottery, for example, will result in different allocations to an English auction. This publication is about the impacts of resource allocation methods on both efficiency and distribution.

Public agencies concerned with addressing distributional matters may be required to cover the costs of providing services from income received from their provision, and may also be concerned with matters of efficiency. Choice of a resource allocation tool will therefore need to be made in light of the relative revenue raising and efficiency characteristics of the tools available. These characteristics may act as constraints to adopting tools that best meet distributional objectives.

In this publication methods available for distribution of goods and services are surveyed along with their implications for efficiency and equity. In doing so, the concentration is upon natural resources that are supplied by a monopolist (the public agency), with a quantity constraint. In everyday terms this assumption means that an agency has a fixed quantity of a natural resource to be allocated in a fixed period. For example, a regional authority may have a supply of aggregate suitable for concrete manufacture, the quantity being fixed by environmental constraints.
The quantity constraint may arise for many reasons, including: health, safety, ecological concerns, a variety of externalities, or congestion. The question of determining the optimal quantity of a resource to be allocated in any period is beyond the scope of this study and is not addressed here. Analysis of outcomes under conditions of congestion is somewhat different to the other cases, and so will not be addressed explicitly here, although many of the principles of rationing are also applicable to the congestion case.

A framework for allocation decisions is presented by McCool and Utter (1981), and a modified version is presented in Figure 1.1. The quantity of the good or service to be allocated is determined exogenously, but the allocating agency must determine whether there is a case for predetermining the allocations to different categories of users. Whether or not the allocation agency or representatives of consumer groups allocate the good to individual users, there is a range of allocation techniques available. A choice of technique is unavoidable. The focus of this study is the impact of the broad classes of resource allocation techniques.

The monopoly supply assumption does not greatly restrict applicability of the results derived. In many instances resources administered by agencies are not available from other sources, or the public agency takes a leading role in an oligopolistic market. Examples of resources that public agencies may have authority to distribute, and to which this analysis is consequently valid, include: real estate, securities, water, pollution rights, timber, grazing and other leases, gravel, minerals, access to cultural and educational facilities and services, health services, transport, housing, welfare grants, electricity, gas, access to reserves and recreation areas, recreation concession rights, roading, fish, game, and non-consumptive uses of wildlife.

In many instances the resource administering agency will be a clear monopolist, often deriving its monopoly power from government statute. In a few cases (e.g. real estate) the public agency will have many options removed from it by the competition presented by other suppliers unless its product is sufficiently different from those offered by the competition. However, there is still a wide choice. Competition places upper limits on prices, but the agency may still wish to price discriminatively within those limits, or to allocate the resource using non-price methods. The presence of competitors will generally change the shape of the demand curve for the public agency product, and hence the prices attainable, but will not change the range of methods available for distribution of that product.
Establish use limit

Yes

Recognise categories of users

No

Allot use between categories

Agency makes individual allocations

Techniques

Agents for category make individual allocations

Techniques

All potential users follow same procedure

Agency makes all individual allocations

Techniques

Figure 1.1  Framework for allocation decisions.

Source:  Adapted from McCool and Utter, 1981.
Most of the literature on pricing policy is directed at profit maximisation for commercial enterprises. Many aspects of the pricing decisions faced by commercial enterprises are not relevant to public agencies. Primary differences concern market structure and objectives. It is extremely rare to find commercial enterprises operating in a guaranteed monopoly situation, and even when they do their profit-making objectives are likely to be different to the objectives of a public agency with wider social concerns. Commercial enterprises employ pricing strategies to obtain market power and avoid taxes (e.g. predatory and transfer pricing) as well as to meet legal constraints that may be different to those faced by public agencies.

A further major area of related study is the domain of antitrust economics. This area of research has important implications for some of the allocation methods studied here. It is primarily concerned with appropriate arrangements for pricing in industries showing decreasing marginal costs (increasing returns to scale). These industries are the 'natural monopolies' and are characterised by a large capital investment with low or zero unit costs of production. Examples include telecommunications and electricity distribution. The traditional efficient solution of setting price equal to marginal cost would result in financial losses to firms supplying these services. The antitrust literature has been concerned with identifying efficient methods of distributing these services that allow the supplying firms to make a 'fair' profit. This literature is the source of the two-part tariff and block pricing mechanisms.

Several simplifying assumptions are retained throughout this analysis. Firstly, the more correct approach of general equilibrium analysis is forsaken for the more tractable partial equilibrium analysis. Under this approach, impacts of management of a particular good are assumed to affect only the consumers of that good. Prices of other goods, and the benefits obtained from their consumption are assumed to be constant. This assumption is not a major problem as long as the expenditure on the goods being allocated by the public agency is only a small fraction of the purchasers' total budgets. Dropping this assumption would greatly increase the complexity of the analysis without greatly affecting the nature of the results. It is therefore unashamably retained for reasons of clarity.

Monopoly supply of a fixed quantity of a homogeneous good is assumed throughout, and demand is greater than supply when there are no constraints on demand. Uncertainty over quantity and quality of the good and the rules under which it is to be managed are both precluded. Property rights to the goods to be allocated are assumed to be well-defined, and secure in the managing public agency. The aggregate demand functions for goods allocated by agencies are assumed to be known in many instances. The first
derivatives of individual (and hence aggregate) demand curves for these goods are assumed to be less than or equal to zero.
Management objectives

Resource managers, amongst others, are involved in the process of determining what actions or outcomes are best. "Best" is usually interpreted to mean 'most socially desirable'. Adoption of this definition implies the need to specify the society of interest (e.g. a town, a region, a country, or subsets of people with interests in these), as well as the need to define social desirability. In some instances resource managers are provided with clear objectives for their management activities (e.g. maximise use, or maximise contribution to gross domestic product), allowing them to act as technicians in determining optimal outcomes and implementing plans to obtain them. More often objectives are not well specified and the resource manager acts as a conduit for information to others who determine socially desirable outcomes or actions and may then charge the resource manager with implementing their decisions.

The objectives for resource management in New Zealand are currently in a state of flux. The Royal Commission on Social Policy (1988, p.24) recommended "The adoption of an integrated and co-ordinated policy approach, with a better and more humane balance between economic and social policy considerations than has occurred in the past. However, overall goals for society must be identified first, so that efficiency and distributional objectives can be specified." Those responsible for the Resource Management Law Reform have also recognised this problem "Above all, the law reform has recognised the need to identify and articulate the objectives of resource management .... In their management plans, decision makers will be expected to justify their selection of management tools, and to assess the intended effect (including the environmental impacts) of what is proposed." (Ministry for the Environment, 1989, p.8).

Since, "[s]tates cannot be socially ordered without someone making prior value judgements ... [and] value judgements are statements of ethics which cannot be found to be true or false on the basis of factual evidence" (Boadway and Bruce, 1984, p.137) a problem arises when determining what information is needed to rank alternatives. The type of information the resource manager will need to supply depends upon the elements of the decision maker's objective function. Knowledge of those elements avoids provision of information that will not be used. Commonly suggested elements of social objective functions include efficiency, equity, and liberty. This list may not be complete. The resource manager whose role is simply to supply information to decision makers does not need to know the form of the social objective function, just its elements. Knowing that
efficiency, equity and liberty may all be relevant does not solve the resource manager's problems, however, as there remain the problems of defining each of these concepts and measuring them.

Social decision rules rank alternatives for their social desirability. In many instances these rules are not able to identify the most socially desirable outcome or action, but simply rank (a subset of) outcomes or actions. Many social decision rules have been suggested that focus on a subset of the objective set listed above. A brief survey of some of the more common of these follows.

2.1 Efficiency

The least contested social decision rule is that of Vilfredo Pareto, which requires that no individual be made worse-off by implementing any proposed change and at least one individual is made better-off. In this case the proposed change is 'Pareto superior' to the status quo. When no Pareto superior state exists the situation is termed Pareto efficient, or Pareto optimal. The Pareto principle appears rather innocuous, but it is not devoid of value judgement since it relies upon the judgement that “social decisions be based exclusively upon individual preferences” (Russell and Wilkinson, 1979, p.400), and the judgement that everyone's preferences count (including those of the insane, criminals, and others whose preferences are currently ignored by society).

Pareto efficiency is determined by the initial distribution of goods or utility. If the initial distribution is unacceptable the Pareto principle is unable to provide guidance about desirable states, and “the choice of income distribution ... is a political matter that can be solved only by value judgements through the political process” (Just et al., 1982, p.11). It could be claimed that efficiency and distribution are separate matters, but “one cannot solve the problem of efficiency and distribution in two stages by first maximising the value of the social product by correctly allocating resources and then distributing the product equitably. The relative value of products depends on income distribution, which depends, in turn, on factor ownership” (Just et al., 1982, p.29).

The Paretian definition of efficiency is limited in that a Pareto efficient state is not necessarily Pareto superior to states that are not Pareto efficient. Further, there is no way of judging between the many possible Pareto efficient states (or between non-efficient states). Since most actions entail negative impacts on some people, the concept of Pareto efficiency is often unable to guide decision makers.
The Pareto principle’s inability to rank many proposals has resulted in the adoption of decision-making criteria that allow the possibility that some people are made worse-off. Principal amongst these is the potential Pareto improvement, or compensation, criterion. This criterion labels proposals socially beneficial if the gainers could compensate the losers and still be made better-off by the proposed change whether compensation is made or not.

The Pareto criterion implicitly recognises that individuals have a right to at least their status quo level of utility (or income, or consumption). The compensation criterion recognises no such right. Adopting it has the potential to make the poor both relatively and absolutely worse-off, and therefore exacerbate inequalities (Sen, 1973). Cost benefit analysis is a method for testing the potential Pareto improvement criterion using specific definitions of welfare.

The compensation criterion is one version of utilitarianism, which is defined by Sen (1986, p.278) to have three elements:

1. **Consequentialism:** The rightness of actions - and (more generally) of the choice of all control variables - must be judged entirely by the goodness of the consequent state of affairs.

2. **Welfarism:** The goodness of states of affairs must be judged entirely by the goodness of the set of individual utilities in the respective states of affairs.

3. **Sum-ranking:** The goodness of any set of individual utilities must be judged entirely by their sum total.

Sen (1986, p.278) claims that each of the features of utilitarianism “remain eminently controversial, and rival theories of morality have argued for the replacement of one or more of these features”.

Criticisms of utilitarianism are based on ethical concerns and practical concerns. The latter are raised by the need to make interpersonal utility comparisons. However, there is no theoretically defensible way of making interpersonal comparisons of welfare (Friedman, 1985, p.38).

As Blackorby and Donaldson (1977) point out, utilitarianism concentrates solely on total utility and completely ignores distribution of utility. The implications of adopting a utilitarian criterion for resource allocation will be unacceptable for many. For example, under this decision rule it is acceptable to commit crimes as long as the benefits to the
criminals outweigh the costs imposed upon the victims. In some cases there is partial support for such practices, as epitomised by the legend of Robin Hood. However, in other cases, such as gang rape or murder, very few people would be willing to endorse the actions of the criminals. The total of net individual benefits is not everything. Society is concerned about the distribution of impacts under varying states of the world.

2.1.1 Cost recovery

A common judgement on distributional fairness is that beneficiaries should fund projects. In essence this is often a means of applying the Pareto criterion where efficiency is determined with respect to willingness to pay. Cost recovery for changes in provision of goods (but not for existing provision) ensures Pareto superiority, but not Pareto efficiency; Pareto superiority is a necessary but not sufficient condition for obtaining Pareto optimality. That cost recovery is not applied to all activities where it is practical (examples include many health, police, and social welfare services) indicates that efficiency concerns are not always paramount in this country.

2.2 Equity

Ethical concerns arise over a variety of issues including liberty, justice, and equality. They may be classified into two major areas, outcome equity and process equity (Friedman, 1985). The former is concerned with the equity of the distribution of goods or welfare that actually occurs. It is not concerned with why the distribution has come about. On the other hand, process equity is not concerned with final distributions, but is concerned with the equity of initial distributions and the equity of processes under which distributions change.

It is not appropriate to investigate fully theories of distributional morality here. A brief summary of some of the main schools of thought follows. Concepts of equity and efficiency can be defined in terms of goods, utility, income, or opportunity. The range of possibilities should be borne in mind throughout the ensuing discussion.

2.2.1 Outcome equity

Utilitarianism is a special case of this class of equity issues. It is concerned with the final allocation of things because of the consequentialism feature. Utilitarianism forms a polar case in excluding any concern for distributional matters and concentrating on total utility. Opposed to this view of the world is another form of outcome ethic in Rawls' (1971) theory of justice, which ignores totals completely. Rawls proposed that social welfare
should be determined solely by the utility of the least well-off member of society. A modified version of Rawls' maxi-min criterion is the lexi-min criterion, which considers the welfare of other members of society to settle ties on the maxi-min criterion.

(i) Equality as a basis for equity
One measure of outcome equity is equality. The more alike the allocations of goods (or whatever) are to all individuals, the more fair the distribution. This view of the world is often termed egalitarianism. A somewhat less rigid form is specific egalitarianism, which is “the view that certain specific scarce commodities should be distributed less unequally than the ability to pay for them” (Tobin, 1970, p.448). Two main arguments support specific egalitarianism as an important goal in public policy. The first is the intuitive notion that it is inherently wrong that some people should have “less than a minimum of decency in terms of income, education, health care, or other basic needs,” and the second is the observation that “an inequitable society is highly unlikely to function smoothly” (Nagel, 1984, p.86).

The limiting case of egalitarianism arises when all individuals receive the same allocation. Suppose goods were distributed equally among all people. If such an initial allocation is deemed “fair” there still remains a problem regarding the evaluation of other outcomes. If such a distribution was made, the differing tastes of individuals would imply that utilities are not equal. Some people are better-off than others. Immediately society is faced with the issue of determining whether it is concerned for equality of goods or equality of welfare. An alternative approach is to allocate goods to equate utilities of individuals. Such a proposal requires the interpersonal comparison of utilities, which is not possible.

Differences in tastes imply that an equal distribution of goods will not be stable. Individuals may make themselves better-off by engaging in trade, resulting in a non-equal distribution. There is no basis for judging the equity of this final outcome. Even if perfect markets exist and trade results in improvements to the welfare of some individuals without making anyone worse-off, it is unclear how to trade-off the increased efficiency with the (possible) increased inequity.

Egalitarianism is criticised for two main reasons, its perversion of incentives and the belief that society prefers unequal outcomes. On the former, Milton and Rose Friedman question “what incentive is there to work and produce?” (Friedman and Friedman, 1980, p.167). Since everyone obtains the same outcome, there is no incentive to work, let
alone work hard or in an occupation that takes years of training. Consequently, total output is likely to be very low, reducing both total and individual welfare levels.

While Kneese (1977, p.21) claims western liberal societies “usually regard ourselves as striving for an egalitarian society, the main obstacle being the possible effects on incentives of extreme redistribution measures,” Tobin (1970, p.448) takes the view that “Americans commonly perceive differences in wealth and income as earned and regard the differential earnings of effort, skill, foresight, and enterprise as deserved.” Friedman and Friedman (1980) cite the preponderance for gambling in many societies and the unwillingness of most of the population to join communes or kibbutz as evidence that people often seek, or prefer, unequal outcomes. The divergent views of social commentators with regard to societies’ acceptance of egalitarianism as a desirable outcome indicates that choice of an appropriate social welfare ordering is likely to entail some value judgement about the importance of equality of the distribution of goods or utility, and any such judgement is likely to be controversial.

(ii) Envy as a basis for equity

Another basis for determining outcome equity is envy, or more correctly - lack of envy. Under this view of the world an outcome is fair if no individual envies the consumption bundle possessed by any other individual (see Feldman, 1980, and especially Baumol, 1986, for discussion of this concept). The equal distribution of goods is therefore fair under this criterion. The concept is appealing in that it does not rely on inter-personal comparisons of utility. However, starting from an equal distribution (or any other envy-free distribution), trade may bring about distributions that are not considered fair (Feldman, 1980; Baumol, 1986), bringing the concept of fairness into conflict with Pareto efficiency, and “since that principle is too reasonable to abandon, this concept of equity is seriously undermined” (Boadway and Bruce, 1984, p.174).

This concept of equity may be criticised on the same grounds of lack of incentives and non-desirability as is egalitarianism. For example:

“it is questionable whether the concept of lack of envy adequately captures the notion of fairness. One can think of cases where someone prefers the consumption bundle of someone else, yet everyone might agree that the economy is fair in the sense of being equitable. For example, I might envy a friend’s ‘lucky find’ in an antique store yet perceive no ‘unfairness’ in the fact that he, not I, owns it” (Boadway and Bruce, 1984, pp.174-175).
(iii) A general concept of outcome equity

Both the Rawls criterion and utilitarianism are complete, meaning they can order all possible social states. Some decision rules are only able to order a sub-set of social states and are termed quasi-orderings. The most common quasi-ordering is the Pareto criterion. There are several quasi-orderings that attempt to trade-off efficiency and equity, examples are provided by the dominance, hull-of-dominance, modified Rawls, egalitarian hull, and other criteria (see Russell and Wilkinson, 1979, Sen, 1986, Blackorby and Donaldson, 1977, for descriptions of some of these). The most general formulation of a social welfare function that trades-off efficiency and outcome equity is the Bergson-Samuelson social welfare function (see, for example, Russell and Wilkinson, 1979; Just et al., 1982). This approach maps a utility possibilities frontier in inter-personal utility space, and determines socially optimal outcomes by overlaying a set of social indifference curves. Such a social welfare ordering may be expressed mathematically as:

\[
W(x) = F(u^1(x), u^2(x),...,u^h(x))
\]

where: \( u^i(x) \) is the utility derived by individual \( i \) from distribution \( x \), and \( W(x) \) is the social welfare of distribution \( x \).

A generalised expression for utilitarian social welfare functions with isoelastic indifference curves is (Boadway and Bruce, 1984):

\[
W = \left[ \sum_{h=1}^{H} (u^h)^{1-\tau} \right] / (1-\tau)
\]

where: \( u^h \) is the utility level of household \( h \), and \( \tau^{-1} \) is the elasticity of substitution of the indifference contours.

When \( \tau = 0 \) this expression reduces to the utilitarian case, whereas the Rawlsian case is derived as \( \tau \) approaches infinity.

This general approach fails because of the lack of agreement on the correct specification of the social indifference curves\(^1\) (selection of the function \( F \), or acceptance of

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\(^1\) Kenneth Arrow first showed, in his oft-cited impossibility theorem, that neither this approach nor any other is able to provide a ranking of states of the world based upon individual preferences, and is consistent with some reasonable constraints that such a procedure would be required to satisfy. See K.J. Arrow, *Social choice and individual values*. John Wiley and Sons, New York, 1951.
utilitarianism and selection of the parameter $\tau$), it is also unable to account for matters of process equity.

2.2.2  *Process equity*

Those concerned primarily with process equity are not concerned that allocations of goods or utility, *per se*, are unequal as long as the procedures under which the goods were obtained were fair. Differences in wealth or utility may have arisen because of hard work on the part of some individuals (and lack of it on behalf of others), or because some individuals were denied opportunities to participate in the workforce, or to obtain the skills necessary to do so. In these cases equality of outcomes may be considered unfair. Sen (1986, p.282) puts it this way, "it is possible to defend a person's rights not in terms of the goodness of its *sic* consequences, but on the grounds that these rights have intrinsic moral acceptability irrespective of the consequences of the exercise of these rights" and proceeds to cite Nozick (1974, p.166): "Rights do not determine the position of an alternative or the relative position of two alternatives in a social ordering; they operate upon a social ordering to constrain the choice it can yield."

The principal notion of process equity is the concept of equal opportunity. For example, it may be considered unfair that some individuals are disadvantaged because of gender or race (say in their ability to obtain finance or education), resulting in diminished welfare for the same amount of work as others. Policies that redistribute benefits toward the disadvantaged groups may then be considered advantageous. More contentious are concepts of equality of opportunity in terms of genetic characteristics and inheritance. Some authors claim that it is unfair that individuals can expect to obtain high utility levels simply because they are fortunate enough to be born into a wealthy family, or because they are an intellectual or sporting genius, while others are certain only of misery because of the circumstances of their births (Boadway and Bruce, 1984, p.176).

The concept of process equity includes the rules for acquiring and transferring rights to goods. These rules provide the only means to obtain rights, and also provide a guarantee of obtaining a right if satisfied. Examples of such rules are provided by Locke (1690) and, more recently, by Nozick (1974). Sen (1986, p.285) notes that these rules have been widely criticised for the arbitrariness of the principles upon which they are based. The same criticism must also apply to all other notions of distributional fairness.
2.3 The role of the analyst

Resource management requires inputs from two parties: the decision maker, who determines what is socially desirable; and the analyst, who provides information to the decision maker. Of course, it is possible that these are the same person or group. The decision maker is required to process information, provided by the analyst, related to often complex concepts that bear upon the objectives of resource management. These concepts must attain the same meaning for both parties if they are to be of use in the resource management process. They must be well defined and measured in a manner that is understood and applicable by both parties.

Given that "in popular discourses fairness is an amalgam of a multiplicity of ad hoc desiderata that no simple and analytically tractable formulation may be able to capture" (Baumol, 1986, p.11), and "no unique concept of equity is widely regarded as definitive for public policy making" (Friedman, 1984, p.40) it is not possible for the analyst to determine "the best" action or policy. Indeed, it appears that society may not apply the same criteria to all things. For example, many societies appear to emphasise strict egalitarianism in allocating one vote per adult and taking considerable effort to prevent trade in votes, while specific egalitarianism is emphasised by the same society in providing a minimum standard of health care for all. Equality of opportunity is emphasised in the concept of free and compulsory education, whereas liberty and the Pareto improvement criterion appear to guide allocation of most goods and services judged to be non-essentials. Somewhere in the decision-making process some person, or group, must make a value judgement about social morality with respect to target variables and their distribution. If the bases for these decisions are conveyed to analysts, they will then be able to provide only the information relevant to the decision.

Most analysts treat the Pareto principle as a generally accepted moral principle. However, to go beyond this principle increasingly controversial moral judgements must be made. Boadway and Bruce (1984) summarise:

"a complete and non-dictatorial welfaristic social ordering will require interhousehold utility level comparisons at the very least. Even stronger utility comparisons must be made to obtain a richer menu of social welfare ordering possibilities. In any event, to go beyond the Pareto principle we must invoke additional and stronger ethical postulates" (p.170).
If decision makers are unwilling to make their views on distributive morality public, either through political expediency or ignorance, the analyst can best assist decision making by providing information on both efficiency and equity. Given that the analyst is unable to predict the variables of concern to the decision maker, the best that can be done is to provide summary measures of efficiency and equity, supported with a description of impacts by categories of those experiencing the impact. Friedman (1984) reaches the same conclusion:

"The diversity of specific concepts of efficiency and equity should receive attention. Given the lack of any predetermined social consensus about which of them to apply and how to integrate those that do apply, policy analysis can usually best help users reach informed normative conclusions by clearly laying out its predictions and evaluating them by the different normative elements (e.g., efficiency, relative efficiency, equality, equal opportunity). Certainly, nontechnical users will find each of the elements more familiar or at least easier to understand than the concept of a social welfare function" (p.47).

Friedman's guidelines for the information that should be supplied by the policy analyst should perhaps be clarified. Relative efficiency is based upon the existing distribution of entitlements, and is concerned with identifying whether one proposal is more efficient than the others, in the potential Pareto sense. Absolute efficiency is also based upon the existing distribution of entitlements, but seeks to identify policies yielding Pareto optima, rather than simply the Pareto superior alternatives identified by relative efficiency. Friedman claims the two most important measures of outcome equity are the minimum standard (specific egalitarianism) and equality. He suggests that the former may be measured as a percentage of those failing to attain the minimum standard. The latter may be measured by either the Gini coefficient or the coefficient of variation. No measurement of process equity is proposed.

Atkinson (1970) and Sen (1973) discuss a wide range of measures of equality, including those proposed by Friedman. Atkinson concludes that:

"a complete ranking of distributions cannot be reached without fully specifying the form of the social welfare function ... examination of the social welfare functions implicit in these measures shows that in a number
of cases they have properties which are unlikely to be acceptable, and in general there are no grounds for believing that they would accord with social values” (p.262).

Summary measures of efficiency and equity are not free of value judgements, leading to the conclusion that, in the absence of detailed information on the social desirability of relevant states, the best that the analyst can do is to provide a description of the impacts experienced by individuals and groups, and/or supply summary measures while taking care to indicate the value judgements implicit in their adoption.

Information should address questions such as: how are different social/user groups affected, and by how much? Only in this way does the decision maker have sufficient information to determine whether the efficiency gains (or losses) of a particular action are sufficient to offset the distributional impacts. Of course, the analyst cannot be expected to perform these tasks in a vacuum. It is impractical to describe the impacts of most resource management proposals on every affected individual, implying the need to categorise individuals. The aid of the decision maker will be necessary in identifying relevant groupings. Typical groups are often defined on grounds of: socio-economic status, income, race, sex, gender, nationality, household structure, age, employment status, or on other variables related to the issue in question.
3 Resource allocation tools

A variety of resource allocation tools is available to resource managers. At the limits are the options of doing nothing and completely precluding access to resources. We assume that the management agency wishes to allow some use of a natural resource, but less than would occur if no action is taken and consumers are free to consume as much as they desire. Hence, while admitting that the polar cases are applicable management options in some circumstances we have no interest in investigating them further here.

Shubik (1970) identifies eight major means of resource allocation:

1. economic markets with prices
2. voting
3. bidding
4. bargaining
5. higher authority, fiat, or dictatorship
6. force, fraud, deceit
7. custom, including gifts and inheritance
8. chance.

Not all elements of Shubik's typology are appropriate to public agency resource allocation. The options of voting (2), force, fraud, and deceit (6), and custom (7) are not investigated here, even though they are extremely common methods of resource allocation in other contexts. Allocation methods are divided into two major categories: market and non-market allocation tools. Market tools are characterised by agreement between trading partners about the amount of one good to be exchanged for another. Typically we encounter markets where goods are exchanged for currency (retailing, auctions), however, the medium of exchange need not be money. An important class of markets where money need not be exchanged is provided by those cases where goods are rationed by coupon or voucher. Usually, but not always, the voucher price of the good is determined by the agency issuing the coupons.
3.1 Market allocation tools

3.1.1 Uniform prices

A monopolistic agency may choose to allocate scarce goods by setting a single, market clearing, money price, allowing everyone to consume as much as they desire at that price. In terms of Figure 3.1, price must be set at \( P_0 \) so that the allowable quantity \( Q_0 \) is consumed. \( P_0 \) is often termed the competitive price, because it is the price that would occur in a competitive market. While this term is used throughout this publication, the reader should recall that the market is not competitive, but the monopolist may choose to act as if it was competitive. Profit-maximising monopolists would never act in this way, since they can (usually) increase their profits by charging a higher price. Competitive pricing earns revenue \( P_0 Q_0 \) for the monopolist.

If the market demand curve,\(^1\) which is the consumers' marginal benefit function, is known with certainty, the market clearing price \( P_0 \) may be chosen and the desired quantity \( Q_0 \) sold. However, at best, demand is uncertain, and for environmental commodities, is often completely unknown. By choosing a price not equal to \( P_0 \) demand will vary from the fixed supply, \( Q_0 \). If the quantity constraint is strongly binding (for example, there are no more trees to fell) it is impossible for \( Q_0 \) to be exceeded. In this case demand is unsatisfied and the management agency will still need to ration the resource (say via queuing) and forsake revenue to the benefit of those successful in obtaining access to the resource. If the quantity constraint is not strong, resource use will exceed the desired level.

If a price greater than \( P_0 \) is chosen demand will be less than \( Q_0 \) and resource users will be disadvantaged since net benefit per unit consumed is less than at price \( P_0 \), and fewer units are consumed. The revenue implications for the rationing agency are uncertain, depending upon the elasticity of demand. If marginal revenue is greater than zero (greater than marginal cost when costs of provision are positive) at \( Q_0 \), selecting a price higher than \( P_0 \) will decrease agency income.

When value is measured by willingness to pay, the market clearing price is known with certainty, and markets operate perfectly, uniform pricing is an efficient means of allocating a fixed quantity of a resource, since all those willing to pay at least the market clearing price obtain access to use, while those willing to pay less than this fail to obtain

---

\(^{1}\) This analysis is developed in terms of ordinary, or Marshallian, demand curves. It could just as easily have been developed in terms of the Hicksian compensating or equivalent demand curves. See Just et al. (1982) for explanation of these concepts.
access. In other words, no-one who fails to obtain access to the good has a greater willingness to pay than anyone who does obtain access. When benefits are measured by willingness to pay, pricing has the advantage of providing a measure of the value of additional capacity.

Pricing may not be a feasible means of allocating some natural resources because of the inability to exclude non-payers from using the resource. Access to national parks and state forests are likely cases. Of course, this criticism applies equally to other methods, such as lotteries and reservations, but not to all (e.g. effort). A notable exception in New Zealand parks is provided by commercially operated guided tramping where capacity is limited by the terms of the concession. The ready identification of those who have paid allows these operations to charge prices that limit demand to capacity.
The main distributional justice concerns are that pricing discriminates not only on grounds of willingness to pay, but also on grounds of ability to pay, and also the fairness of recovering costs of provision. The first concern is an expression that either (i) consumers' surplus does not provide a relevant measure of benefits, or (ii) the existing pattern of wealth distribution is inappropriate. These two arguments are not identical – in some cases (ii) implies (i), but consumers' surplus may be judged to be an inappropriate measure of benefits even when wealth is optimally distributed. Costs of providing existing units may be sunk, and therefore of little consequence. However, if future provision is costly and is paid for out of taxes or rates, those obtaining use at less than the cost of provision are being subsidised by other members of society. The fairness of such a policy cannot be determined a priori. It may be deemed unfair for luxury goods, such as yachts, while totally appropriate for others, such as non-cosmetic surgery.

The area $P_0AB$ in Figure 3.1 is termed Marshallian consumers' surplus and provides a measure of the benefits accruing to consumers of the rationed good. Monopolists and others possessing market power commonly attempt to obtain a share of these benefits by adopting a variety of discriminatory pricing practices.

### 3.1.2 Discriminatory pricing

Discriminatory pricing is a term used to describe a variety of techniques that firms with some market power are able to apply to appropriate some of the consumer surplus to which uniform pricing does not give them access. This is done by charging different prices for different people purchasing identical goods, the price charged being dependent upon the individual’s demand characteristics. Typical examples include: student and senior citizen discounts, season tickets, tied purchases, peak-load pricing, connection fees, quantity discounts, and minimum hire requirements.

The best a monopolist can do is to appropriate all the consumer surplus with what is commonly referred to as perfect, or first degree, price discrimination. Consumers are charged their maximum willingness to pay for each unit of the good purchased. Implementing such a policy requires that the seller has perfect knowledge of each consumer’s demand curve. Most authors assert that the transaction costs involved in obtaining this information would be enormous, making perfect discrimination a theoretical fantasy. However, it may be possible to approach perfect discrimination in some industries, as indicated by Phlips' (1983) example of railways charging different freight rates for the same goods going to different end uses.
While first degree price discrimination is uncommon, the same cannot be said for second or third degree discrimination. Second degree discrimination involves charging varying unit prices for the same good. For example, the price per marginal unit of electricity may fall after a given number of units has been purchased. Advanced schemes may include numerous steps, or price blocks. By charging more for infra-marginal units the seller appropriates some of the consumer surplus, but not all of it. Phlips (1983) likens this to a tax on infra-marginal units equal to the difference in marginal and unit prices.

Third-degree discrimination requires that there exist groups of buyers with differing price elasticities of demand. By setting a price for each group so that marginal revenues for all groups are equated, the monopolist maximises profits. This type of discrimination is often the main reason for student and pensioner discounts.

Price discrimination is particularly important in the field of natural monopolies (increasing returns to scale), where marginal costs of production continue to decrease with increased output, and average cost is greater than average revenue for all quantities produced. Without price discrimination such an industry will never be viable, however, it may be possible to earn some profit by discriminating, allowing the needs of consumers to be met and improving the welfare of producers and consumers, even those ‘discriminated against’.

Pre-requisites for application of discriminatory pricing are market power, the ability to distinguish members of the various groups, knowledge of their demand characteristics, and the ability to preclude trade in the commodity between groups. Friedman (1985, p.315) indicates that two main groups of commodities satisfy these conditions well. They are services and utilities, both of which are commonly provided by public agencies. Services include such things as health care, legal advice, accounting, taxi rides, restaurant meals, and automobile servicing. Utilities include telephone, electricity, gas, and water. Public agencies therefore have considerable scope for implementing discriminatory pricing practices, and often do so, implementing policies that charge different prices (for example) for business and domestic consumers of electricity and telecommunications.

3.1.3 Vouchers

Prices may be set in terms of money, or some other form of currency, which may or may not be exchangeable for money. Such other currencies are usually termed ration coupons, permits, or vouchers, and have commonly been used to ration foodstuffs and other basic requirements during wartime. Vouchers may be directly redeemable for goods, or may also require money transactions. Demand for the rationed commodities
is restricted by the number of vouchers allocated. Distributional and efficiency impacts of vouchers are determined by their method of initial distribution and whether trade in vouchers is permitted. A white market occurs when trade in vouchers is permitted, while restrictions on trade often result in illegal trading (black markets) as individuals attempt to appropriate the gains to be made from transferring vouchers from low to high value recipients.

3.1.4 **Auctions**

Auctions require the exchange of money for rationed goods, but the exchange price is not predetermined. Price is determined at the time of sale by bidding. Bids are offers to buy at stated prices. Cassady (1967) describes the main types of auction mechanisms used worldwide. These include the English, Dutch, and simultaneous auctions. Many other forms of auction exist, but they are essentially variations on one or more of the three main types.

(i) **English auction**

The English auction is the variety most common to New Zealanders. Buyers make bids for the good(s) on offer. The last bid made is termed the current bid. Only bids greater than the current bid are accepted. When the point is reached that no-one is willing to bid more than the current bid the goods are sold, at the price bid, to the person who made the current bid. The end of bidding is signalled by the auctioneer, or by the passage of a predetermined amount of time (often the time taken for a candle to burn). In cases where multiple items are being sold (e.g. cases of fruit) the successful bidder may have the option of taking only part of the consignment, the rest being offered to other purchasers at the same price, or re-auctioned.

(ii) **Dutch auction**

The Dutch auction is a descending price auction. The seller nominates a price that purchasers are able to accept (typically by calling out “mine,” leading to the alternative name of mining for this type of auction). If the offer is not accepted within a pre-specified unit of time the price is reduced. This procedure continues until the first person accepts an offer, at which time the auction ends, the goods being sold to the acceptor at the current price. A common variation is to constantly reduce prices that are indicated on the face of a large clock which 'counts prices down'. Alternatively, the clock marks the passage of time with prices being adjusted as each mark on the clock face is passed.
(iii) Simultaneous bid auctions
The English and Dutch auctions are characterised by successive bids, only one bid being current. Simultaneous bid auctions allow more than one bid to be made, often in secrecy, and rely upon the auctioneer to determine who made the highest bid. Bids may be made with simultaneous hand signals, by electronic means, be whispered to the auctioneer, or be submitted in written form. The latter approach is commonly known as tendering.

(iv) Discussion
Variations on the basic forms of auction are numerous, and present a vast array of combinations for comparative analysis. A major dichotomy occurs between the discriminative and competitive auction rules. Under the former, each successful offer in a multi-good auction is accepted at the price offered, while in the latter the nominated bids determine who obtains access to the goods, but price is determined by the lowest accepted (or highest rejected) bid, and is the same for all.

Clearly, this dichotomy is only of importance where there is more than one unit of a good to be disposed of, say thousands of cases of fish. In many instances the auction is used to dispose of a single, unique good, works of art, antiques, and real estate providing typical examples. In this case price may be determined by either the highest or second highest bids. These are known as first and second price auctions respectively. In either case the item is obtained by the person bidding the highest.

Bidding behaviour is affected markedly by the rules set for the auction, as each bidder attempts to adopt a strategy that maximises their individual benefits. It is not in the individual's interest to reveal their demand function, since the auction is a strategic game with uncertainty arising over the value of the good to opposing bidders. Different forms of auction are known to result in different expected prices, and consequently different expected benefits to sellers and buyers. In general there can be no guarantee that those with the highest willingness to pay will obtain access to the good(s) being auctioned, implying that auctions are not necessarily efficient. Much effort has been expended to determine the relative benefits of alternative auction formats without coming to any firm conclusions. What is known is that auctions are of use where there is uncertainty. If the seller knew buyer demand functions it would be possible to use discriminatory pricing schemes to obtain a better return than could be obtained from disposing of the same goods by auction.
3.2 Non-market allocation tools

3.2.1 Lottery
The lottery is a method of allocation by chance. In simple lotteries all participants have an equal probability of success, however it is possible to apportion successes amongst different categories of participants to alter the probability of success for the different categories. In its simplest form, all those wishing to consume the rationed good have their names recorded and at some predetermined time names are drawn randomly to determine successful applicants. Pure lotteries are open to all and are free of any qualifying conditions or fees. Impure lotteries may require that applicants meet some merit requirement, queue for the limited number of ballots, or pay fees for entering or success in the lottery.

Lotteries are impartial and therefore are often viewed as being "eminently fair" (Hardin, 1969). They are relatively simple for consumers to partake in, but impose high transaction costs on managers to ensure all applicants are included in the draw, duplicate applications are not included, and all applicants are advised of the outcome. The uncertainty of outcomes may induce individuals to enter many lotteries simultaneously, when they are only able to benefit from one "win." This and the long lead times required to administer a lottery result in a large proportion of "no-shows"—people who are successful in a lottery but who do not exercise their rights to consume the rationed good.

The no-show problem may be dealt with by increasing the number of successes in the lottery to obtain the same expected number of users, or by allocating no-shows on the day by some other method, such as queuing or pricing. The former approach is suitable for allocating services or goods where the quantity constraint is not strictly binding in the short-term. An example is provided by outdoor recreation areas where use is limited because of the ecological impacts of the total amount of use, and where the amount of use in any one day (for example) may not be critical. This approach clearly does not work for other goods where the quantity constraint is strongly binding, such as access to a hunting block where safety and non-disturbance of game are prime concerns, and alternative allocation mechanisms would have to be adopted to deal with no-shows.

Lotteries in their pure form do not capture rent for the resource administering agency. However, the imposition of entry or success fees allows some rent to be captured. Because lottery winners are chosen at random, without any reference to intensity of preferences, some highly desirable potential resource users may be tempted to use the
resource despite their exclusion by the lottery. The lottery "maximises the incentive for the unlucky to flout the allocation process. Enforcement may be a problem for this device" (Cullen, 1985, p.13).

Because "a lottery would not discriminate among users according to the relative value they place on the [resource,] persons who entered the lottery frivolously or to whom [the resource] is relatively unimportant would hold the same chance of winning as the ... enthusiast" (Stankey and Baden, 1977, p.7), leading to the conclusion that the lottery will be inefficient however value is defined.

3.2.2 Reservation
Reservation is a commonly used tool (in association with price) for allocating accommodation and travel and (without pricing) hunting blocks. The first person to request consumption of a given unit of the good is allocated that unit. By reserving far enough into the future one may (almost) be guaranteed to obtain the rationed good.

Several authors (e.g. Shelby and Danley, 1979; Stankey and Baden, 1977) have questioned the fairness of such a system that favours those with long planning horizons. This is the main reason that in many cases where the reservation method is used not all units of the rationed good are allocated by this method. To meet better the needs of those who are unable to plan long-term some units may be allocated by pricing or queuing at the time of use. An example is air travel. By reserving early it is possible to obtain low priced seats, while some seats are retained to satisfy the demands of urgent, short-notice travellers who are required to pay more for them.

3.2.3 Queues
Queues are similar to pricing in that they impose a time price for use of a resource. Reservations are an application of the first-come, first-served principle prior to the time of use, and often remote from the physical location of the good. Reservations can result in instant confirmation of future use for the user. Queuing, on the other hand, is first-come, first-served at the time of use, usually at the physical location of the good. Queues therefore eliminate the problem of no-shows at the cost to consumers of increased uncertainty. Queues may be either physical or paper. The person who has been waiting the longest obtains the next unit of the good to be distributed.

It is often argued that because everyone is equally endowed with time queuing is the fairest means of resource allocation. Fairness only comes at the cost of inefficiency however, as time spent queuing (and travel costs for physical queues) is wasted, those
who obtain access to the resource do so by paying with their time, however those who do not obtain access also pay. Further, the marginal value of time is not the same for all individuals. Those who place a low value on their time (probably the unemployed, old people, and those in low earning occupations) will clearly be advantaged by physical queues relative to those who place a high value on their time (business executives, people on short holidays, etc.), while paper queues will disadvantage those for whom time of use is important.

Paper queues impose costs upon the management agency to deal with applications to join the queue, updating positions on the queue, and informing queuers of their position. Because a paper queue is essentially costless to the consumer, and there is uncertainty over the time of success, the paper queue will be subject to the same no-show problems as lotteries and reservations.

Physical queues impose management agency costs to prevent queue jumping, to provide facilities for the queuers, and to administer the rationing mechanism, which will require the physical presence of an agency representative in most instances.

3.2.4 Merit
Goods may be allocated only to people satisfying arbitrary qualifications. These qualifications may be related to past behaviour or skills in use of the good. For example, in introducing individual transferable quotas to New Zealand fisheries the initial distribution of quotas was determined by historical involvement in the fishery. Alternatively, allocations may be made on any arbitrary basis, such as racial or socioeconomic background as a proxy for need or deservedness, or friendship with the decision-making authority.

3.2.5 Effort
A special class of merit rationing is rationing by effort. It is common to find natural resources rationed by effort. In this country, wilderness area management guidelines indicate that these areas should require (even though they don’t always) one day’s walk to reach their boundaries. This, along with the difficulty of access to many publicly provided outdoor recreation areas has lead Cullen (1985, p.7) to describe effort as “the New Zealand way of rationing,” in respect to outdoor recreation. Fishing technology is often restricted to outmoded methods to limit the effort applied to harvesting, and therefore to limit catch. Effort need not be applied directly to the target activity. It could be regarded as a price that may be levied in any unit. For example, wapiti hunting
blocks in Fiordland have been partly rationed by the requirement that applicants must have contributed to animal management operations in the area.

Because the effort required to obtain access to the resource is often 'wasted' rationing by effort is inefficient. Obviously, the fishing example provides clearer evidence of this than the wapiti case. The method also discriminates amongst those with different abilities to supply effort, e.g. the old or physically, mentally, or financially less able members of society.

If this method is applied as a once only requirement, it will work like a two-part tariff with a zero marginal price. This will effectively discriminate against casual or infrequent resource users.

In many instances, increases in demand will cause problems as effort requirements to meet any desired level of use will have to be amended upwards. This may be quite infeasible in rationing some resources. Public roads and rail services, for example, cannot be closed or re-routed simply to control access to a wilderness area. It may be equally as absurd to increase proficiency requirements to levels requiring extraordinary levels of knowledge, or extraordinary investment to obtain that knowledge. If, however, little investment is required to meet requirements, then effort is unlikely to provide a useful management tool. High effort requirements are therefore likely to be both discriminatory and inefficient. Low effort requirements are likely to be ineffective.
4 Methods for comparing allocation tools

The total benefit obtained from any resource allocation scheme is the sum of consumers' and producers' surpluses. Consumers' surplus is a measure of the benefits accruing to consumers. It is equal to the difference between the total amount that the consumers who actually obtain the goods would have been willing to pay for them and the total amount they actually paid to obtain them. Similarly, producers' surplus is the difference between the revenue obtained by the producer (or distributor) and the cost of supplying the goods. Efficient distribution schemes maximise the sum of consumers' and producers' surpluses, without regard to which group obtains the benefits. Clearly, benefits are maximised when the lowest cost producers supply goods to those consumers willing to pay the most. As long as willingness to pay, also known as marginal benefit, is greater than marginal costs of provision it is efficient to supply more of the good, and vice versa. In the cases we are concerned with here supply is fixed and there is only one supplier (the management agency), implying that efficient allocations may be determined by reference to demand characteristics alone.

Again, it should be noted that efficient allocation is a restricted concept of efficiency, since it relies on the exogenous determination of quantities. A general concept of efficiency requires that marginal social cost equals marginal social benefit. Satisfying this condition generally requires that quantity is an endogenous variable.

There are many measures of consumers' surplus. The most common are Marshallian surplus, compensating surplus, compensating variation, equivalent surplus and equivalent variation. Marshallian consumers' surplus is simply the area under the demand curves of those consumers who obtain the goods, less any costs of obtaining the goods. To obtain a true measure of welfare change, the compensating or equivalent measures must be used. These measures indicate willingness to pay for increments or decrements in consumption given a fixed level of utility. Compensating measures use the existing level of utility as a base, while equivalent measures use the utility level that would result if the changed conditions occurred. The compensating measures are appropriate to determine potential Pareto welfare changes, and are therefore preferred for efficiency analyses. Compensating measures are not easily derived, certainly in comparison to the much more readily accessible Marshallian surplus. A seminal paper by Willig (1976) identifies conditions under which these measures approximate each other. In most practical cases they may be used interchangeably. In the interests of greater clarity, and without great
loss of generality, the Marshallian measure of consumers' surplus will be used throughout this paper to determine the magnitude and distribution of consumer benefits. Further discussion of welfare measurement may be found in Devine (1987).

Producer (management agency) benefits will be measured by producer's surplus, also known as profits. Profit is the difference between total revenue and total cost of supply. Since cost information is unavailable here, the measure of producer benefits used is total revenue. Again there is little loss in generality, as the measure will be indicative of the relative impacts of alternative allocation mechanisms. Since the quantity of the good to be distributed is fixed, so is the cost of supply (recalling the earlier assumption of zero or homogeneous costs of supply). Hence, producer benefits will vary directly with revenue. An increase (or decrease) of $X in revenue will result in a $X increase (or decrease) in producer's surplus.

In many instances the transactions costs of resource allocation methods are not known, but these are real, and vary by method for consumers and producers. Hence, the measures of benefit identified here are gross. They do not (and cannot) incorporate these unknown transactions costs. Wherever possible, the nature of transactions costs will be identified.

Measurement of distributional impacts is not as straightforward as the efficiency analysis. It has already been indicated that there are no unambiguous measures of equity, consequently there arises a point where some ad hoc choice must be made. This study will be concerned with two major distributional impacts: the distribution of benefits and costs between producers and consumers, and the distribution of benefits amongst consumers. The former will be analysed by comparing consumers' and producer surpluses for alternative allocation procedures. The latter will be analysed by attempting to identify which consumer groups are advantaged and disadvantaged by each of the resource allocation schemes investigated.
Measurement of allocation tool impacts

Throughout the following analysis the aggregate demand curve (which is the marginal social benefit function, remembering the earlier assumption of no externalities) is represented by the function \( p = f(q) \), or by its inverse \( q = h(p) \).

5.1 Fixed competitive prices

In the single, fixed (competitive) price case, illustrated by Figure 5.1, the monopolist chooses price \( p_0 \) to allocate the fixed supply \( q_0 \). Charging a lower price will result in excess demand, leading to the adoption of additional rationing mechanisms or overuse of the resource, depending upon the strength of the quantity constraint. If the quantity constraint is immutable, those consumers who gain access to the goods will obtain benefits equal to the difference between \( p_0 \) and the lower price for each unit distributed. However, there is no guarantee that no consumers with marginal benefits less than \( p_0 \) will obtain access to the good, resulting in inefficient allocations.

![Figure 5.1 Competitive pricing.](image-url)
When the competitive price, $p_0$, is charged the resulting benefit distribution is:

\[
\text{Revenue} \quad = \quad R \quad = \quad p_0 q_0
\]

\[
\text{Consumers' surplus} \quad = \quad CS \quad = \quad \int_0^{q_0} f(q) \, dq - p_0 q_0
\]

\[
\text{Total benefits} \quad = \quad B \quad = \quad \int_0^{q_0} f(q) \, dq
\]

These benefits may be interpreted as areas in Figure 5.1. These are:

\[
R \quad = \quad 0 \cdot p_0 b q_0
\]

\[
CS \quad = \quad p_0 a b
\]

\[
B \quad = \quad 0 \cdot a b q_0
\]

Fixed pricing at $p_0$ provides an efficient allocation of resources. It is not possible to obtain greater aggregate benefits without changing the quantity of the good supplied. No recipient of the good has a willingness to pay what is less than any individual who did not obtain access to the good. It may, however, be possible to find other allocation schemes with identical total benefits, but that distribute those benefits differently.

It often occurs that those who are responsible for resource allocation do not have intimate knowledge of the market demand curve, and consequently are unable to identify accurately the competitive price. The implications of setting a price different to $p_0$ depend on whether the price set is greater than or less than the competitive price. If price is less than $p_0$ the revenue obtained is reduced by the difference in price multiplied by the quantity distributed. If $p$ is less than $p_0$ consumers obtain additional benefits relative to the case in which $p$ equals $p_0$, but these additional benefits are less than the loss in revenue incurred by the distributor since some people with marginal benefits less than $p_0$ probably obtain access to the resource, displacing some of those with higher valuations. Pricing too low is therefore inefficient and the distributor still has the problem of allocating the good, since demand is greater than supply.

If price is set above the competitive level the distributor will be left with unallocated goods. If these goods are not subsequently allocated then overpricing is clearly
inefficient. It could, however, be made efficient if price is lowered until the market clears. Either way, those obtaining access to the goods receive lower benefits than if the competitive price is charged. The change in distributor revenue from pricing above \( p_0 \) is dependent upon demand elasticity. It may be positive (if demand is inelastic at \( p_0 \)) or negative (if demand is elastic at \( p_0 \)). This issue is examined further in the next section.

5.2 Single-price revenue maximisation

The monopolist may decide not to allocate all of the good. It may be possible to increase revenue in some instances by charging a price \( p_1 \) greater than \( p_0 \) and hence allocate a quantity \( q_1 \) that is less than \( q_0 \). This possibility is illustrated in Figure 5.2. Because the \( q_1 \) units distributed are allocated to those with the greatest willingness to pay this strategy is efficient for allocating the quantity \( q_1 \), but since there is no cost in providing the additional \( q_0 - q_1 \) units, and there are positive marginal benefits from doing so, there is a loss in efficiency from decreasing supply in this manner. The efficiency loss is equal to the shaded area \( q_1cbq_0 \) in Figure 5.2.

![Figure 5.2 Single-price revenue maximisation.](image_url)
We now have:

\[
CS = \int_0^{q_1} f(q) \, dq - p_1q_1 = \text{area } p_1ac
\]

\[
R = p_1q_1 = \text{area } 0p_1cq_1
\]

\[
B = \int_0^{q_1} f(q) \, dq = \text{area } 0acq_1
\]

The losses in efficiency and consumer benefits relative to a fixed, competitive price policy are:

\[
\Delta CS = \int_0^{q_1} f(q) \, dq + q_1(p_0-p_1) + p_0(q_0-q_1)
\]

\[
= \text{area } p_0p_1cb < 0
\]

\[
\Delta B = \int_0^{q_1} f(q) \, dq
\]

\[
= \text{area } q_1cbq_0 < 0
\]

There may, however, be an increase in revenue:

\[
\Delta R = (p_1-p_0)q_1 - p_0(q_0-q_1)
\]

\[
= \text{area } p_0p_1cd \text{ less area } q_1dbq_0,
\]

which is greater than zero when demand is inelastic at \( p_0 \).

Increasing price above the competitive level will only increase total revenue if demand is inelastic at \( q_0 \). In other words, the own-price elasticity for the good must be less than unity, implying that marginal revenue is negative.

Own price demand elasticity (\( \eta \)) is defined as:

\[
\eta = \frac{-dQ_d \cdot P}{dP \cdot Q_d}
\]

where \( Q_d \) is the quantity demanded at price \( P \).
Demand is defined to be inelastic when $\eta$ is less than one. This means that a one percent increase in price will result in less than a one percent decrease in demand. Consequently, charging a higher price will result in more revenue, even though less units are sold.

### 5.3 Lottery

Assuming a negligible cost to consumers of entering a lottery to obtain access to the rationed good, all $q_2$ consumers with positive willingness to pay will enter the lottery. Of these, only $q_0$ will be successful. Since the lottery chooses randomly from all applicants it is most unlikely that the $q_0$ individuals with the greatest marginal benefits will be selected. The lottery is therefore inefficient *a priori*. If there is no fee all benefits accrue to consumers and revenue is zero. Because allocation is random it is not possible to determine benefits *a priori*. Expected benefits will be used here for the purpose of comparative analysis. It is possible to incorporate measures of central tendency, once the demand function is known, to provide confidence limits on predicted outcomes. For clarity, this will not be done here.

$$E[CS] = E[B] = \frac{q_2}{q_0} \int_0^{q_2} f(q) \, dq$$

Figure 5.3 illustrates this case. The average benefit obtained by the $q_2$ potential users is $p_L$, resulting in total (expected) benefits of $p_Lq_0$ from allocating $q_0$ units. This is area $0p_Lq_0$. An efficient allocation mechanism (e.g. competitive pricing) will allocate the resource to the $q_0$ people with highest marginal benefits, resulting in average benefits of $p_p$ and total benefits equal to area $0p_pq_0$ in Figure 5.3. Clearly, total benefits from pricing are greater than expected benefits from a lottery.

The pure lottery has a major disadvantage to the management agency in that it does not earn any revenue. This problem may be addressed by combining the method with pricing. Two alternatives exist: charge applicants a non-refundable fee to enter the lottery, and charge successful applicants a fee for using the resource.

#### 5.3.1 Lottery with fee for successful applicants

Suppose a fee $p_3$ is charged for successful lottery entrants and all entrants are aware of the fee before entering the lottery. Only those who would obtain marginal benefits greater than or equal to $p_3$ would enter the lottery. The result of eliminating those obtaining the smallest use benefits in this way is an improvement in efficiency *vis a vis*
the pure lottery. In the limit, as the success fee is raised to the competitive price total benefits become identical to those obtained from a fixed, competitive price, \( p_0 \), as only those willing to pay \( p_0 \) enter the lottery and the probability of success is unity.

Figure 5.3 Lottery.
At success-fees $p_3$ the number of people entering the lottery will be $q_3 = h(p_3)$, as illustrated in Figure 5.4. Benefit levels are then:

$$R = q_0 p_3$$
$$= \text{area } 0p_3gq_0$$

$$E[CS] = \left(\frac{q_0}{q_3}\right) \int_0^{q_3} f(q) \, dq - q_0 p_3$$
$$= \text{area } p_3psfg$$

$$E[B] = \left(\frac{q_0}{q_3}\right) \int_0^{q_3} f(q) \, dq$$
$$= \text{area } 0p_3fq_0$$

Figure 5.4 Lottery with success fee.
5.3.2 Lottery with entry fee

Analysis of outcomes resulting from a lottery in which there is a non-refundable participation fee ($P_4$) is complicated by the fact that the expected benefits of paying the fee are determined by the number of people entering the lottery. If individuals do not have accurate information on the likely actions of others, choosing an optimal policy becomes problematical. For the sake of analysis, let us assume that individuals know each others' preferences intimately, or there has been a long history of similar lotteries which provides an accurate estimate of the probability of success ($\prod$).

Success in the lottery results in benefits to the individual of $\alpha - P_4$, where $\alpha$ is the individual's willingness to pay for access to the good. Failure to win the lottery results in a loss of $P_4$. The expected benefit to the individual of entering the lottery is therefore:

$$E[CS] = \Pi(\alpha - P_4) - (1-\Pi)P_4 = \Pi\alpha - P_4$$

The expected benefits of not entering the lottery are zero. A risk-neutral individual will enter the lottery as long as the expected benefits of doing so are at least as great as from abstaining. That is, a risk-neutral individual will enter the lottery as long as $\Pi\alpha \geq P_4$. Alternatively, only those individuals with marginal benefits at least as great as $\beta$ ($\beta = P_4/\Pi$) will enter the lottery, resulting in $q_4 = h(\beta)$ applicants (Figure 5.5). Note that the probability of success is determined by the number of applicants ($\Pi = q_0/q_4$), providing three equations in three unknowns; $q_4$, $\beta$, $\Pi$. The three equations are:

(i) $\beta = P_4/\Pi$

(ii) $\beta = f(q_4)$

(iii) $\Pi = q_0/q_4$

Solving this series of equations yields the equilibrium result:

$$f(q_4).q_0 = P_4q_4$$

which may be solved for $q_4$ in terms of the known parameters $q_0$ and $P_4$. The resulting distribution of benefits is:
Revenue

\[ \text{Revenue} = p_4 q_4 \]

\[ = \text{area } 0p_4kq_4 \]

\[ \text{E[CS] to successful applicants} = \Pi \int_0^{q_4} f(q) \, dq - p_4 q_0 \]

\[ = \text{area } p_4p_hj \]

\[ \text{E[CS] to unsuccessful applicants} = p_4(q_4 - q_0) \]

\[ = \text{area } q_0kq_4 \]

(N.B. this is a loss)

\[ \text{E[B]} = \Pi \int_0^{q_4} f(q) \, dq \]

\[ = \text{area } 0p_hq_0 \]

---

Figure 5.5 Lottery with entry fee.
5.4 *Advance reservation*

Advance reservations allocate the resource to those who make their plans the earliest. There is no reason to believe that these people will be the ones obtaining the highest marginal benefits from use of the resource. The benefits obtained from the resulting allocation will depend upon the correlation between willingness to pay and ability to predict desires in the future. A perfect positive correlation will result in the same efficient allocation as competitive pricing but, since there is no fee payable, consumers obtain additional benefits from advance registration equal to the revenue obtained under competitive pricing. If correlation is perfectly negative advance registration will result in the least efficient allocation possible. Zero correlation results in the result expected from a pure lottery.

If correlation between forward planning and willingness to pay is perfect and positive:

$$ CS = B = \int_{q_0}^{q_0} f(q) \, dq $$

If there is no correlation:

$$ CS = B = \frac{q_0}{q_4} \int_{0}^{q_4} f(q) \, dq $$

If correlation is perfect and negative:

$$ CS = B = \int_{\gamma}^{q_4} f(q) \, dq \quad \text{where} \quad \gamma = q_4 - q_0 $$

No-shows present a particular problem for analysis of advance reservations. The foregoing results assume that there are none. If there is no cost to cancelling a reservation, all potential resource users will find it advantageous to ‘take out insurance’ by making reservations to cover future contingencies. If some of these people then decide not to use the resource, others who would benefit from resource use may be precluded from access.
Shelby and Danley (1979) summarise research into use of reservation systems for campgrounds. They list the following points:

(1) Reservations favour users who can and do plan ahead, so not everyone benefits from the change to such systems. Identification of and provision for users who do not plan ahead is important to avoid their exclusion.

(2) Reservation systems involve a wide range of variables, including automation, centralisation, method of making the reservation, and specific reservation policies. These should be carefully evaluated in light of agency goals and constraints because they significantly affect efficiency and acceptability of the system.

(3) No-shows remain one of the significant drawbacks to reservations. Methods to reduce no-shows include pre-payments, penalties, and adjusting the method by which reservations are made.

(4) Reservation systems are expensive; it is important to consider who benefits from the service and who pays for it.

(5) Overall use of campgrounds is reported to increase with reservations, probably as a result of visitor referral. Campers who would otherwise be turned away during peak times are referred by the system to less popular places or times. This may result in more complete utilisation of the resource.

(6) Campgrounds using reservation systems show a significant reduction in visitor-related problems such as thefts and vandalism. This is apparently due to either the type of users most likely to make reservations or the accountability that results from recording names and addresses.

(7) Users who obtain satisfactory reservations will be happy with the system; those turned away will probably be disgruntled, but may still support the system. Referral to available places or times is preferred to denial, both from an efficiency and a political standpoint.

The time lag between making reservations and use of the resource result in uncertainty for consumers. Consequently, the same problems that affect lotteries also affect reservation systems. Stankey and Baden (1977) reviewed the use of reservation systems for allocating wilderness and found:

"Where free of charge, people make reservations even if there is a low probability that they will ever, in fact, use their privilege. In effect, the reservation is free insurance of the opportunity to go. For example, in 1973 the Inyo National Forest, California, rationed use of the Mt. Whitney Trail to a maximum of 75 parties per day. Forest officials estimate that
approximately one-half of the reservations resulted in no-shows. People also make multiple reservations to maintain the broadest options until a decision has to be made. Unless no-shows can be allocated, the area will often be underutilised even at times when demand for entry is very high,”

and continue,

“a wilderness buff who gains great satisfaction from wilderness could be denied entry by a casual, relatively disinterested visitor whose request happened to be postmarked earlier. ... The relative worth of the experience would have little bearing on chances for getting a reservation. Obviously, a perfectly functioning system for marketing reservations would substantially reduce this source of inefficiency”.

5.5 Queuing

Physical queues are conceptually similar to advance reservations. The major differences occur because of the added costs of queuing, and avoidance of the no-show problem. Queues may also be considered a form of pricing in which the price is the amount of time that must be expended to obtain access. Unlike pricing, however, the time is wasted and the time price is not necessarily known before joining the queue. Because time is wasted in queues, the queue can never be an efficient rationing mechanism. Introduction of the concept of transactions costs could alter this conclusion however if, for example, the value of time wasted plus the cost of administering a queue was less than the costs of administering a fixed price market.

5.6 Effort

Resource use may be limited by imposing effort requirements that force up the cost of using the resource. Each individual faces the same physical costs (e.g. a hike of 10 km to reach a recreation area), but each individual places a different value on the physical cost. For example, to an athlete this may represent a minor inconvenience, while to a paraplegic it may become an insurmountable obstacle. By deducting this additional cost from the benefit of use a new (nett) measure of benefit is obtained. This measure is illustrated in Figure 5.6. If effort is to be the sole method of rationing, the nett benefit curve must pass through the x-axis at q0. The area under the nett benefit curve is clearly
less than the area under the original demand curve, implying that effort can never be an efficient rationing mechanism. Since no money costs are incurred by users, rationing by effort may increase the benefits accruing to them. Whether this occurs depends upon the relative shapes of the two demand curves and no judgement can be made \textit{a priori}.

![Graph of net and gross marginal benefits](image)

**Figure 5.6** Effort.

### 5.7 Discriminatory pricing

Discriminatory pricing schemes allow the possibility that different people are charged different prices for identical goods. The most common discriminatory pricing procedures are: first-degree, or perfect, price discrimination; second-degree discrimination, incorporating block tariffs and two-part tariffs; and third-degree, or inter-group, price discrimination.
5.7.1 First-degree price discrimination

Perfect price discrimination requires that each user is charged a price equal to that individual's maximum willingness to pay for the total quantity consumed by them. This allocation method requires perfect knowledge of every individual's demand function. If this knowledge is available it is a simple matter to identify those individuals with the greatest willingness to pay and to allocate the resource to them, resulting in an efficient distribution that delivers all benefits to the resource administrator, and none to consumers. Of course, allocation could occur free-of-charge, in which case all benefits accrue to the users. When a charge is levied we have:

\[ CS = 0 \]

\[ R = B = \int_0^{q_0} f(q) \, dq \]

The efficiency of perfect discrimination arises because the monopolist is able to use the market marginal benefit function as his or her marginal benefit function. The monopolist will maximise profits by equating market marginal benefits with (the monopolist's) marginal costs when there is no capacity constraint, or maximising the difference between total benefits and total (monopolist's) costs when there is a capacity constraint. In either case, in the absence of externalities, the monopolist's benefits are maximised when the resource is allocated efficiently.

5.7.2 Two-part tariffs

Two-part tariffs are a method for extracting consumer surplus by charging a fixed fee before allowing any use of a service, or purchasing the first unit of a good. Examples include 'connection fees', tied sales, and entrance fees. Once the initial fee has been paid the individual may purchase any number of units at a constant unit price. The two-part tariff is discriminatory in that individuals purchasing different quantities face different average prices. Those consuming small quantities face higher average costs than those consuming larger quantities. A prerequisite for the introduction of a two-part tariff is that the product cannot be resold. If this condition was not met there would be an advantage to consumers in forming associations to limit the number of connection fees paid.

Oi (1971) raised the question of whether it is optimal for a vendor to charge high admission fees and charge a low unit price, or to allow free entry and charge a high unit price. His conclusion was that profits are maximised by extracting all consumer surplus as an entry fee and charging marginal costs for each unit consumed. Given that
individuals are not identical, this implies the need for third-degree discrimination in entrance fees.

Since the entrance fee part of the tariff is a lump-sum transfer from consumers to vendor, and individual units are sold at marginal cost, the two-part tariff is an efficient means of resource allocation when there is no quantity constraint, since the good will be consumed to the point where marginal cost equals marginal benefit. In the presence of a quantity constraint the fees are set so that the entrance fee is equal to the value of consumer surplus when a market clearing price is charged, and the unit price is set equal to that market clearing price. This situation is also Pareto-optimal, given the quantity constraint.

Maximum vendor revenue is obtained from non-identical consumers by charging each consumer an entry fee equal to the consumer surplus (s)he would obtain at the current unit price. We now consider the case in which a uniform entry fee must be charged for non-identical consumers. Two situations are commonly addressed: (i) no consumers are excluded from the market, and (ii) the monopolist may choose the number of consumers in the market. In the first case, maximum revenue is (usually) obtained by setting the entrance fee at less than the consumer surplus earned by the consumer earning the least surplus when price equals marginal cost, and setting the unit price above marginal cost. Oi (1971) describes conditions in which revenue is maximised when unit price is set below marginal cost.

Because the restriction that all consumers must be serviced is a constraint on the options of the monopolist, it is apparent that the monopolist can earn greater revenue in the case where it is able to choose an entrance fee that limits the number of consumers.

These conclusions are best illustrated by a simple example. Suppose there are two individuals (A and B) who demand a specific product (x). Their respective linear demand functions are:

Individual A: \[ x_a = 25 - \frac{p}{4} \]
Individual B: \[ x_b = 12 - \frac{p}{5} \]
The aggregate demand function is therefore:

\[
X = \begin{cases} 
37-9p/20 & \text{if } 0 \leq p \leq 60 \\
25-p/4 & \text{if } 100 \geq p \geq 60 
\end{cases}
\]

The product is costless to produce. Given no restrictions on the monopolist’s behaviour the revenue-maximising strategy is to allocate 37 units at zero unit cost, but charging discriminative entrance fees of $1250 and $360 for individuals A and B respectively, yielding a profit of $1610 for the monopolist and zero surplus for consumers. The monopolist has efficiently extracted all the consumer surplus. This outcome occurs because the marginal revenue function for allocating additional units to each individual is simply the individual’s demand function. Setting marginal revenue to marginal cost results in 25 units being allocated to individual A and 12 units to B.

Now assume that the monopolist is unable to charge discriminating tariffs. The monopolist has two options:

1. charge a high entrance fee, so that only one consumer enters the market,
2. charge a (entrance fee, unit price) pair of consumers so that maximum revenue is obtained when both consumers remain in the market.

Under option (i) the monopolist would set unit price to zero and charge an entrance fee equal to the surplus obtained by individual A ($1250), resulting in revenue of $1250 from the 25 units allocated and zero consumers’ surplus.

Under option (ii) the outcome is not as clear cut. The monopolist no longer maximises revenue by setting unit price equal to marginal cost. As long as unit price is zero the monopolist can charge lump-sum entrance fees up to $360 without driving anyone from the market. Setting unit price greater than zero will require correspondingly smaller entrance fees to retain all consumers. The maximum entrance fee is the consumer’s surplus earned by individual B for any given price \((CS=[60-p][6-p/10])\). Sales revenue at price \(p\) is simply price multiplied by the quantity sold, which may be determined from the aggregate demand curve \((SR=p[37-9p/20])\). Total revenue may therefore be expressed as a function of unit price \((TR=720+13p-p^2/4)\). Differentiating with respect to \(p\) and solving yields a revenue-maximising unit price of $26.00, which allocates 25.30 units. The entrance fee is $115.60, resulting in total revenue of $889.00.
The monopolist maximises profits in this example by charging an entrance fee that drives one consumer from the market and reduces total consumption of the good. Total benefits are maximised by allowing the monopolist to charge differential entrance fees, this policy is efficient but robs consumers of all benefits. Retaining both consumers in the market is inefficient (total benefits equal the monopolists profits [$889] plus the surplus obtained by individual A [$568.90] for a total of $1357.90) and results in lowered monopolist profits, but does ensure some consumers' surplus accrues. Allowing the monopolist to dictate the number of consumers in the market improves the monopolist's profits [$1250], but this option extracts all consumer surplus in this case and is the least efficient option.

Similar reasoning pertains to the quantity constrained case, except that in the two buyer case only one (unit price, entrance fee) combination will satisfy the quantity constraint when both individuals are in the market. Clearly, when there are more than two buyers a number of options exist, but efficiency is attained only in the case where the monopolist is free to discriminate on entrance fees.

5.7.3 Block tariffs

Many pricing schemes entail changes in marginal prices for individual consumers beyond consumption thresholds. The price may be $X per unit for the first A units, $Y per unit for the next B units, and $Z per unit for each unit after A+B units. Block tariffs can be discrete, with as few as two blocks, or may be continuous, in which case each unit has a unique cost. Block tariffs are often preferred to two-part tariffs because they reduce the need for the selling agency to continually collect information on individual buyers. The buyers 'select' their own tariff by their choice of quantity. However, the prerequisite of inability to re-sell remains, with the added necessity of monitoring total sales to each buyer.

The importance of this allocation tool is summarised by Willig (1978, p.58) “when a uniform price at marginal cost is rendered undesirable by economies of scale and the infeasibility of lump-sum transfers, Pareto efficiency requires a nonlinear outlay schedule whose marginal price for the largest purchase is equated to marginal cost.” This theme is echoed by Spence (1977, p.9): “Quantity dependent prices can be thought of as a generalisation of two-part tariffs for instances in which the firm either cannot distinguish among consumers or is not permitted to do so.” Willig proceeds to show that “Skewed and possibly undesirable income distributional effects of the two-part tariff can be avoided by offering consumers a choice between a uniform price and a two-part rate.
The surprising fact is that a choice which is preferred to [a constant unit price] by all consumers and which also increases [supplier profits] can be proffered” (Willig 1978, p.61).

5.7.4 Third-degree price discrimination

Vendors possessing market power have the opportunity to increase revenue and profits by differentiating amongst types of resource user and charging members of each group a constant unit price unique to that group. This practice commonly manifests itself as 'discounts' to particular social groups, such as the aged, the unemployed, the poor, beneficiaries, and children. While some merchants may be offering discounts out of compassion for the less-well-off, and usually seek to proclaim publicly such benevolence, it is often claimed that they are interested solely in maximising their own welfare. Market segregation is a device for extracting consumer surplus. While it may benefit some people who obtain access to goods at cheaper prices than they would otherwise face, these benefits are more than offset by the loss of benefits to those members of society with relatively less elastic demand functions.

The procedure entails charging prices to each group to equate marginal revenues across all groups. Because groups have different demand elasticities, equating marginal revenues implies that marginal benefits are not uniform across groups, and inter-group price discrimination is inefficient. The degree of inefficiency is directly dependent upon the differences in demand elasticities, which is cause for concern because it is precisely those cases where large differences exist that inter-group price discrimination is most beneficial to vendors.

The conditions for profit maximisation under inter-group price discrimination are:

(1) \[ p_i + q_i \left( \frac{\delta p_i}{\delta q_i} \right) = p_j + q_j \left( \frac{\delta p_j}{\delta q_j} \right) \quad \forall i, j \]

(2) \[ \sum_i q_i = Q \quad \text{where } Q \text{ is the total quantity to be allocated.} \]

In the two group case the quantities to be allocated to each group are determined by equation 3:

(3) \[ q_i = \frac{Q(1+1/\eta_i)(2+1/\eta_i+1/\eta_j)}{2+1/\eta_i+1/\eta_j} \]

where \( \eta_k \) is own price elasticity of demand for group k.
The price to be charged each group may be found by substitution in the relevant demand equations.

To illustrate the effects of third-degree price discrimination, let us investigate a hypothetical linear case. Suppose there are 20 (divisible) units of a particular good to be allocated, with demand from two separate, identifiable groups. The demand functions for each group are:

Group 1: \( p_1 = 100 - 4q_1 \)
Group 2: \( p_2 = 40 - 2q_2 \)

The market demand curve is therefore:

\[
Q_d = \begin{cases} 
45 - 0.75p & \text{when } p \geq 40 \\
25 - 0.25p & \text{when } p \leq 40 
\end{cases}
\]

A single, uniform price of $33.33 would clear the 20 units on the market, allocating 16.67 units to Group 1 and 3.33 units to Group 2. A profit-maximising, discriminating monopolist would charge prices of $53.33 to members of Group 1 and $23.33 to members of Group 2, resulting in sales of 11.67 and 8.33 units to the respective groups\(^1\).

The outcomes under the two approaches are:

<table>
<thead>
<tr>
<th></th>
<th>Uniform price</th>
<th>Discriminatory price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits to Group 1</td>
<td>$ 555.67</td>
<td>$ 272.72</td>
</tr>
<tr>
<td>Benefits to Group 2</td>
<td>$ 11.11</td>
<td>$ 69.43</td>
</tr>
<tr>
<td>Total consumer benefits</td>
<td>$ 566.78</td>
<td>$ 341.65</td>
</tr>
<tr>
<td>Revenue</td>
<td>$ 666.66</td>
<td>$ 816.24</td>
</tr>
<tr>
<td>Total benefits</td>
<td>$1233.44</td>
<td>$1158.49</td>
</tr>
</tbody>
</table>

While total benefits have been reduced only slightly (a six percent loss in efficiency), the distribution of benefits has changed dramatically. Members of Group 2 have benefited,

\[^1\] The marginal revenue functions for the groups are:

\[
\begin{align*}
MR_1 &= 100 - 8q_1 \\
MR_2 &= 40 - 4q_2
\end{align*}
\]

Equating marginal revenues and letting \( q_1 + q_2 = 20 \) yields the result reported above.
as has the vendor, however the most dramatic change is the loss of benefits to members of Group 1.

Two major pre-requisites must be met before implementation of third-degree price discrimination schemes is possible. Members of each group must be readily identifiable, and transactions between groups must not be possible. Such conditions are easily met in the utilities markets where groups may be readily identifiable by property location or value, or people may be required to prove membership of a particular group (e.g. pensioner) before being eligible for concessionary rates. The products of utilities are not easily re-sold as it is difficult and expensive to transfer gas, electricity and water from one property to another. Airlines address these problems by requiring certification of group membership (e.g. student identification card) and issuing non-transferable tickets.

5.8 Single item auctions

In addressing auction behaviour it is important to differentiate between two major causes for individuals to place different values on the good(s) being auctioned. In the first instance, the good has some common, but unknown, value to each individual. For example, the value of an oil right is determined to a large extent by the market price of the oil, the quantity present, and the costs of its extraction. The first of these factors is generally well known, however the other two are both uncertain, causing different individuals to make different estimates of the value of the oil right to them even though the actual value to each individual is identical. The second cause of disparity in value is termed the independent private values model. In this instance the value of the good is different to each individual. This value is determined by the individual's circumstances, including tastes and factors such as quality of harvesting, processing, and marketing services. Tastes are likely to be the basis for determining values of goods such as artworks, antiques, or collectibles, while business efficiency is likely to determine individual values of natural resources such as millable forest, farmland, and fish stocks.

Our primary interest is in the second cause of value disparity. Cases of common but uncertain value present distributional issues, but do not involve issues of efficiency. Both distributional matters and efficiency are determined by the resulting allocation in the independent private values case. An interesting aspect of the common value case is the 'winners curse'. Since value is determined exogenously and bidders are uncertain of that value it is possible that the net value of the good to the winning bidder is negative. Winning an auction of this nature is a signal that the estimate of value placed on the
good is greater than all other estimates and is therefore likely to be greater than the true value of the resource.

We now concentrate our attention on the class of auction that allocates a single item, such as a work of art, or the rights to operate a concession operation, extract minerals, or harvest a discrete block of forest. The three common types of auction we will address are English, Dutch and simultaneous auctions. The latter has two major forms; first-price and second-price. In the first-price simultaneous auction the winning bidder pays the amount bid by him or her, whereas in the second-price variant (often termed the Vickrey auction) the winner pays the value of the next highest bid.

5.8.1 English auction

This form of auction is probably the most common in New Zealand. It is used widely to sell wool, fruit and vegetables, livestock, real estate, second-hand furniture and automobiles, and to dispose of surplus, repossessed, or confiscated goods. It is characterised by the auctioneer (who represents the seller) announcing an opening value and seeking bids at that level. If unsuccessful the auctioneer is forced to lower the value until a bid is forthcoming. The auctioneer then announces a higher value than the current bid and seeks a bid at this level. The bid is increased until no-one is willing to bid any higher, and the goods are sold to the person who made the highest bid, for the price that person bid. All bidders are aware of the current bid (but not necessarily who holds it) throughout the auction, and are able to bid as often as they desire at any point during the auction as long as the bid is not less than the current bid, leading to the description of this mechanism as an open, ascending bid auction.

The English auction is an efficient method for allocating single units. There is no incentive for any individual to bid greater than his or her maximum willingness to pay \( P_1 \) since this will result in a loss of utility should that individual win the auction\(^2\). Suppose there are two individuals still bidding, with maximum willingness to pay \( P_1 \) and \( P_2 \) respectively. Assume \( P_1 \) is greater than \( P_2 \). Whenever the bid is less than \( P_2 \) the individual not holding the bid has an incentive to increase the bid. If the person not holding the bid does not increase the bid they will not obtain the good and their utility is unchanged from its present level. If they do increase the bid to some level less than their own maximum willingness to pay they have a chance of winning the auction and improving their welfare (by the difference between \( P_1 \) and their new bid). Clearly, the

---

\(^2\) Some individuals may see some benefit in bidding above their maximum willingness to pay and not winning the auction. For example, they may wish to force the price up for their competitors.
English auction will result in the good are then allocated to individual 1 at some price between \( P_1 \) and \( P_2 \). If the incremental bid size is small relative to \( P_2 \) the sale price will approximate \( P_2 \).

Little can be said about the distribution of benefits, except that the vendor is likely to obtain less revenue than would be possible by perfect discrimination. If \( P_2 \) is much less than \( P_1 \) the buyer is likely to obtain a large surplus, whereas if \( P_2 \) and \( P_1 \) are nearly equal the buyer will obtain a negligible surplus. The price attained at auction is not governed by the winner's maximum willingness to pay, but by the maximum willingness to pay of the second-highest bidder. If there is little competition and the vendor has some knowledge of the likely distribution of willingness to pay, revenue may be increased by selling at a fixed price. However, if consumers also have knowledge of the demand for the good they may be unwilling to pay the asked price, the sale price is thus determined by relative bargaining power.

5.8.2 Dutch auction

The Dutch auction is an open, decreasing bid auction. Anyone can bid at any time. The current value is announced by the auctioneer, and if no-one bids at this level the value is lowered. This procedure continues until the first bid is received, the good(s) being sold to the bidder at the price bid. The potential problems of ties are circumvented in many auctions of this type by the use of electronic apparatus requiring bidders to hit a switch.

As with the English auction, there is no incentive to bid at a price above the value of the good to the individual (\( P_1 \)). Bidding \( P_1 \) does not result in any change in utility so only bids less than \( P_1 \) will be made. In choosing how far below \( P_1 \) to bid, an individual will consider the expected payoffs from making bids at different levels. These payoffs are influenced by the level of the bid and the probability of success, which is determined by the bidder's expectations of other contestants' actions. A high bid will have a relatively high probability of a low benefit, while a low bid will have a low probability of a high benefit. As long as the probability of winning by making a bid below \( P_1 \) is positive there is an incentive for each individual to bid below \( P_1 \). Individual bids will be influenced by the individual's attitude to risk, and their expectations over the distribution of bids of the other bidders.

The Dutch auction will be an efficient method for allocating a single item as long as the person with the highest \( P_1 \) makes the highest bid, although the price at which the good is traded is indeterminate. There is, of course, no guarantee that an efficient allocation will occur, especially as individuals have different attitudes to risk-taking, and different
expectations of the other bidders. No comment can be made on the distribution of benefits, although Riley and Samuelson (1981) indicate the same expected revenue from this form of auction as from the English and Vickrey auctions when buyers are risk-neutral and the common value assumption is applicable. It would be expected that where many individuals attend the auction and each is unaware of the others’ preferences or intended bidding behaviour a higher price would pertain than in the few bidders or known preferences cases.

5.8.3 Simultaneous, first-price auctions
Simultaneous auctions are closed. Bidders are unaware of who the other participants are, or the level of their bids. In the first-price variant the winning bidder is the individual bidding the highest amount, and this person is required to make a payment equal to their own bid.

There is an expected payoff \( EB_X \) to making a bid at each price \( \$X \).

\[
EB_X = \Pi_X (P_i - \$X)
\]

where, \( \Pi_X \) is the probability of winning the auction when bidding \( \$X \).

\( EB_X \) is clearly greater than or equal to zero for all values of \( X \) that are less than \( P_r \), equal to zero when \( X \) equals \( P_r \), and less than or equal to zero when \( X \) is greater than \( P_r \). As with the English auction there is a disincentive to bidding greater than \( P_r \) and no benefit in bidding \( P_r \). The only sensible course of action is to make a bid less than \( P_r \).

The outcome is determined by the individual perceptions of the distributions of probabilities over bid values, and individual attitudes toward risk-taking. As with the Dutch auction, there is no \textit{a priori} reason to expect that the person with the highest \( P_i \) will win the auction and provide an efficient outcome. The first-price simultaneous auction is therefore expected to be inefficient, although it is not necessarily so. No comment can be made on distributional matters.

Maskin and Riley (1983) describe two classes of auction that result in greater expected revenue than the first-price, simultaneous auction: “it is always possible to raise expected revenue from a high bid auction by giving buyers a choice as to whether or not to pay an entry fee. ‘Free bids’ are considered only if no buyer submits an entry fee”, and “it is always possible to raise expected revenue from a high-bid auction with a positive reserve price by lowering the latter and introducing a required entry fee”. They go on,
however, to indicate the costs of such revenue-maximising behaviour: "expected revenue is generally maximized by establishing auction rules such that those with sufficiently low valuations in excess of that of the seller choose not to participate. The resulting auction is therefore inefficient ex post, because there is a chance that some buyer with a valuation in excess of that of the seller remains out of the auction.

5.8.4 Simultaneous second-price auctions

The second-price auction differs from the first-price auction only in the payment that the highest bidder is required to make. In this instance it is not that person's own bid, but the value of the second-highest bid.

This form of auction is termed incentive-compatible because the optimal strategy for individual bidders is to bid their maximum willingness to pay ($P_i$). Incentive compatibility occurs because payments are independent of bids. Each person has three options in choosing a bid ($X$). They may bid greater than, equal to, or less than $P_i$. Let us examine the options for a representative individual (A).

1. $X > P_i$ (Bidding more than maximum willingness to pay)
   a) If A loses the auction there is no change in welfare for A.
   b) A may win the auction and be required to pay the second highest bid ($Z$). If $Z$ is greater than $P_i$, A incurs a welfare loss of $(Z-P_i)$.
   c) If A wins and $Z$ is less than $P_i$, A obtains a gain of $(P_i-Z)$. Note, however, that if A gains ($Z<P_i$) the gain would still have been made by bidding $P_i$. Further, bidding $P_i$ does not incur the risk of making a welfare loss if $X>Z>P_i$.

   **Bidding $P_i$ (telling the truth) dominates overstating one's maximum willingness to pay.**

2. $X < P_i$ (Bidding less than maximum willingness to pay)
   a) A could win the auction and pay $Z$, but would not be any better-off than if he or she had bid $P_i$.
   b) A could lose to someone who bid more than $P_i$. In this case A is no worse-off than if he or she had told the truth, since the other person would have won the auction anyway.
   c) A could lose to someone bidding $Y$ such that $P_i > Y > X$. In this case, the only way that A could have won was to bid a value greater than $Y$. But, since any
bid greater than $Y$ would result in $A$ paying $\$Y$ and $A$ does not know what $Y$ is, $A$ would be best to bid $P_i$ and beat all bids less than $P_i$.

**Bidding $P_i$ therefore dominates underbidding.**

Since telling the truth is superior to either underbidding or overbidding it is the dominant strategy for individual $A$. There is nothing special about individual $A$, implying that all individuals will respond in a similar manner and bid their maximum willingness to pay in a simultaneous second-price auction.

This form of auction has a major advantage in identifying the market demand curve for the good, which may have important implications for the resource administrator if further units are to be sold in the future. It provides sufficient information to allow some form of discriminatory pricing to be implemented, resulting in increased vendor revenue.

A simultaneous second-price auction will result in an efficient distribution of the item being auctioned, regardless of buyer attitudes toward risk-taking. Vickrey first indicated that first and second-price auctions result in identical expected vendor revenue for risk-neutral bidders, and that when the seller sets a reserve price equal to the value of the item to him or her both mechanisms are efficient. Most research on single-item auctions has focused upon optimal auction design from the seller’s point of view. Maskin and Riley (1983) summarise the results of this research, concluding that:

"when buyers are risk-neutral and a mild restriction on [the distribution of buyer valuations] is satisfied, there is no auction mechanism which yields greater expected revenue than the high bid (or second bid) auction with the appropriately selected minimum price. ... Various authors have also shown that, when buyers are risk averse, the high- and second-bid auctions no longer generate the same expected revenue ... the high bid auction yields greater expected revenue than the second-bid auction. It is then natural to inquire as to whether the high-bid auction can itself be improved upon. The answer turns out to be in the affirmative."

Here Maskin and Riley are alluding to the possibilities of charging a fee to enter the auction and the seller announcing a reserve price greater than the seller’s use value.
5.8.5 Summary
The difficulty of choosing a socially optimal auction mechanism is summarised by Maskin and Riley (1983, p.205) "a major theme of the recent theoretical advances in the theory of auctions is that auction rules which maximize expected revenue are not efficient ex post. That is, a seller exploiting his monopoly power to the maximum will design a scheme in which there is a finite possibility that the agent with the highest valuation will not end up with the object for sale". The common single-item auction formats yield identical expected revenues in some instances under the assumption of risk-neutral buyers. The English and simultaneous second-price auctions are efficient methods of allocating a single item. The Dutch and first-price simultaneous auctions are not efficient a priori. When buyers are risk-averse the simultaneous first-price auction yields higher expected revenue than the other types. Expected revenue may be further increased in this case by announcing an optimally chosen reserve price before the auction. This reserve price will be greater than the value of the item to the seller and is based upon seller estimates of the distribution of buyer values.

5.9 Multiple item auctions
Analysis of single item auctions introduced the notion of uncertainty with regard to the actions of other bidders. When many homogeneous or similar items are auctioned simultaneously, or in close temporal proximity, the number of sources of uncertainty are increased many times. Bidding strategies become extremely important as individuals attempt to maximise their own welfare in the absence of complete knowledge of the preferences and strategies of their opponents. This is the domain of game theory and outcomes are far from certain. What has been concluded is that multiple item auctions are generally not efficient and that different forms of auction result in different expected revenues.

Vickrey (1976) summarises:

"the optimal [efficient] solution appears to be less often reached in practice when there are several items to be auctioned that react in some way. The simplest case is that of two or more, say n items and such that no bidder will want to acquire more than one of them. The straightforward method of auctioning them off in an open [English] auction in sequence is now no longer optimal, since in bidding for the first item each bidder will be uncertain as to where to stop in view of the possibility..."
that a subsequent item might become available for less. A Pareto optimal procedure is available, however, if all the items are auctioned simultaneously, with up to n bids permitted at any given level, the rule being that once n bids have been made equal to the highest bid, any further bid must be higher than this. Within the 'jitter' determined by the minimum acceptable bid increment, this assures optimal results, as does the strategically equivalent closed bid procedure where the n items are awarded to the n highest bidders at the price bid by the n+1st bidder” (p14).

The simultaneous multiple-unit auction can be divided into two classes, discriminative and competitive bidding (Belovicz, 1979). In the former, each successful bidder pays the amount nominated in their own bid, while in the latter each successful bidder pays the amount of the highest unsuccessful bid. Competitive bidding is the multiple-item equivalent of the single-item second-price auction. For the same reasons discussed under single-item auctions the bids received under the competitive auction format will be for greater amounts than under the discriminative format. The strategy earning the greatest revenue for the vendor is determined by the relative magnitudes of the mean successful discriminative bid and the highest unsuccessful competitive bid. Harris and Raviv (1981a, p.1488) report the results of empirical studies comparing competitive and discriminative sealed-bid, multiple-unit auctions:

“1. Mean bid is larger under the competitive than under the discriminating auction.
2. The variance of bids is larger under the competitive auction.
3. The evidence regarding the comparison of seller’s revenue under the two types of auction is inconclusive.”

Harris and Raviv proved that 1. holds whether buyers are risk-neutral or risk-averse, and proceeded to show that “when buyers are risk averse, the results indicate that the discriminating auction dominates the competitive auction in terms of expected revenue to the seller”.

There has been very little analysis of multiple-unit auctions in which buyers are able to purchase more than one unit. Vickrey indicated as early as 1961 (Vickrey, 1961) that the competitive, first-rejected-bid auction would be inefficient.
"It is not possible to consider a buyer wanting up to two units as merely an aggregation of two single-unit buyers: combining the two buyers into one introduces a built-in collusion and community of interest, and the bid offered for the second unit will be influenced by the possible effect of this bid on the price to be paid for the first, even under the first-rejected-bid method. ... Nor could optimal results be obtained merely by restricting all bids to an offer to take up to a given quantity at any price below a specified price, the final terms being a price equal to the price bid by the first unsuccessful bidder, each bidder bidding more than this being allocated the amount which he specified. Under such a scheme, for any quantity that a bidder might decide to specify, it would be advantageous for him to specify as his bid price the full average value of this quantity to him, since he would prefer this quantity to be allotted at any price lower than this bid rather than be excluded altogether, and a change in his bid price within the range in which he would be successful would not affect the contract price."

To circumvent this problem, the incentive-compatible demand revelation procedures for public goods have been adapted to provide incentive-compatible bidding processes. Lyon (1982, pp.18-19) describes one type of incentive-compatible bidding mechanism for multiple-unit auctions. The Groves mechanism3 (Groves and Ledyard, 1977) that Lyon employs guarantees that goods are distributed efficiently. This mechanism will always result in payments less than or equal to those under a single-price auction because the \( n_i \) highest rejected bids (where \( n_i \) is the number of units allocated to individual i) are necessarily less than or equal to the highest rejected bid in the single-price procedure.

5.9.1 Summary

Multiple-unit auctions are not well understood. The first-rejected-bid procedure is an efficient method for distributing items when each buyer only demands one unit, domestic

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3 The particular Groves mechanism described by Lyon is: "Define R as the sum of the winning bids under the efficient assignment of rights to bidders. Define \( R_j \) as the sum of winning bids if [bidder] i's bids are omitted from consideration. Define the extra value created by [bidder] i as \( C_i = R - R_j \). Let i's payment (\( P_i \)) equal the sum of i's winning bids (\( B_i \)) minus \( C_i \). Where [bidder] i bids truthfully (as is its dominant strategy) its profit will equal \( C_i \) because the profit also equals \( B_i - P_i \). (In the case of an auction for a single right this procedure implies that the right would be sold to the highest bidder for the price bid by the second highest bidder. Thus, in the single-right case this procedure is a second-price auction: ... The mechanism is guaranteed to be incentive compatible, however, only if participants have additively separable preferences. The mechanism is also susceptible to manipulation by coalitions of bidders" (Lyon, 1982, p.19).
real estate auctions probably provide the best example of an appropriate case. This form of auction is unlikely to be adopted in private auctions, however, as the discriminating auction yields greater expected seller revenue when buyers are risk-averse.

Auctions are commonly used to dispose of multiple units of homogeneous commodities in cases where each buyer may require more than one unit. The sale of government bonds provides an appropriate example. Efficient distribution involves the adoption of incentive-compatible demand revelation schemes. Use of such schemes results in lower revenue than first-rejected-bid auctions.

The costs of efficiency losses incurred by adopting non-efficient auction techniques, and the costs to the seller of adopting efficient techniques, have not been measured. They cannot be predicted without information on buyer and seller preferences, their attitudes to risk-taking, and the amount of information each agent possesses about the likely actions of others. Given that auctions are generally adopted in cases of uncertainty or imperfect markets, this information is likely to be unavailable.

5.10 Benefits of auctions

The question remains as to why auctions are used. Typically, three major cases arise;

(1) **Urgent sales.** Urgency may arise because of the perishable nature of the goods (fruit, vegetables, fish), or because of the need to realise a quick return for the vendor (e.g. liquidation sales)

(2) **Fairness of disposal.** Typically this is an argument in disposal of public assets (surplus government stores, confiscated or stolen goods), creditor sales, and deceased estates

(3) **Demand uncertainty.** When sellers have little information on demand an auction is commonly used to dispose of goods, or to set a market price. Examples include the sale of artworks and disposal of mineral leases.

Auctions provide a convenient vehicle for urgent sales because price is immediately responsive to market demands. If a fixed price is set there is always the possibility that the good will sell out before demand is met, with the result that the vendor forgoes revenue, or that the vendor will set price too high and fail to dispose of all units. This may result in reduced revenue, but in the case of perishable items where the goods are
valueless unless sold immediately the opportunity for sale at a lower price at a later date ensures the opportunity costs of making a sale are greater than for durable goods.

Public auctions are an impersonal method of disposing of goods, the price being set by the bidders, and not by the agent disposing of the goods. This is an important reason why auctions are often preferred to negotiated sales. The agents responsible for disposal of the goods are not able to receive side payments from people offering to purchase at a low price, or to offer preferential treatment to buyers of their acquaintance. In this sense auctions are seen as fair, yielding ‘market’ prices for vendors and allowing all interested persons to participate.

When demand is uncertain any allocation mechanism that relies on some predetermined pricing scheme provides the possibility that seller revenue will be less than could be obtained under conditions of certainty. Auctions provide a method for reducing uncertainty about market-clearing prices. This is especially true where individual items of uncertain (to the seller) value are to be distributed and there is enough demand to force the sale price to approximate the highest individual willingness to pay through either an English or a simultaneous auction. This conclusion also holds for multiple item auctions where each buyer may purchase only one unit. Although auctions in which individuals may purchase multiple units may not force prices to ‘competitive market’ levels, they are likely to entail less risk to the vendor since, in common with other auction types, they cause potential buyers to reveal some demand information. The threat of many competing buyers in the auction encourages potential buyers to reveal values higher than they would under a negotiable price arrangement. With sufficient potential buyers it is possible that bids may approach the maximum each individual would be willing to pay.

5.11 Coupon and voucher rationing

The resource distribution agency may choose to allocate the limited quantity of the commodity by coupon rationing. Normally, coupon rationing is put in place by governments to allocate scarce essential commodities fairly during times of crisis, such as following a natural disaster or during wartime. The sorts of resources typically controlled in this way include accommodation, clothing, food, and transport. The commodity may be provided directly by the rationing agency, or by independent agents who are usually able to charge for its provision. The former situation is the most
relevant to our purposes, since we are concerned with allocating an existing supply of goods already under control of the management agency.

Two major types of coupon exist, those that entitle the bearer to obtain a given quantity of the good, but do not form part of the payment for the good, and those that provide both right of access and (part) payment. The former are termed ration coupons, while the later are termed vouchers. The implications of employing coupons and vouchers depend upon the method of their initial distribution and whether they are transferable or not.

In summary, there are four main types of ration coupons available. These are:

1. Transferable coupons
2. Non-transferable coupons
3. Transferable vouchers

Each type of coupon may be initially allocated in a number of ways. They might be distributed free on merit, sold at fixed prices, auctioned, raffled, or handed out on a first-come, first-served basis.

5.11.1 Non-transferable coupons and vouchers

Before it is possible to implement non-transferable rationing, it is necessary to have some method of identifying recipients of the service. This is similar to the problem faced in implementing price discrimination. Supply of utilities is therefore a suitable area for application of these methods. Supply of non-identifiable and easily transported commodities, such as food, is not as easily policed. While it may be possible to distribute vouchers or coupons to individuals, and only allocate the goods to those individuals upon presentation of suitable identification, trade in the commodity cannot be prevented. Friedman (1985) provides the example of company parking space allocation as a common application of voucher rationing. The user of the parking space is easily identified by the car registration number, so others can be prevented from obtaining access to the good. The allocation of parking spaces may be done on a variety of criteria. These might include some notion of merit (seniority in the company, or years of employment with the company), or a market device (competitive pricing or auction).
One may consider coupons and vouchers as identical except for the time of payment. For example, a voucher sold for a fixed price (say $X) is equivalent to a coupon that is given away, but that requires that the holder pay $X per unit to obtain the good.

When the non-transferable voucher meets the full cost of the good (to the consumer) the method of rationing is equivalent to direct allocation of the good. The efficiency and distributional implications are directly determined by the initial allocation mechanism. For example, free, equal distribution will ensure lack of envy but is likely to be inefficient. Sale at a competitive price is likely to be efficient but is also likely to fail to meet distributional objectives. The impacts are identical to those discussed under each allocation method elsewhere in this publication.

When the voucher must be supplemented by a cash payment, or coupons are used, the results are not as clear cut. The distributional and equity implications are determined by both the initial allocation method and the unit price (or other payment schedule) charged for the good. For example, if the coupons are sold in a competitive market the allocation will be efficient and the sale price of coupons will be the difference between the market clearing price for the good and the unit price in effect. Efficiency would also occur if the distributing agency could perfectly discriminate in the sale of coupons. However, if coupons are allocated free of charge in equal numbers the outcome will be inefficient, even though it may be considered very fair. This approach may also fail to allocate the full quantity available as some people will receive a number of coupons at which their marginal benefits are below the unit price. Consequently, more coupons than the available quantity of the good must be allocated.

Non-transferable coupons are an effective means of redistributing wealth. Figure 5.7 illustrates the simple, two consumer case. Suppose the scarce good is allocated by competitive pricing. The price required to clear the market is $P_0$, with the poor person consuming $Q_p$ and the rich person consuming $Q_r$. Now suppose $Q_p+X$ non-transferable coupons are distributed to the poor person and $Q_r-X$ coupons to the rich. The aggregate

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4 An even more effective method is to allocate a cash grant to the target group. Economists have long argued that cash grants are a superior method of transferring wealth than are transfers in kind (see Friedman (1985, Chapter 3) for example). There may, however, be compelling reasons for insisting on support in kind, or assistance with purchasing particular goods. An oft-cited example is that of providing food, clothing, and education to underprivileged children. The parent(s) may choose to spend a cash grant on things that do not assist the child, or are detrimental to its welfare (e.g. drugs or alcohol), whereas non-transferable assistance in purchasing those items is more likely to result in an improvement in children's welfare.
demand curve now crosses the supply curve at a lower price ($P_1$) to allow the market to clear. The distributor receives less income from sales ($P_0 - P_1 Q$ less) while the poor consumer obtains more consumer surplus, the change in surplus for the rich consumer is indeterminate, and is dependent upon the relative impacts of the change in price (area A) and the reduction in supply (area B). Overall, this reallocation scheme entails a loss in efficiency equal to area RST.

If the individuals were given vouchers, instead of having to present coupons and pay, the same efficiency result holds, but there is a transfer of benefits from the distributor to the consumers. Under non-transferable schemes efficiency is determined by who gets the coupons or vouchers, and distributional impacts are determined largely by the payment mechanism in place.

Figure 5.7 Non-transferable coupons.
5.11.2 Transferable coupons and vouchers

The introduction of transferability of either coupons/vouchers or goods improves the efficiency of this class of allocation mechanisms. Suppose coupons are transferable, and are allocated as before (poor person receives \( Q_p + X \), rich person receives \( Q_R - X \) coupons). There is an incentive for the individuals to trade since, at the margin, the rich person is willing to pay more for a coupon than the poor person requires to compensate for the loss of a coupon. \( X \) coupons will be sold to the rich person at a total cost of between \$C\) and \$(B+G)\) for an efficiency gain equal to area RST in Figure 5.7. At equilibrium (with many people in the market) coupons will trade at the difference between the competitive price \( P_o \) and the non-transferable price \( P_1 \). Ignoring income effects, the final allocation will be identical to that under a fixed, competitive price market.

The distribution of benefits will be determined by the pricing decision of the distributor. If price remains at \( P_1 \) consumer benefits equal area \( P_1UVST \) and revenue is \( 0P_1TQ_1 \). The distribution of surplus between the consumers is dependent upon the final price at which the coupons were exchanged. The distributor may choose to raise the unit price as high as \( P_o \) and still allocate all units. In this case consumer benefits equal area \( P_0UVS \) and revenue equals area \( 0P_0SQ_1 \). If the distributor holds price at \( P_1 \) the consumers extract all the gains from trade, but by raising the price the distributor also obtains some of those gains.

In Table 5.1, Figure 5.8 is used to summarise the impacts of a variety of coupon-rationing policies.

The costs of assisting a target group are now evident. All three coupon-allocation schemes result in benefits to the target group (in this case the poor person). The transferable scheme at the low price maximises this group's benefits. If the additional allocation of coupons to the target group is large the transferable coupon scheme at the high price is more beneficial to the target group than non-transferable coupons.

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5 The real income of the poor person has been increased by enabling her/him to consume the rationed good at a lower price, leading to a higher level of welfare for that person. This increase in wealth causes the poor person's demand curve to move out from the origin. Consequently, at any price they will now consume more of each good than they did prior to the implementation of the rationing scheme. See Russell and Wilkinson (1979) for explanation.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Competitive sale of coupons</th>
<th>Non-transferable coupon allocation</th>
<th>( P_1 )</th>
<th>( P_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor person's benefits</td>
<td>area ( E )</td>
<td>area ( (E+D+C) )</td>
<td>area ( (E+D+G) )</td>
<td>area ( (E+G) )</td>
</tr>
<tr>
<td>Rich person's benefits</td>
<td>area ( (F+B) )</td>
<td>area ( (F+A) )</td>
<td>area ( (F+A+B) )</td>
<td>area ( (F+B-G) )</td>
</tr>
<tr>
<td>Total consumer benefits</td>
<td>area ( (E+F+B) = ) area ( P_0 \text{UVS} )</td>
<td>area ( (E+D+C+F+A) = ) area ( P_1 \text{UVRT} )</td>
<td>area ( (E+D+F+A+B+G) = ) area ( P_0 \text{UVS} )</td>
<td>area ( P_1 \cdot Q_t )</td>
</tr>
<tr>
<td>Revenue</td>
<td>area ( \text{OP}_0 \text{SO}_t ) = ( P_0 \cdot Q_t )</td>
<td>area ( \text{OP}_1 \text{TQ}_t = ) area ( P_1 \cdot Q_t )</td>
<td>area ( \text{OUVS}_Q )</td>
<td>area ( \text{OP}_0 \text{SO}_t + P_0 \cdot Q_t )</td>
</tr>
<tr>
<td>Total benefits</td>
<td>area ( \text{OUVS}_Q )</td>
<td>area ( \text{OUVRTQ}_t )</td>
<td>area ( \text{OUVRQ}_t )</td>
<td>area ( \text{OUVS}_Q )</td>
</tr>
</tbody>
</table>

Is it efficient? Yes  No  Yes  Yes

The benefits accruing to the non-target group are determined by the elasticity of the target group's demand curve, since that determines the new selling price for the good. If target group demand is highly elastic the non-target group will obtain superior welfare after the imposition of the non-transferable coupon scheme. The costs under this scheme are borne completely by the vendor in this case, otherwise the non-target group subsidises target group consumption to some degree.

When coupons are transferable at a low price \( (P_1) \) the non-target group unambiguously attains a welfare improvement relative to the free market situation. Both consumer groups obtain gains at the expense of the vendor. When coupons are transferable and the vendor sets a high price there is a transfer of welfare from non-target to target consumer groups. This transfer of welfare is Pareto optimal relative to the distribution after the coupons have been allocated.
5.11.3 Summary
Non-transferable voucher allocation is comparable to direct allocation of the good. Non-transferable coupon allocation involves efficiency losses, but transfers welfare to the target group. The target group may be made even better-off, however, if members are able to trade coupons or vouchers. Transferability results in efficient allocation and, when the price of the rationed good can be controlled at a low level, all consumers become better-off than when goods are allocated competitively.

Figure 5.8 Transferable coupon rationing.
6 Comparison of methods

6.1 Lottery and competitive pricing

Figure 6.1 allows comparison of benefit measures under lottery and competitive pricing strategies (see Table 6.1).

Table 6.1: Comparison of benefit measures under lottery and competitive pricing strategies.

<table>
<thead>
<tr>
<th>Benefit measure</th>
<th>Allocation scheme</th>
<th>Benefits</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total benefits</td>
<td>Competitive prices</td>
<td>$P_p q_0$ = area $O P a q_0$</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Lottery</td>
<td>$P_1 q_0$ = area $O P d q_0$</td>
<td>4</td>
</tr>
<tr>
<td>Entry fee lottery</td>
<td>$P_e q_0$</td>
<td>area $O P b q_0$</td>
<td>2</td>
</tr>
<tr>
<td>Success fee lottery</td>
<td>$P_s q_0$</td>
<td>area $O P c q_0$</td>
<td>3</td>
</tr>
<tr>
<td>Revenue</td>
<td>Competitive prices</td>
<td>$P_0 q_0$ = area $O P e q_0$</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Lottery</td>
<td>zero</td>
<td>4</td>
</tr>
<tr>
<td>Entry fee lottery</td>
<td>$P_e q_4$ = $a q_0$</td>
<td>area $O j q_0$</td>
<td>2</td>
</tr>
<tr>
<td>Success fee lottery</td>
<td>$P_3 q_0$</td>
<td>area $O P g q_0$</td>
<td>3</td>
</tr>
<tr>
<td>Consumer benefits</td>
<td>Competitive prices</td>
<td>$(P_p - P_0) q_0$ = area $P_0 P e a e$</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Lottery</td>
<td>$P_1 q_0$ = area $O P d q_0$</td>
<td>1</td>
</tr>
<tr>
<td>Entry fee lottery</td>
<td>$(P_e - b) q_0$</td>
<td>area $b P e b j$</td>
<td>3</td>
</tr>
<tr>
<td>Success fee lottery</td>
<td>$(P_s - P_3) q_0$</td>
<td>area $P_3 P s e g$</td>
<td>2</td>
</tr>
</tbody>
</table>

Notes:
1. Since $a q_0 = P_4 q_4$, area $O j q_0$ equals area $O P_4 q_4$
2. The consumer benefit rankings are derived by appeal to the fact that the average benefit curve is less steep than the marginal benefit curve, hence $P_p - P_0 < P_1,0$, etc.

Average benefits under pricing are $P_p$. Under a pure lottery all people with marginal benefits from consumption greater than zero have an incentive to enter the lottery.
These people have average benefits equal to $P_1$. Since $P_1$ is less than $P_p$ for any negatively sloping demand curve, the lottery is less efficient than competitive pricing. Lotteries that employ either entry or success fees rank between competitive pricing and the pure lottery on the efficiency criterion. For a given fee ($P_3$ in Fig. 6.1) average benefits are $P_e$ and $P_s$ respectively. The entry fee is more efficient than the success fee. As the fees increase, total benefits increase until efficient allocations occur when fees are set equal to the competitive price.

For these four allocation schemes the efficiency and revenue rankings are identical, and are the reverse of the consumer benefit rankings. Hence resource suppliers wishing to maximise profits will prefer the competitive pricing scheme to any of the lottery schemes,
while (risk-neutral) consumers would prefer a pure lottery that is inefficient, but that ensures consumers obtain all the benefits produced.

6.2 Other mechanisms

(i) Efficiency

It is not possible to compare the efficiency rankings of merit, reservation, effort, queuing, non-Groves auctions, non-transferable coupons and vouchers, or second and third-degree price discrimination without specific demand and behavioural information.

Preceding analysis identified competitive pricing, first-degree price discrimination, the Groves auction (in the absence of coalitions), and transferable coupons and vouchers as efficient allocation mechanisms.

Although both competitive pricing and single-price revenue maximisation are efficient means of allocating their respective quantities, the increased quantity consumed under competitive pricing ensures that total benefits are greater under that mechanism.

The efficiency ranking of single-price revenue maximisation and the lotteries depends upon the shape of the aggregate demand curve and the degree of rationing being imposed. Neither approach is universally more efficient.

For example, take the linear demand schedule \( P = a + bQ \), where \( a > 0 \) and \( b < 0 \). Let the open access use level be \( Q_0 = -a/b \), and the lottery rationed use level be \( Q_2 \).

\[
Q_2 < Q_0
\]

Marginal revenue equals zero at \( Q_1 = -a/(2b) \). This is the level of use of the resource under single-price revenue maximisation, yielding total benefits \( TB_{sprm} \):

\[
TB_{sprm} = -3a^2/(8b)
\]

Under a pure lottery it is not possible to be certain of total benefits. Expected total benefits from a lottery are:

\[
E[TB_l] = aQ_2/2
\]
The two schemes will be equally as efficient when:

\[
\begin{align*}
TB_{\text{sprm}} &= E[TB_1] \\
-3a^2/(8b) &= aQ_2/2 \\
\Rightarrow Q_2 &= -3a/(4b) \\
\therefore 0 < Q_2 < Q_0
\end{align*}
\]

Further, we have:

\[
Q_2 - Q_1 = -a/(4b) > 0
\]

\[
\therefore Q_1 < Q_2 < Q_0
\]

In other words, there is some quantity \(Q_2\) between the open access and single-price revenue maximising quantities at which these two allocation schemes are of equal efficiency. At quantities less than \(Q_2\) the lottery is less efficient, while at quantities above \(Q_2\) it is more efficient, than single-price revenue maximisation. With the introduction of entry or success fees \(Q_2\) will decrease. High enough fees will ensure the lottery is more efficient than single-price revenue maximisation.

(ii) Revenue

Several rankings are immediately apparent. No revenue is obtained from pure versions of: merit, queuing, vouchers, lottery, or advance registration. The monopoly-based methods for extracting consumers surplus are only adopted because they yield more revenue than competitive pricing. The better a monopolist is able to discriminate, the more revenue he or she may earn, therefore the revenue ranking of these methods is (where > means "generates more revenue than"):

first-degree price discrimination > second-degree price discrimination >
third-degree price discrimination > single-price revenue maximisation >
competitive pricing.
Competitive pricing can generate more revenue than either entry or success fee lotteries, and the Groves auction procedure. It is unclear how other auction procedures rank against these methods, but in many instances it has been found that revenues are less than would have been generated by competitive markets.

(iii) Consumer benefits
We do not have enough information to rank consumer benefits under reservation, queuing, non-tradeable coupon and voucher, auction, or merit allocation mechanisms. While each of these methods is expected to be inefficient, consumer benefits may actually be greater than under some efficient allocation schemes because consumers do not have to pay (cash) for use of the resource. For example, reservation systems impose minimal costs on consumers, and while they may let 'inefficient' consumers obtain access to the resource, because those consumers do not have to pay for access in cash or time, total consumer benefits are likely to be greater than under, say, competitive pricing or queuing.

For efficient schemes it is possible to draw upon the fact that total benefits equal the sum of consumer benefits and revenue to conclude that the consumer benefit ranking of these schemes will be reversed from the revenue-generation ranking. Hence we have the consumer benefit ranking (greatest to least consumer benefits) of: tradeable vouchers, Groves auction, competitive pricing and tradeable coupons, first-degree price discrimination.

Because revenue generation from single-price revenue maximisation and second and third-degree price discrimination is greater than from competitive pricing, and because these methods are less efficient than competitive pricing, it is possible to conclude that each of these methods results in fewer consumer benefits than competitive pricing. On the other hand, because they are unable to capture all benefits, they do result in some surplus accruing to consumers, and so are preferential to first-degree price discrimination from the consumer’s viewpoint.

Comparison of consumer benefits between lottery and either competitive pricing or single-price revenue maximisation is not possible without information on the shape of the demand curve and the rationed quantity. For example, the lottery is always a better producer of consumer benefits than single-price revenue maximisation when the aggregate demand curve is linear. However, when the demand curve is initially very elastic but trails off into an inelastic 'tail' the lottery is inferior. Similarly, with a linear demand schedule, competitive pricing produces more consumer benefits than the lottery.
when consumption is heavily rationed, but fewer consumer benefits when consumption is only lightly rationed.

(iv) Consumer preferences
Several studies have determined consumer preferences for resource allocation tools. These studies have primarily been completed to assist in allocating recreational opportunities, such as backpacking and river running, in cases of congestion or environmental degradation. McCool and Utter (1981, 1982) asked users of the Middle Fork of the Salmon River in Idaho to evaluate several rationing tools. Table 6.2 indicates the percentages of consumer groups who rated each method as acceptable.

Table 6.2: Percentages of consumer groups who rated various rationing techniques.

<table>
<thead>
<tr>
<th>Rationing technique</th>
<th>Percentage rating “acceptable”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commercial users</td>
</tr>
<tr>
<td>Lottery</td>
<td>57</td>
</tr>
<tr>
<td>Knowledge and skill</td>
<td>66</td>
</tr>
<tr>
<td>Advance reservation</td>
<td>84</td>
</tr>
<tr>
<td>Priority for first time users</td>
<td>43</td>
</tr>
<tr>
<td>Lottery-reservation</td>
<td>52</td>
</tr>
<tr>
<td>Priority for Idahoans</td>
<td>21</td>
</tr>
</tbody>
</table>

Advance reservation and lottery systems were the most acceptable to commercial and private users respectively, but, as McCool and Utter (1982) note:

"These rankings indicate that each group ranks highest the rationing system with which it is most familiar. The second highest rating for all three groups was merit rationing. Giving priority to either first-time users or local residents was not favoured - in no group did more than half the respondents rate these two methods as acceptable" (p.11).

Private users who had recently been rejected by the lottery system still overwhelmingly favoured it. Part of this acceptance may be explained by the findings that over 40% of rejectees were able to run the river by joining other parties or waiting for cancellations.
Another 35% of rejectees ran alternative rivers. The importance of fairness in resource allocation is emphasised by the finding that Idahoans preferred the lottery system to a system that would give priority to residents of Idaho.

McCool and Utter (1981) conclude:

"It is important to recognize that there will be few settings where any allocation technique can be implemented in its pure form. In fact, it may be beneficial to have a mixture of allotment techniques on any given river so that the weaknesses of one technique are balanced by the strengths of another" (p.76).

In a similar study, Shelby et al. (1982) surveyed Oregon river runners and backpackers to determine user preferences amongst pricing, reservation, lottery, queuing, and merit allocation systems. For each system, users were asked: (1) how they thought the system would affect their chances of getting a permit, (2) whether they thought it was a fair method for distributing permits, (3) whether the system was acceptable to them, and (4) whether they would try to obtain a permit by that method. Results are summarised in Table 6.3.

Pricing and reservation systems are most favoured by all three user groups, because "these systems were seen as least detrimental to permit availability, fairest, most acceptable, and the largest percentages of users were willing to try them." (Shelby et al., 1982: p.418). In accordance with the findings of McCool and Utter, this study found that river runners were strong supporters of reservation systems. "River runners were the strongest supporters of reservations, probably because they plan further in advance than hikers do and because this was the existing system on the Snake and, therefore, the most familiar.... River runners were more likely to rate lotteries as fair or acceptable and more willing to try them, probably because lotteries have been tried on other rivers .... River runners were less likely than backpackers to rate queuing as fair or acceptable and less willing to try it, probably because this option was felt to limit advance planning, to add risk to a long trip to the launch site with no substitutes if access were denied, and to diminish chances of getting permits." (ibid, p.418).

It is interesting to observe that lotteries were the least acceptable mechanism for backpackers, who viewed the lottery system as having a strong impact on the chances of obtaining a permit and, more surprisingly, viewed it as unfair. River runners ranked
queuing and merit as less fair than lotteries, while pricing was perceived as intermediate in fairness between lotteries and reservations, reservations being the most preferred. In all cases pricing was judged superior to lottery, queuing, and merit systems.

Table 6.3: Percentages of users agreeing with assessments of alternatives.

<table>
<thead>
<tr>
<th>Allocation alternative</th>
<th>Hells Canyon river runners</th>
<th>Eagle Cap backpackers</th>
<th>Mt Jefferson backpackers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Little or no effect on chances of obtaining permits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing</td>
<td>48</td>
<td>70</td>
<td>54</td>
</tr>
<tr>
<td>Reservation</td>
<td>64</td>
<td>56</td>
<td>45</td>
</tr>
<tr>
<td>Lottery</td>
<td>31</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Queuing</td>
<td>14</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>Merit</td>
<td>37</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td><strong>System is fair</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing</td>
<td>45</td>
<td>49</td>
<td>43</td>
</tr>
<tr>
<td>Reservation</td>
<td>78</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>Lottery</td>
<td>39</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Queuing</td>
<td>12</td>
<td>34</td>
<td>29</td>
</tr>
<tr>
<td>Merit</td>
<td>23</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td><strong>System is acceptable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing</td>
<td>66</td>
<td>66</td>
<td>55</td>
</tr>
<tr>
<td>Reservation</td>
<td>95</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>Lottery</td>
<td>50</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Queuing</td>
<td>25</td>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>Merit</td>
<td>37</td>
<td>42</td>
<td>49</td>
</tr>
<tr>
<td><strong>Willing to try system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing</td>
<td>62</td>
<td>68</td>
<td>64</td>
</tr>
<tr>
<td>Reservation</td>
<td>84</td>
<td>71</td>
<td>64</td>
</tr>
<tr>
<td>Lottery</td>
<td>51</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>Queuing</td>
<td>16</td>
<td>53</td>
<td>55</td>
</tr>
<tr>
<td>Merit</td>
<td>36</td>
<td>56</td>
<td>60</td>
</tr>
</tbody>
</table>
In a survey of 2829 backpackers in Mt McKinley National Park (Alaska) Bultena, Albrecht, and Womble (1981) measured attitudes toward various rationing methods. The survey participants were strongly in support of rationing, with over 85% of respondents opposing use without rationing because of the physical and social impacts. Response percentages are shown in Table 6.4.

Table 6.4: Response percentages for the rationing methods.

<table>
<thead>
<tr>
<th>Rationing method</th>
<th>Support</th>
<th>Neutral</th>
<th>Oppose</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queue</td>
<td>82</td>
<td>8</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Advance reservation</td>
<td>37</td>
<td>14</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Merit</td>
<td>26</td>
<td>21</td>
<td>49</td>
<td>4</td>
</tr>
<tr>
<td>Pricing</td>
<td>11</td>
<td>18</td>
<td>68</td>
<td>3</td>
</tr>
<tr>
<td>Lottery</td>
<td>6</td>
<td>15</td>
<td>76</td>
<td>3</td>
</tr>
</tbody>
</table>

The most favoured mechanism amongst Mt McKinley backpackers was queuing, with moderate levels of support for advance reservations and merit, and little support for pricing or lotteries. The support for queuing is curious given the long distances many people travelled to the park, but is explained by the existence of a first-come, first-served permit allocation system.

New Zealand hunters, who generally favoured rationing use to increase deer numbers, were surveyed to determine preferred rationing methods by Nugent and Mawhinney (1987). The preferences for the sample of 335 hunters were:

- Permit reduction 34%
- 1-2 year closure 25%
- Stags only 23%
- Difficult access 9%
- Fees 1%
- Other 8%

Hunters showed a strong dislike of fees and of difficulty of access. This is understandable when it is considered that in either case the additional surplus realised from increased kill rates is dispersed for most hunters, either as cash or as sweat. The more favoured
options return all the benefits of the rationing to the hunters, except under the stag-only option where trophy hunters undoubtedly benefit, but meat hunters do not necessarily.

In accordance with Groome et al. (1983), Nugent and Mawhinney (1987) found that hunters preferred the resource allocation method that was already in place and that they were familiar with. These findings concur with those of the North American researchers reviewed earlier (Bultena et al., 1981; McCool and Utter, 1982; Shelby et al., 1982).

The foregoing studies illustrate that it is not possible to predict consumer acceptability of rationing methods from a theoretical analysis of the distribution of benefits. Choices are not uniform across or within activities. For example, Mt McKinley backpackers showed strong opposition to pricing, while Eagle Cap and Mt Jefferson backpackers found the system acceptable and were willing to try it.

People tend to favour rationing systems that they are familiar with from previous experience. It is likely that notions of fairness influence consumer choices of allocation techniques, and it does not necessarily follow that because (say) pricing delivers fewer consumer benefits than a lottery or advance reservations that it will be a less favoured mechanism. Further, there is the issue of uncertainty and risk. Under pricing and advance reservation mechanisms consumers can be certain of access and its cost, or can insure themselves from being precluded access. Risk-averse individuals will therefore discount the costs imposed by these methods to some degree.
7 Choice of an allocation mechanism

7.1 Management objectives

This report does not address the choice of objectives, it endeavours only to look at various methods for achieving some objectives, and to analyse the sorts of impacts expected. However, it is apparent that resource managers are influenced by many factors. Some of these will bear upon the actions of managers by restricting choices, or by the provision of incentives to act in particular ways. These factors may cause the agency to act in some 'socially non-optimal' way when judged against a different set of criteria. Some of the more important factors are now summarised as a list of questions that the agency may pose itself before choosing a strategy.

(1) What information is available?
(2) Who owns or has rights to the resource?
(3) What legal constraints exist?
(4) What political constraints exist?
(5) Do resource recipients have opportunities to re-sell or trade in the resource?
(6) Who bears the management costs?
(7) Who obtains the resource rents?
(8) How will managerial performance be judged and rewarded?
(9) Are there any target groups that should obtain preferential access to the resource?
(10) Are there other objectives?

The responses to questions 1-6 are primarily important for determining what tools are available to the manager, although they may also influence objectives, while questions 7-10 are primarily influential in determining management objectives.

7.1.1 Factors primarily influencing option availability

(i) What information is available?
A major factor limiting the range of tools at the management agency's disposal is the amount of information available about consumer demand for the rationed good. This is not a major problem for non-market tools. No demand information is needed to implement lottery, queuing, or reservation systems. However, when a resource is to be allocated using effort or merit rationing the management agency must be aware of total
demand for the good, in terms of effort or ability to meet the merit requirements, before being able to set a standard that will produce the required level of consumption. These levels could, of course, eventually be found by trial and error.

Market tools are more information-sensitive. The only market tools that are applicable without any demand information are auction mechanisms and coupon/voucher rationing. Some market techniques require information on aggregate demand only. For example, competitive prices and uniform revenue-maximising prices can be determined from this information. Pricing techniques that have superior revenue-earning abilities require more information. Demand functions for sub-groups are necessary to allow implementation of second- and third-degree price discrimination and reallocation via coupons and vouchers, while individual demand functions are needed for perfect price discrimination.

Information requirements are shown in Table 7.1.

Table 7.1: Information requirements of various market and non-market tools.

<table>
<thead>
<tr>
<th>Demand information available</th>
<th>Non-market</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Lotteries</td>
<td>Auctions</td>
</tr>
<tr>
<td></td>
<td>Queues</td>
<td>Coupons</td>
</tr>
<tr>
<td></td>
<td>Reservations</td>
<td>Vouchers</td>
</tr>
<tr>
<td>Aggregate demand</td>
<td>Above plus,</td>
<td>Above plus,</td>
</tr>
<tr>
<td></td>
<td>Effort</td>
<td>Competitive pricing</td>
</tr>
<tr>
<td></td>
<td>Merit</td>
<td>Revenue-maximising pricing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lotteries with fees</td>
</tr>
<tr>
<td>Aggregated demand for sub-groups</td>
<td>All above</td>
<td>Above plus,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Block tariffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two-part tariffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Third-degree price discrimination</td>
</tr>
<tr>
<td>Individual demand</td>
<td>All above</td>
<td>Above plus,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perfect price discrimination</td>
</tr>
</tbody>
</table>
These information requirements represent a constraint upon the choices available to the resource distributing agency. However, even when there is little information available the agency retains a long list of options for resource allocation, and hence retains the ability to influence the distribution of welfare.

(ii) Who owns the resource?
This publication has dealt exclusively with new allocations. At the outset we used the assumption that the allocating agency had secure rights to the resources being distributed. This assumption clearly does not always hold. It is commonly violated in cases where rights have been ceded in perpetuity, or in some long-term arrangement, and becomes important when it is desired to reallocate or reduce the total allocation of the good. Increases in the allocation do not pose a problem, since they may be treated as new allocations.

Examples of areas in which long-term rights arrangements have been, or are likely to be, altered include pastoral leases, water rights, and individual transferable quotas for marine fish. In such cases the resource allocation agency has two major options, it may (i) convince right holders to freely renounce or transfer their rights through trade or persuasion, or (ii) obtain the rights through coercion, which may require special legislation. The management agency may not have the financial resources to obtain the rights it is seeking, leading it towards compulsory acquisition policies where these are legally and politically viable.

The first course of action poses no particular problem. Because actions are undertaken voluntarily they comply with requirements for procedural justice and efficiency. They may have some negative outcome equity impacts, however. Coercion poses problems in the realm of procedural justice, and may be inefficient. Since some individuals are forced into actions against their will, this approach will often be judged to be unfair. The desirability of such a course of action depends upon the reason(s) for wanting the reallocation in the first place. These may be concerns for efficiency, outcome equity (including intergenerational equity), environmental, or other matters. The desirability of compromising procedural justice criteria can only be judged against the desirability of meeting the criteria motivating the proposed change.

(iii) What legal constraints exist?
The resource manager may not have freedom to choose management objectives, but may be required to allocate the resource according to some legally defined procedure, or to meet some objective defined in legislation. Many Acts of Parliament determine who has
access to resources, how those resources may be used, how much can be allocated to one person, whether the resource may be traded, and what trading practices may be employed. For example, the National Parks Act 1980 outlines situations in which access to national parks may be controlled and limits the control mechanisms available to managers by stipulating that access must be free.

Further constraints exist in legislation designed to limit the range of allocation procedures available to anyone. The most relevant New Zealand legislation is the Commerce Act 1986, which primarily limits actions that increase market power, and therefore the ability to apply discriminatory pricing practices. Section 36 of the Commerce Act places restrictions on use of market dominance, but does not, *per se*, preclude any of the allocation practices discussed here.

(iv) What political constraints exist?
While a manager may possess sufficient information to implement particular allocation schemes, and have the legal ability to do so, some schemes may still be judged politically undesirable. While this is an especially important factor for elected managers, it can also act as a constraint on appointed officials.

(v) Opportunities for re-sale
Our review of the implications of coupons and vouchers highlighted the implications of the ability to re-sell rationed resources, or access to them. In general, the ability to re-sell results in Pareto improvements in welfare. This conclusion does not necessarily hold in the instances where (1) the recipients do not have full information on the merits of the good to them, (2) externalities exist, or (3) the recipient does not have the ability to retain their rights to the good. Examples of these cases would be: resale of medical aid when the recipients of that aid do not understand the nature of the disease they are exposed to, wartime trade in foodstuffs required for health and high productivity, and parental sale or use of assistance allocated to children. Inability to prevent black markets (or unwillingness to preclude white markets) may result in unwanted redistribution of benefits which can prevent desired outcomes from occurring. The presence of middle-people may present a false picture of the existence of any externalities associated with final uses of the resource.

(vi) Who bears the management costs?
This question is central to choice of management strategy, especially in times of budget restraints. When a management agency has to cover management costs from 'user pays' systems it will be forced to adopt some form of market allocation mechanism. If
management costs are high, efficient allocation mechanisms may be precluded because of their inability to meet revenue requirements. This publication has not addressed the issue of management costs closely, but they are clearly a central element in the overall efficiency and distributional impacts of any allocation scheme.

(vii) Who bears the risk?
Risk and uncertainty are common in dealings associated with natural resources. Sources of risk and uncertainty are manifold, including lack of knowledge about demand for raw materials and final products, the quantity and quality of the resource, the costs of resource extraction, weather conditions, and so on. Different rationing schemes result in different risk allocations. Some place the risk on the seller/distributor, some on the user, and some on the resource. These differences arise from the type of risk as well as the ability to reallocate demand. For example, suppose there is a risk of supply shortfalls (e.g. in water allocations during a drought). Unless there is some contingency plan for reallocations, lotteries and advance reservations that occurred before the shortfall was apparent will result in the need for a revised rationing regime. Failure to implement a new scheme may result in unwanted environmental impacts (e.g. fish deaths if too much water is withdrawn) or user conflict when supply fails to meet allocated demand. On the other hand, daily sales, whether by auction, competitive, or discriminatory sale, do not result in these problems. However, discriminatory, monopolistic, and competitive pricing is not well suited to conditions where demand varies greatly. A competitive price one day may result in either excess or insufficient demand on other days.

7.1.2 Factors primarily important in determining manager objectives
In the public sector the basic objectives for managers are determined to a large extent by legislation and/or government directive, however, other factors also influence the ways in which managers act.

(i) Who obtains the resource rents?
Distribution of rents will act as an influence in determining manager objectives. In cases where managers (or their agencies) retain rights over rents there is a wider range of possible objectives, and a greater probability of market allocation mechanisms being adopted. Ability to retain rents enables managers to pursue objectives such as profit maximisation, revenue maximisation, subsidisation of other activities, and so on.

(ii) How will managerial performance be judged and rewarded?
This may be the most important issue affecting management of resources. Managerial performance may be judged on profits earned, popularity of agency actions, number of
people served, number of people employed, revenue generated, costs incurred, or any combination of these and other criteria. Managers may be compensated for their efforts with a fixed salary, status, publicity, profit shares, or bonuses. The interaction of judgement and reward mechanisms, along with the manager's personality may largely influence the type of actions implemented.

(iii) Target groups
Many resource allocation agencies are given resources to assist particular groups or interests. Examples include: Department of Social Welfare, Intellectually Handicapper Children, Crippled Childrens' Society, Department of Maori Affairs, Ministry of Womens' Affairs, and Department of Conservation. Other agencies, such as regional and territorial authorities, have greater freedom to choose their own target groups, although these agencies may still be required by national government policy directives to target specific groups.

(iv) Other objectives
This publication has measured efficiency strictly in terms of willingness to pay. By doing so we have precluded any distortionary effects caused by externalities. Clearly there are some cases where end uses may have external effects that influence efficiency of resource use, even though they do not influence the end user's willingness to pay. Oft-cited cases include differential flow-on and employment creation effects of alternative end uses. These impacts may be the sole justification for selection of particular resource allocation strategies. Clearly, external effects can also have strong re-distributional impacts as costs and benefits are bestowed upon people outside the direct resource allocation process.

7.2 Mechanisms for particular objectives

7.2.1 Efficiency
When operated perfectly, several tools result in efficient resource allocations. Those tools are:

(1) competitive pricing;
(2) perfect price discrimination;
(3) single unit, English auctions;
(4) simultaneous, n+1\textsuperscript{st} price auctions;
(5) Groves auctions;
(6) saleable coupons and vouchers.
It is not possible to derive a complete ranking of the efficiency of other tools without information on the aggregate demand function. It must be stressed that although these allocation techniques are all efficient, they do not result in identical outcomes. For example, saleable coupons and vouchers confer windfall gains on those to whom the coupons or vouchers are initially distributed. A Pareto optimal result will be achieved relative to this distribution of welfare after trade in the coupons or vouchers. Total benefits will, in general, differ from total benefits obtained under the other efficient allocation systems. A choice amongst the set of Pareto efficient outcomes can only be made with reference to the social welfare function - in other words, by comparison of distributional impacts.

7.2.2 Revenue generation

Merit and effort are two allocation tools that never produce any revenue for the administering agency (unless the agency charges fees above average cost to sit 'proficiency tests', or determines merit by value of 'donations' to the agency). In their pure forms lotteries, queues, advance reservations, and vouchers produce no revenue. Allocation systems that are self-funding, or that are designed to earn profits, will never employ any of these tools in their pure forms. Revenue-earning tools may be ranked according to their ability to generate funds for the resource administering agency.

Impure forms of non-revenue-generating tools produce less revenue than the revenue generating tool that creates the impurity. For example, if a queue is used in conjunction with competitive pricing the market clearing price will be lower than pure competitive pricing since some people who are willing to pay higher prices are eliminated by the queue. This occurs because the market has already been reduced by the presence of the non-revenue-generating tool, and because that reduction will not generally eliminate from the market only those willing to pay the lowest dollar amounts.

<table>
<thead>
<tr>
<th>No revenue</th>
<th>Lotteries/queues/advance reservations/vouchers/merit/effort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>↓</td>
</tr>
<tr>
<td>Little revenue</td>
<td>Auctions/non-transferable coupons</td>
</tr>
<tr>
<td></td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Competitive pricing/transferable coupons</td>
</tr>
<tr>
<td></td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Single-price revenue maximisation</td>
</tr>
<tr>
<td></td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Third-degree price discrimination</td>
</tr>
<tr>
<td></td>
<td>↓</td>
</tr>
<tr>
<td></td>
<td>Second-degree price discrimination</td>
</tr>
<tr>
<td>Most revenue</td>
<td>Perfect price discrimination</td>
</tr>
</tbody>
</table>

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7.2.3 **Consumer benefits**

Consumers receive no benefits under perfect price discrimination, however if perfect discrimination is employed without pricing [a form of merit allocation] consumers (in aggregate) receive maximum benefits.

When a fixed quantity is to be allocated it is possible to rank consumer benefits from some market allocation procedures and the lottery. Without knowledge of the distribution of the costs associated with non-market allocation mechanisms it is not possible to rank the consumer benefits of these methods.

<table>
<thead>
<tr>
<th>No consumer benefits</th>
<th>Perfect price discrimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓</td>
<td>Second-degree price discrimination</td>
</tr>
<tr>
<td>↓</td>
<td>Third-degree price discrimination—Single-price revenue maximisation</td>
</tr>
<tr>
<td>↓</td>
<td>Competitive pricing—Single unit English auction</td>
</tr>
<tr>
<td>Most consumer benefits</td>
<td>Lottery—Groves auction</td>
</tr>
</tbody>
</table>

Because the Groves auction is efficient, but individuals face lower costs than competitive pricing, the Groves auction bestows more consumer benefits than competitive pricing. While both the lottery and the Groves auction bestow more consumer benefits than competitive pricing, there is no way to tell *a priori* which results in greater consumer benefits. This problem also exists with competitive pricing and single-unit English auctions, which are expected to provide approximately equal consumer benefits. This form of equivalence is denoted by ~ above.

7.2.4 **Summary**

It is now possible to determine a partial ranking for most allocation schemes according to the criteria of efficiency, revenue, and consumer benefits.
Table 7.2: Ranking for allocation schemes.

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Revenue</th>
<th>Consumer benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max.</td>
<td>First-degree price discrim.</td>
<td>Non-transferable vouchers,</td>
</tr>
<tr>
<td>Competitive pricing,</td>
<td>Second-degree price discrim.</td>
<td>Merit, Reservations,</td>
</tr>
<tr>
<td>Groves auction,</td>
<td>Third-degree price discrim.</td>
<td>Auctions, Lottery,</td>
</tr>
<tr>
<td>Transferable vouchers,</td>
<td>Single-price revenue max.</td>
<td>Non-transferable coupons,</td>
</tr>
<tr>
<td>Transferable coupons,</td>
<td>Competitive pricing,</td>
<td>Competitive pricing,</td>
</tr>
<tr>
<td>First-degree price discrim.</td>
<td>Transferable coupons.</td>
<td>Transferable coupons,</td>
</tr>
<tr>
<td>Auditions, Lottery, Merit,</td>
<td>Non-transferable coupons</td>
<td>Auctions, Non-transferable coupons,</td>
</tr>
<tr>
<td>Non-transferable coupons,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second-degree price discrim.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>*First-degree price discrim.</td>
<td></td>
</tr>
</tbody>
</table>

* Benefit measure equals zero
1 Solid lines indicate methods producing identical benefits
2 Arrowed lines indicate groups of methods which are not directly comparable on the benefit criterion. The arrows indicate the likely range within which the ranks are likely to fall. Order within the group is irrelevant.

7.2.5 *Distributional implications*

Inability to measure equity or fairness ensures that ranking allocation tools with respect to distributional matters can never be a simple task. The best that can be done is to indicate which groups do (or do not) obtain the good and who pays for the good when different allocation tools are used (Table 7.3).
The favoured group column identifies the groups receiving benefits from the allocation method. Most market allocation methods bestow benefits upon 'those willing and able to pay' and 'rent receivers'. The former category refers to the consumer surplus benefits obtained by users, but is cognisant of the reality that desire to consume is constrained by ability to pay the market price. The second category recognises that these allocation methods bestow rents whenever revenue is greater than cost of supply. Therefore, whenever profit is earned, rent receivers are favoured in that they obtain profits.

The group paying column indicates who pays for provision of the goods. Under market allocation methods this is generally the resource user, while for non-market allocation methods it is generally the resource owner (i.e. the Crown, the taxpayer, or residents of the region). This occurs because there is no means of directly compensating the resource owner for supply of the good. Any costs of provision are therefore borne by the resource owner/users.

### Table 7.3: Groups obtaining and paying for the good when different allocation tools are used.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Group favoured</th>
<th>Group paying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merit</td>
<td>Target group</td>
<td>Resource owners</td>
</tr>
<tr>
<td>Effort</td>
<td>Physically fit and skilled</td>
<td>Resource owners</td>
</tr>
<tr>
<td>Lottery</td>
<td>Advance planners</td>
<td>Resource owners</td>
</tr>
<tr>
<td>Queue</td>
<td>Low value on time</td>
<td>Resource owners</td>
</tr>
<tr>
<td>Advance reservation</td>
<td>Longer planning horizons</td>
<td>Resource owners</td>
</tr>
<tr>
<td>Coupons (i) non-tradeable</td>
<td>Target group</td>
<td>Resource owners</td>
</tr>
<tr>
<td></td>
<td>(ii) tradeable</td>
<td>Resource owners</td>
</tr>
<tr>
<td></td>
<td>Target group/those willing and able to pay Rent receivers</td>
<td>Resource owners/users</td>
</tr>
<tr>
<td>Vouchers (i) non-tradeable</td>
<td>Target group</td>
<td>Resource owners</td>
</tr>
<tr>
<td></td>
<td>(ii) tradeable</td>
<td>Resource owners</td>
</tr>
<tr>
<td></td>
<td>Target group/those willing and able to pay Rent receivers</td>
<td>Resource owners/users</td>
</tr>
<tr>
<td>Competitive pricing</td>
<td>Those willing and able to pay/Rent receivers</td>
<td>Resource users</td>
</tr>
<tr>
<td>Monopolistic pricing</td>
<td>Those willing and able to pay/Rent receivers</td>
<td>Resource users</td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; degree price discrim.</td>
<td>Rent receivers</td>
<td>Resource users</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; degree price discrim.</td>
<td>Those willing and able to pay/Rent receivers</td>
<td>Resource users</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; degree price discrim.</td>
<td>Those willing and able to pay/Rent receivers</td>
<td>Resource users</td>
</tr>
<tr>
<td>Groves auction</td>
<td>Those willing and able to pay/Rent receivers</td>
<td>Resource owners/users?</td>
</tr>
<tr>
<td>Other auctions</td>
<td>Those willing and able to pay/Rent receivers</td>
<td>Resource users</td>
</tr>
</tbody>
</table>
owners. In cases of positive externalities the resource owners may be compensated via the external effects. Examples arise in taxpayer-funded health expenditures and provision of recreational facilities.

There are questions associated with costs and benefits of the Groves auction mechanism because the revenue generated by this system is low compared with other market mechanisms, implying that it may not be possible to cover supply costs and that resource owners subsidise the users. Because payments are not directly related to bids under this allocation procedure, ability to pay is less of a constraint than under other market methods, especially when demand is elastic.

### 7.3 Case study

To help indicate the sorts of impacts that result from application of some of the different allocation mechanisms we will now proceed to an example. There are 20 units of a resource to be allocated between two groups, a rich group and a poor group. There are equal numbers of identical individuals in each group. It is possible to deal with individual allocations, but for simplicity we will deal with group aggregates in most instances. If one wishes to determine the allocation to any individual it is a simple matter of dividing aggregate allocations by the number in the group. Prices are identical for all members of a group. To simplify analysis we assume that the good is infinitely divisible, allowing us to deal in fractions of units. This would be the case if we thought of each unit of the resource as, say, one million cubic metres of gravel.

The demand and inverse demand functions for each group are:

- **Rich group:** \( X_R = 25 - p/4 \) \( \rightarrow p = 100 - 4X_R \)
- **Poor group:** \( X_p = 12 - p/5 \) \( \rightarrow p = 60 - 5X_p \)

The aggregate demand function is then:

\[
X = 25 - p/4 \quad 100 \geq p \geq 60
\]

and

\[
X = 37 - 9p/30 \quad 60 \geq p \geq 0
\]
The outcomes are presented in Table 7.4. The mathematical derivation of the outcomes is not presented here, readers are left to verify these for themselves. The example should indicate, however, the range of distributional outcomes attainable and the efficiency costs of obtaining some outcomes (ignoring transaction costs). While total benefits do not vary greatly for this example, this small variance should not be accepted as typical. The variance in total benefits (and distribution of benefits) is a function of the nature of the demand curves.

Table 7.4: Outcomes of allocation methods in a hypothetical case study.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Quantities</th>
<th></th>
<th>Consumers surplus</th>
<th>Revenue</th>
<th>Total benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive pricing</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>484</td>
</tr>
<tr>
<td>Monopolist pricing</td>
<td>14.72</td>
<td>3.78</td>
<td>14.72</td>
<td>3.78</td>
<td>433</td>
</tr>
<tr>
<td>Perfect discrimination</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>0</td>
</tr>
<tr>
<td>Third-degree discrimination</td>
<td>13.51</td>
<td>6.49</td>
<td>13.51</td>
<td>6.49</td>
<td>365</td>
</tr>
<tr>
<td>Two-part tariff (disc.)</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>0</td>
</tr>
<tr>
<td>Two-part tariff (non-disc.)</td>
<td>20.00</td>
<td>0.00</td>
<td>20.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Block tariff (all in)</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>460</td>
</tr>
<tr>
<td>Block tariff (exclusion)</td>
<td>20.00</td>
<td>0.00</td>
<td>20.00</td>
<td>0.00</td>
<td>400</td>
</tr>
<tr>
<td>Lottery</td>
<td>13.51</td>
<td>6.49</td>
<td>13.51</td>
<td>6.49</td>
<td>675</td>
</tr>
<tr>
<td>Vouchers (non-trans.)</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>700</td>
</tr>
<tr>
<td>Vouchers (transferable)</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>862</td>
</tr>
<tr>
<td>Coupons (non-trans.)</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>700</td>
</tr>
<tr>
<td>Coupons (transferable)</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>330</td>
</tr>
<tr>
<td>Groves auction</td>
<td>15.56</td>
<td>4.44</td>
<td>15.56</td>
<td>4.44</td>
<td>929</td>
</tr>
</tbody>
</table>

Notes:
1. Monopolist pricing is single price revenue maximisation.
2. Two-part tariff (disc) is the variant allowing discrimination in entrance fees, while two-part tariff (non-disc) does not allow discrimination on entrance fees.
3. Block tariff (all in) has the block prices set so that no individual is excluded from the market, whereas Block tariff (exclusion) does not include this restriction.
4. The consumer surplus estimates for transferable coupons and vouchers are based upon an assumption of competitive trading. There may be some transfer of surplus between groups according to the actual prices infra-marginal units are sold at. The transferable coupon example assumes that the vendor of the good increases prices to extract consumer surplus after all coupons have been transferred to the highest valuing consumers.
It is not possible to include all of the non-market allocation schemes in this analysis. For example, we have no information on the distribution of the costs of queuing, or the distribution of ability to meet merit requirements, plan in advance, or supply effort.

This example highlights some interesting outcomes. Many different schemes are efficient (all schemes with total benefits of $1289 are efficient in this case). Given the homogeneity within user groups and our perfect demand information, the discriminatory two-part tariff and the non-exclusive block tariff techniques appear efficient. In real applications these methods are unlikely to be efficient since groups are not homogeneous. In other words, not all ‘rich people’ have identical demand functions, although they may be similar and distinctly different from those of ‘poor people’.

Several approaches eliminate all benefits to some agents. The resource distributor obtains no revenue if a pure lottery or pure vouchers are used, while consumers obtain no benefits under perfect discrimination and two-part tariffs when these are applied perfectly. The pricing schemes adopted by monopolists to increase their profits (revenue in this case) relative to the competitive pricing case range from monopolist pricing through exclusive block tariffs. These schemes all result in a reduction of benefits to consumers, in some cases eliminating all benefits to specific groups, although third-degree price discrimination actually results in an improvement of welfare for poor people.

Those tools that are primarily designed to be used as consumer welfare instruments (coupons, vouchers) result in reduced income for the distributing agency. Transferability of vouchers improves the welfare of all consumers, resulting in an efficient allocation of resources. The outcome under transferable coupons is determined to a large extent by the actions of the resource distributing agency. After the coupons have been transferred the distributor has the option of increasing prices to obtain access to the gains from trade. This results in an efficient allocation, with aggregate consumers’ surplus being identical to the competitive market case. There is, however, a shift in the distribution of that consumers’ surplus from rich people to poor people. All of these ‘redistributive’ tools result in dramatic increases in the welfare of the poor group.

There is no dominant tool. A gain in one area implies a loss in some other area. Some tools do dominate others, however. For example, the exclusive block tariff is dominated by the non-exclusive block tariff in this case. This finding will not always hold. The lottery is dominated by non-transferable coupons and both types of voucher. This finding only occurs because of the specific (equal) distribution of vouchers and coupons in this example. The discriminatory two-part tariff dominates the non-discriminating alternative.
If the distributing agency is seeking to maximise profits it will use one of the discriminatory pricing schemes. Only if the distributor has perfect demand information will these schemes be efficient, and then consumers will not obtain any benefits. Consumers clearly prefer the voucher, coupon, and lottery options. The Groves auction is preferred by all consumers to the competitive pricing strategy, although it places greater costs on consumers who must consider their full demand functions rather than simply concentrate on the margins as they are able to do under competitive pricing.

7.4 Conclusions

Choice of an optimal resource allocation mechanism is a complex matter. An agency can choose from only a sub-set of tools because of practical, legal, and political constraints over which it may have no control. The agency is then required to choose a tool from a set of tools; these tools differ immensely in their performance on several major evaluative criteria. Making a choice involves a decision on the relative rankings of these criteria and the willingness to sacrifice performance on any one to obtain improvements on any other(s). Selection of a tool therefore indicates the agency's objectives to some extent when the staff of the agency understand the impacts of the set of tools.
References


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